ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 86 and 600

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Parts 531, 533, 537, and 538

[EPA–HQ–OAR–2009–0472; FRL–8959–4; NHTSA–2009–0059]

RIN 2060–AP58; RIN 2127–AK90

Proposed Rulemaking To Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards

AGENCY: Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA).

ACTION: Proposed rule.

SUMMARY: EPA and NHTSA are issuing this joint proposal to establish a National Program consisting of new standards for light-duty vehicles that will reduce greenhouse gas emissions and improve fuel economy. This joint proposed rulemaking is consistent with the National Fuel Efficiency Policy announced by President Obama on May 19, 2009, responding to the country's critical need to address global climate change and to reduce oil consumption. EPA is proposing greenhouse gas emissions standards under the Clean Air Act, and NHTSA is proposing Corporate Average Fuel Economy standards under the Energy Policy and Conservation Act, as amended. These standards apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles, covering model years 2012 through 2016, and represent a harmonized and consistent National Program. Under the National Program, automobile manufacturers would be able to build a single light-duty national fleet that satisfies all requirements under both programs while ensuring that consumers still have a full range of vehicle choices.

FOR FURTHER INFORMATION CONTACT: *Comments:* Comments must be received on or before November 27, 2009. Under the Paperwork Reduction Act, comments on the information collection provisions must be received by the Office of Management and Budget (OMB) on or before October 28, 2009. See the **SUPPLEMENTARY INFORMATION** section on ''Public Participation'' for more information about written comments.

Hearings: NHTSA and EPA will jointly hold three public hearings on the following dates: October 21, 2009 in Detroit, Michigan; October 23, 2009 in New York, New York; and October 27, 2009 in Los Angeles, California. EPA and NHTSA will announce the addresses for each hearing location in a supplemental **Federal Register** Notice. The hearings will start at 9 a.m. local time and continue until everyone has had a chance to speak. See the **SUPPLEMENTARY INFORMATION** section on ''Public Participation'' for more information about the public hearings.

ADDRESSES: Submit your comments, identified by Docket ID No. EPA–HQ–OAR–2009–0472 and/or NHTSA–2009–0059, by one of the following methods:

- *www.regulations.gov:* Follow the on-line instructions for submitting comments.
- *E-mail: a-and-r-Docket@epa.gov.*
- *Fax:* EPA: (202) 566–1741; NHTSA: (202) 493–2251.
- *Mail:*
  - *EPA:* Environmental Protection Agency, EPA Docket Center (EPA/DC), Air and Radiation Docket, Mail Code 2822T, 1200 Pennsylvania Avenue, NW., Washington, DC 20460, Attention Docket ID No. EPA–HQ–OAR–2009–0472. 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.
  - *NHTSA:* Docket Management Facility, M–30, U.S. Department of Transportation, West Building, Ground Floor, Rm. W12–140, 1200 New Jersey Avenue, SE., Washington, DC 20590.
- *Hand Delivery:*
  - *EPA:* Docket Center, (EPA/DC) EPA West, Room B102, 1301 Constitution Ave., NW., Washington, DC, Attention Docket ID No. EPA–HQ–OAR–2009–0472. Such deliveries are only accepted during the Docket's normal hours of operation, and special arrangements should be made for deliveries of boxed information.
  - *NHTSA:* West Building, Ground Floor, Rm. W12–140, 1200 New Jersey Avenue, SE., Washington, DC 20590, between 9 a.m. and 5 p.m. Eastern Time, Monday through Friday, except Federal Holidays.

Instructions: Direct your comments to Docket ID No. EPA–HQ–OAR–2009–0472 and/or NHTSA–2009–0059. See the **SUPPLEMENTARY INFORMATION** section on ''Public Participation'' for more information about submitting written comments.

Public Hearing: NHTSA and EPA will jointly hold three public hearings on the following dates: October 21, 2009 in Detroit, Michigan; October 23, 2009 in New York, New York; and October 27, 2009 in Los Angeles, California. EPA and NHTSA will announce the addresses for each hearing location in a supplemental **Federal Register** Notice. *See* the **SUPPLEMENTARY INFORMATION** section on ''Public Participation'' for more information about the public hearings.

Docket: All documents in the dockets are listed in the *www.regulations.gov* index. Although listed in the index, some information is not publicly available, *e.g.,* confidential business information (CBI) or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in *www.regulations.gov* or in hard copy at the following locations: *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 Public Reading Room is (202) 566–1744. 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.

FOR FURTHER INFORMATION CONTACT: *EPA:* Tad Wysor, Office of Transportation and Air Quality, Assessment and Standards Division, Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor MI 48105; telephone number: 734–214–4332; fax number: 734–214–4816; e-mail address: *wysor.tad@epa.gov,* or Assessment and Standards Division Hotline; telephone number (734) 214–4636; e-mail address *asdinfo@epa.gov. NHTSA:* Rebecca Yoon, Office of Chief Counsel, National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE., Washington, DC 20590. Telephone: (202) 366–2992.

SUPPLEMENTARY INFORMATION:

A. Does This Action Apply to Me?

This action affects companies that manufacture or sell new light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles, as defined under EPA's CAA regulations,[1]

[1] ''Light-duty vehicle,'' ''light-duty truck,'' and ''medium-duty passenger vehicle'' are defined in 40 CFR 86.1803–01. Generally, the term ''light-duty

and passenger automobiles (passenger cars) and non-passenger automobiles (light trucks) as defined under NHTSA's CAFE regulations.[2] Regulated categories and entities include:

Category	NAICS codes [A]	Examples of potentially regulated entities
Industry	336111 336112	Motor vehicle manufacturers.
Industry	811112 811198 541514	Commercial Importers of Vehicles and Vehicle Components.

[A] North American Industry Classification System (NAICS).

This list is not intended to be exhaustive, but rather provides a guide regarding entities likely to be regulated by this action. To determine whether particular activities may be regulated by this action, you should carefully examine the regulations. You may direct questions regarding the applicability of this action to the person listed in **FOR FURTHER INFORMATION CONTACT**.

B. Public Participation

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

How Do I Prepare and Submit Comments?

In this joint proposal, there are many issues common to both EPA's and NHTSA's proposals. For the convenience of all parties, comments submitted to the EPA docket will be considered comments submitted to the NHTSA docket, and vice versa. An exception is that comments submitted to the NHTSA docket on 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.

EPA: Direct your comments to Docket ID No EPA–HQ–OAR–2009–0472. EPA's policy is that all comments received will be included in the public docket without change and may be made available online at *www.regulations.gov*, including any personal information provided, unless the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through *www.regulations.gov* or e-mail. The *www.regulations.gov* Web site is an ''anonymous access'' system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an e-mail comment directly to EPA without going through *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*.

NHTSA: Your comments must be written and in English. To ensure that your comments are correctly filed in the Docket, please include the Docket number NHTSA–2009–0059 in your comments. Your comments must not be more than 15 pages long.[3] 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 length of the attachments. If you are submitting comments electronically as a PDF (Adobe) file, we ask that the documents submitted be scanned using the Optical Character Recognition (OCR) process, thus allowing the agencies to search and copy certain portions of your submissions.[4] 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 guidelines. Accordingly, we encourage you to consult the guidelines in preparing your comments. OMB's guidelines may be accessed at *http://www.whitehouse.gov/omb/fedreg/reproducible.html*. DOT's guidelines may be accessed at *http://www.dot.gov/dataquality.htm*.

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 agency may ask you to respond to specific questions or organize comments by referencing a Code of Federal Regulations (CFR) part or section number.

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

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

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

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

vehicle'' means a passenger car, the term ''light-duty truck'' means a pick-up truck, sport-utility vehicle, or minivan of up to 8,500 lbs gross vehicle weight rating, and ''medium-duty passenger vehicle'' means a sport-utility vehicle or passenger van from 8,500 to 10,000 lbs gross vehicle weight rating. Medium-duty passenger vehicles do not include pick-up trucks.

[2] ''Passenger car'' and ''light truck'' are defined in 49 CFR part 523.

[3] *See* 49 CFR 553.21.

[4] 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.

• 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.

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.

How Do I Submit Confidential Business Information?

Any confidential business information (CBI) submitted to one of the agencies will also be available to the other agency. However, as with all public comments, any CBI information only needs to be submitted to either one of the agencies' dockets and it will be available to the other. Following are specific instructions for submitting CBI to either agency.

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 information in a disk or CD–ROM that you mail to EPA, mark the outside of the disk or CD–ROM as CBI and then identify electronically within the disk or CD–ROM the specific information that is claimed as CBI. In addition to one complete version of the comment that includes information claimed as CBI, a copy of the comment that does not contain the information claimed as CBI must be submitted for inclusion in the public docket. Information so marked will not be disclosed except in accordance with procedures set forth in 40 CFR part 2.

NHTSA: If you wish to submit any information under a claim of confidentiality, you should submit three copies of your complete submission, including the information you claim to be confidential business information, to the Chief Counsel, NHTSA, at the address given above under **FOR FURTHER INFORMATION CONTACT**. When you send a comment containing confidential business information, you should include a cover letter setting forth the information specified in our confidential business information regulation.[5]

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

[5] *See* 49 CFR part 512.

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 rule. However, the agencies' ability to consider any such late comments in this rulemaking will be limited due to the time frame for issuing a final rule.

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

How Can I Read the Comments Submitted by Other People?

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

How Do I Participate in the Public Hearings?

NHTSA and EPA will jointly host three public hearings on the dates and locations described in the **DATES** and **ADDRESSES** sections above.

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

The 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.

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

Table of Contents

I. Overview of Joint EPA/NHTSA National Program

A. Introduction

The National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA) are each announcing proposed rules whose benefits would address the urgent and closely intertwined challenges of energy independence and security and global warming. These proposed rules call for a strong and coordinated *Federal* greenhouse gas and fuel economy program for passenger cars, light-duty-trucks, and medium-duty passenger vehicles (hereafter light-duty vehicles), referred to as the National Program. The proposed rules can achieve substantial reductions of greenhouse gas (GHG) emissions and improvements in fuel economy from the light-duty vehicle part of the transportation sector, based on technology that is already being commercially applied in most cases and that can be incorporated at a reasonable cost.

This joint notice is consistent with the President's announcement on May 19, 2009 of a National Fuel Efficiency Policy of establishing consistent, harmonized, and streamlined requirements that would reduce greenhouse gas emissions and improve fuel economy for all new cars and light-duty trucks sold in the United States.[6] The National Program holds out the promise of delivering additional environmental and energy benefits, cost savings, and administrative efficiencies on a nationwide basis that might not be available under a less coordinated approach. The proposed National Program also offers the prospect of regulatory convergence by making it possible for the standards of two different *Federal* agencies and the standards of California and other States to act in a unified fashion in providing these benefits. This would allow automakers to produce and sell a single fleet nationally. Thus, it may also help to mitigate the additional costs that manufacturers would otherwise face in having to comply with multiple sets of *Federal* and State standards. This joint notice is also consistent with the Notice of Upcoming Joint Rulemaking issued by DOT and EPA on May 19[7] and responds to the President's January 26, 2009 memorandum on CAFE standards for model years 2011 and beyond,[8] the details of which can be found in Section IV of this joint notice.

1. Building Blocks of the National Program

The National Program is both needed and possible because the relationship between improving fuel economy and reducing CO_2 tailpipe emissions is a very direct and close one. The amount of those CO_2 emissions is essentially constant per gallon combusted of a given type of fuel. Thus, the more fuel efficient a vehicle is, the less fuel it burns to travel a given distance. The less fuel it burns, the less CO_2 it emits in traveling that distance.[9] While there are emission control technologies that reduce the pollutants (*e.g.,* carbon monoxide) produced by imperfect combustion of fuel by capturing or destroying them, there is no such technology for CO_2. Further, while some of those pollutants can also be reduced by achieving a more complete combustion of fuel, doing so only increases the tailpipe emissions of CO_2. Thus, there is a single pool of technologies for addressing these twin problems, *i.e.,* those that reduce fuel consumption and thereby reduce CO_2 emissions as well.

a. DOT's CAFE Program

In 1975, Congress enacted the Energy Policy and Conservation Act (EPCA), mandating that NHTSA establish and implement a regulatory program for motor vehicle fuel economy to meet the various facets of the need to conserve energy, including ones having energy independence and security, environmental and foreign policy implications. Fuel economy gains since 1975, due both to the standards and market factors, have resulted in saving billions of barrels of oil and avoiding billions of metric tons of CO_2 emissions. In December 2007, Congress enacted the Energy Independence and Securities Act (EISA), amending EPCA to require substantial, continuing increases in fuel economy standards.

The CAFE standards address most, but not all, of the real world CO_2 emissions because EPCA requires the use of 1975 passenger car test procedures under which vehicle air conditioners are not turned on during fuel economy testing.[10] Fuel economy is determined by measuring the amount of CO_2 and other carbon compounds emitted from the tailpipe, not by attempting to measure directly the amount of fuel consumed during a vehicle test, a difficult task to accomplish with precision. The carbon content of the test fuel[11] is then used to calculate the amount of fuel that had to be consumed per mile in order to

[6] President Obama Announces National Fuel Efficiency Policy, The White House, May 19, 2009. Available at: *http://www.whitehouse.gov/the_press_office/President-Obama-Announces-National-Fuel-Efficiency-Policy/* (last accessed August 18, 2009). Remarks by the President on National Fuel Efficiency Standards, The White House, May 19, 2009. Available at: *http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-on-national-fuel-efficiency-standards/* (Last accessed August 18, 2009).

[7] 74 FR 24007 (May 22, 2009).

[8] Available at: *http://www.whitehouse.gov/the_press_office/Presidential_Memorandum_Fuel_Economy/* (last accessed on August 18, 2009).

[9] Panel on Policy Implications of Greenhouse Warming, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, "Policy Implications of Greenhouse Warming: Mitigation, Adaptation, and the Science Base," National Academies Press, 1992. p. 287.

[10] EPCA does not require the use of 1975 test procedures for light trucks.

[11] This is the method that EPA uses to determine compliance with NHTSA's CAFE standards.

produce that amount of CO_2. Finally, that fuel consumption figure is converted into a miles-per-gallon figure. CAFE standards also do not address the 5–8 percent of GHG emissions that are not CO_2, *i.e.,* nitrous oxide (N_2O), and methane (CH_4) as well as emissions of CO_2 and hydrofluorocarbons (HFCs) related to operation of the air conditioning system.

b. EPA's Greenhouse Gas Standards for Light-Duty Vehicles

Under the Clean Air Act EPA is responsible for addressing air pollutants from motor vehicles. On April 2, 2007, the U.S. Supreme Court issued its opinion in *Massachusetts* v. *EPA,*[12] a case involving a 2003 order of the Environmental Protection Agency (EPA) denying a petition for rulemaking to regulate greenhouse gas emissions from motor vehicles under section 202(a) of the Clean Air Act (CAA).[13] The Court held that greenhouse gases were air pollutants for purposes of the Clean Air Act and further held that the Administrator must determine whether or not emissions from new motor vehicles cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, or whether the science is too uncertain to make a reasoned decision. The Court further ruled that, in making these decisions, the EPA Administrator is required to follow the language of section 202(a) of the CAA. The Court rejected the argument that EPA cannot regulate CO_2 from motor vehicles because to do so would *de facto* tighten fuel economy standards, authority over which has been assigned by Congress to DOT. The Court stated that ''[b]ut that DOT sets mileage standards in no way licenses EPA to shirk its environmental responsibilities. EPA has been charged with protecting the public's 'health' and 'welfare', a statutory obligation wholly independent of DOT's mandate to promote energy efficiency.'' The Court concluded that ''[t]he two obligations may overlap, but there is no reason to think the two agencies cannot both administer their obligations and yet avoid inconsistency.''[14] The Court remanded the case back to the Agency for reconsideration in light of its findings.[15]

EPA has since proposed to find that emissions of GHGs from new motor vehicles and motor vehicle engines cause or contribute to air pollution that may reasonably be anticipated to endanger public health and welfare.[16] This proposal represents the second phase of EPA's response to the Supreme Court's decision.

c. California Air Resources Board Greenhouse Gas Program

In 2004, the California Air Resources Board approved standards for new light-duty vehicles, which regulate the emission of not only CO_2, but also other GHGs. Since then, thirteen States and the District of Columbia, comprising approximately 40 percent of the light-duty vehicle market, have adopted California's standards. These standards apply to model years 2009 through 2016 and require CO_2 emissions for passenger cars and the smallest light trucks of 323 g/mi in 2009 and 205 g/mi in 2016, and for the remaining light trucks of 439 g/mi in 2009 and 332 g/mi in 2016. On June 30, 2009, EPA granted California's request for a waiver of preemption under the CAA.[17] The granting of the waiver permits California and the other States to proceed with implementing the California emission standards.

2. Joint Proposal for a National Program

On May 19, 2009, the Department of Transportation and the Environmental Protection Agency issued a Notice of Upcoming Joint Rulemaking to propose a strong and coordinated fuel economy and greenhouse gas National Program for Model Year (MY) 2012–2016 light duty vehicles.

B. Summary of the Joint Proposal

In this joint rulemaking, EPA is proposing GHG emissions standards under the Clean Air Act (CAA), and NHTSA is proposing Corporate Average Fuel Economy (CAFE) standards under the Energy Policy and Conservation Action of 1975 (EPCA), as amended by the Energy Independence and Security Act of 2007 (EISA). The intention of this joint rulemaking proposal is to set forth a carefully coordinated and harmonized approach to implementing these two statutes, in accordance with all substantive and procedural requirements imposed by law.

Climate change is widely viewed as the most significant long-term threat to the global environment. According to the Intergovernmental Panel on Climate Change, anthropogenic emissions of greenhouse gases are very likely (90 to 99 percent probability) the cause of most of the observed global warming over the last 50 years. The primary GHGs of concern are carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Mobile sources emitted 31.5 percent of all U.S. GHG in 2006, and have been the fastest-growing source of U.S. GHG since 1990. Light-duty vehicles emit four GHGs—CO_2, methane, nitrous oxide, and hydrofluorocarbons—and are responsible for nearly 60 percent of all mobile source GHGs. For Light-duty vehicles, CO_2 emissions represent about 95 percent of all greenhouse emissions, and the CO_2 emissions measured over the EPA tests used for fuel economy compliance represent over 90 percent of total light-duty vehicle greenhouse gas emissions.

Improving energy security by reducing our dependence on foreign oil 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 U.S., causing financial hardship for many families. The export of U.S. assets for oil imports continues to be an important component of the U.S.' historically unprecedented trade deficits. Transportation accounts for about two-thirds of U.S. petroleum consumption. Light-duty vehicles account for about 60 percent of transportation oil use, which means that they alone account for about 40 percent of all U.S. oil consumption.

NHTSA and EPA have coordinated closely and worked jointly in developing their respective proposals. This is reflected in many aspects of this joint proposal. For example, the agencies have developed a comprehensive joint Technical Support Document (TSD) that provides a solid technical underpinning for each agency's modeling and analysis used to support their proposed standards. Also, to the extent allowed by law, the agencies have harmonized many elements of program design, such as the form of the standard (the footprint-based attribute curves), and the definitions used for cars and trucks. They have developed the same or similar compliance flexibilities, to the extent allowed and appropriate under their

[12] 549 U.S. 497 (2007).

[13] 68 FR 52922 (Sept. 8, 2003).

[14] 549 U.S. at 531–32.

[15] For further information on *Massachusetts* v. *EPA* see the July 30, 2008 Advance Notice of Proposed Rulemaking, ''Regulating Greenhouse Gas Emissions under the Clean Air Act'', 73 FR 44354 at 44397. There is a comprehensive discussion of the litigation's history, the Supreme Court's findings, and subsequent actions undertaken by the Bush Administration and the EPA from 2007–2008 in response to the Supreme Court remand.

[16] 74 FR 18886 (Apr. 24, 2009).

[17] 74 FR 32744 (July 8, 2009).

respective statutes, such as averaging, banking, and trading of credits, and have harmonized the compliance testing and test protocols used for purposes of the fleet average standards each agency is proposing. Finally, as discussed in Section I.C., under their respective statutes each agency is called upon to exercise its judgment and determine standards that are an appropriate balance of various relevant statutory factors. Given the common technical issues before each agency, the similarity of the factors each agency is to consider and balance, and the authority of each agency to take into consideration the standards of the other agency, both EPA and NHTSA are proposing standards that result in a harmonized National Program.

This joint proposal covers passenger cars, light-duty-trucks, and medium-duty passenger vehicles built in model years 2012 through 2016. These vehicle categories are responsible for almost 60 percent of all U.S. transportation-related GHG emissions. EPA and NHTSA expect that automobile manufacturers will meet these proposed standards by utilizing technologies that will reduce vehicle GHG emissions and improve fuel economy. Although many of these technologies are available today, the emissions reductions and fuel economy improvements proposed would involve more widespread use of these technologies across the light-duty vehicle fleet. These include improvements to engines, transmissions, and tires, increased use of start-stop technology, improvements in air conditioning systems (to the extent currently allowed by law), increased use of hybrid and other advanced technologies, and the initial commercialization of electric vehicles and plug-in hybrids.

The proposed National Program would result in approximately 950 million metric tons of total carbon dioxide equivalent emissions reductions and approximately 1.8 billion barrels of oil savings over the lifetime of vehicles sold in model years 2012 through 2016. In total, the combined EPA and NHTSA 2012–2016 standards would reduce GHG emissions from the U.S. light-duty fleet by approximately 21 percent by 2030 over the level that would occur in the absence of the National Program. These proposals also provide important energy security benefits, as light-duty vehicles are about 95 percent dependent on oil-based fuels. The benefits of the proposed National Program would total about $250 billion at a 3% discount rate, or $195 billion at a 7% discount rate. In the discussion that follows in Sections III and IV, each agency explains the related benefits for their individual standards.

Together, EPA and NHTSA estimate that the average cost increase for a model year 2016 vehicle due to the proposed National Program is less than $1,100. U.S. consumers who purchase their vehicle outright would save enough in lower fuel costs over the first three years to offset these higher vehicle costs. However, most U.S. consumers purchase a new vehicle using credit rather than paying cash and the typical car loan today is a five year, 60 month loan. These consumers would see immediate savings due to their vehicle's lower fuel consumption in the form of reduced monthly costs of $12–$14 per month throughout the duration of the loan (that is, the fuel savings outweigh the increase in loan payments by $12–$14 per month). Whether a consumer takes out a loan or purchases a new vehicle outright, over the lifetime of a model year 2016 vehicle, consumers would save more than $3,000 due to fuel savings. The average 2016 MY vehicle will emit 16 fewer metric tons of CO_2 emissions during its lifetime.

This joint proposal also offers the prospect of important regulatory convergence and certainty to automobile companies. Absent this proposal, there would be three separate Federal and State regimes independently regulating light-duty vehicles to reduce fuel consumption and GHG emissions: NHTSA's CAFE standards, EPA's GHG standards, and the GHG standards applicable in California and other States adopting the California standards. This joint proposal would allow automakers to meet both the NHTSA and EPA requirements with a single national fleet, greatly simplifying the industry's technology, investment and compliance strategies. In addition, in a letter dated May 18, 2009, California stated that it ''recognizes the benefit for the country and California of a National Program to address greenhouse gases and fuel economy and the historic announcement of United States Environmental Protection Agency (EPA) and National Highway Transportation Safety Administration's (NHTSA) intent to jointly propose a rule to set standards for both. California fully supports proposal and adoption of such a National Program.'' To promote the National Program, California announced its commitment to take several actions, including revising its program for MYs 2012–2016 such that compliance with the *Federal* GHG standards would be deemed to be compliance with California's GHG standards. This would allow the single national fleet used by automakers to meet the two Federal requirements and to meet California requirements as well. This commitment was conditioned on several points, including EPA GHG standards that are substantially similar to those described in the May 19, 2009 Notice of Upcoming Joint Rulemaking. Many automakers and trade associations also announced their support for the National Program announced that day.[18] The manufacturers conditioned their support on EPA and NHTSA standards substantially similar to those described in that Notice. NHTSA and EPA met with many vehicle manufacturers to discuss the feasibility of the National Program. EPA and NHTSA are confident that these proposed GHG and CAFE standards, if finalized, would successfully harmonize both the *Federal* and State programs for MYs 2012–2016 and would allow our country to achieve the increased benefits of a single, nationwide program to reduce light-duty vehicle GHG emissions and reduce the country's dependence on fossil fuels by improving these vehicles' fuel economy.

A successful and sustainable automotive industry depends upon, among other things, continuous technology innovation in general, and low greenhouse gas emissions and high fuel economy vehicles in particular. In this respect, this proposal would help spark the investment in technology innovation necessary for automakers to successfully compete in both domestic and export markets, and thereby continue to support a strong economy.

While this proposal covers MYs 2012–2016, EPA and NHTSA anticipate the importance of seeking a strong, coordinated national program for light-duty vehicles in model years beyond 2016 in a future rulemaking.

Key elements of the proposal for a harmonized and coordinated program are the level and form of the GHG and CAFE standards, the available compliance mechanisms, and general implementation elements. These elements are outlined in the following sections.

C. Background and Comparison of NHTSA and EPA Statutory Authority

This section provides the agencies' respective statutory authorities under which CAFE and GHG standards are established.

1. NHTSA Statutory Authority

NHTSA establishes CAFE standards for passenger cars and light trucks for each model year under EPCA, as

[18] These letters are available at *http://www.epa.gov/otaq/climate/regulations.htm.*

amended by EISA. EPCA mandates a motor vehicle fuel economy regulatory program to meet the various facets of the need to conserve energy, including ones having environmental and foreign policy implications. EPCA allocates the responsibility for implementing the program between NHTSA and EPA as follows: NHTSA sets CAFE standards for passenger cars and light trucks; EPA establishes the procedures for testing, tests vehicles, collects and analyzes manufacturers' data, and calculates the average fuel economy of each manufacturer's passenger cars and light trucks; and NHTSA enforces the standards based on EPA's calculations.

a. Standard Setting

We have summarized below the most important aspects of standard setting under EPCA, as amended by EISA.

For each future model year, EPCA requires that NHTSA establish standards at ''the maximum feasible average fuel economy level that it decides the manufacturers can achieve in that model year,'' based on the agency's consideration of four statutory factors: technological feasibility, economic practicability, the effect of other standards of the Government on fuel economy, and the need of the nation to conserve energy. EPCA does not define these terms or specify what weight to give each concern in balancing them; thus, NHTSA defines them and determines the appropriate weighting based on the circumstances in each CAFE standard rulemaking.[19]

For MYs 2011–2020, EPCA further requires that separate standards for passenger cars and for light trucks be set at levels high enough to ensure that the CAFE of the industry-wide combined fleet of new passenger cars and light trucks reaches at least 35 mpg not later than MY 2020.

i. Factors That Must Be Considered in Deciding the Appropriate Stringency of CAFE Standards

(1) Technological Feasibility

''Technological feasibility'' refers to whether a particular method of improving fuel economy can be available for commercial application in the model year for which a standard is being established. Thus, the agency is not limited in determining the level of new standards to technology that is already being commercially applied at the time of the rulemaking. NHTSA has historically considered all types of technologies that improve real-world fuel economy, except those whose effects are not reflected in fuel economy testing. Principal among them are technologies that improve air conditioner efficiency because the air conditioners are not turned on during testing under existing test procedures.

(2) Economic Practicability

''Economic practicability'' refers to whether a standard is one ''within the financial capability of the industry, but not so stringent as to'' lead to ''adverse economic consequences, such as a significant loss of jobs or the unreasonable elimination of consumer choice.''[20] This factor is especially important in the context of current events, where the automobile industry is facing significantly adverse economic conditions, as well as significant loss of jobs. In an attempt to ensure the economic practicability of attribute-based standards, NHTSA considers a variety of factors, including the annual rate at which manufacturers can increase the percentage of its fleet that employs a particular type of fuel-saving technology, and cost to consumers. Consumer acceptability is also an element of economic practicability, one which is particularly difficult to gauge during times of frequently-changing fuel prices. NHTSA believes this approach is reasonable for the MY 2012–2016 standards in view of the facts before it at this time. NHTSA is aware, however, that facts relating to a variety of key issues in CAFE rulemaking are steadily evolving and seeks comments on the balancing of these factors in light of the facts available during the comment period.

At the same time, the law does not preclude a CAFE standard that poses considerable challenges to any individual manufacturer. The Conference Report for EPCA, as enacted in 1975, makes clear, and the case law affirms, ''a determination of maximum feasible average fuel economy should not be keyed to the single manufacturer which might have the most difficulty achieving a given level of average fuel economy.''[21] Instead, NHTSA is compelled ''to weigh the benefits to the nation of a higher fuel economy standard against the difficulties of individual automobile manufacturers.'' *Id.* The law permits CAFE standards exceeding the projected capability of any particular manufacturer as long as the standard is economically practicable for the industry as a whole. Thus, while a particular CAFE standard may pose difficulties for one manufacturer, it may also present opportunities for another. The CAFE program is not necessarily intended to maintain the competitive positioning of each particular company. Rather, it is intended to enhance fuel economy of the vehicle fleet on American roads, while protecting motor vehicle safety and being mindful of the risk of harm to the overall United States economy.

(3) The Effect of Other Motor Vehicle Standards of the Government on Fuel Economy

''The effect of other motor vehicle standards of the Government on fuel economy,'' involves an analysis of the effects of compliance with emission,[22] safety, noise, or damageability standards on fuel economy capability and thus on average fuel economy. In previous CAFE rulemakings, the agency has said that pursuant to this provision, it considers the adverse effects of other motor vehicle standards on fuel economy. It said so because, from the CAFE program's earliest years[23] until present, the effects of such compliance on fuel economy capability over the history of the CAFE program have been negative ones. For example, safety standards that have the effect of increasing vehicle weight lower vehicle fuel economy capability and thus decrease the level of average fuel economy that the agency can determine to be feasible.

In the wake of *Massachusetts* v. *EPA* and of EPA's proposed endangerment finding, granting of a waiver to California for its motor vehicle GHG standards, and its own proposal of GHG standards, NHTSA is confronted with the issue of how to treat those standards under the ''other motor vehicle standards'' provision. To the extent the GHG standards result in increases in fuel economy, they would do so almost exclusively as a result of inducing manufacturers to install the same types of technologies used by manufacturers in complying with the CAFE standards. The primary exception would involve increases in the efficiency of air conditioners.

Comment is requested on whether and in what way the effects of the California and EPA standards should be

[19] *See Center for Biological Diversity* v. *NHTSA*, 538 F.3d. 1172, 1195 (9th Cir. 2008) (''The EPCA clearly requires the agency to consider these four factors, but it gives NHTSA discretion to decide how to balance the statutory factors—as long as NHTSA's balancing does not undermine the fundamental purpose of the EPCA: Energy conservation.'')

[20] 67 FR 77015, 77021 (Dec. 16, 2002).

[21] *CEI–I*, 793 F.2d 1322, 1352 (D.C. Cir. 1986).

[22] In the case of emission standards, this includes standards adopted by the Federal government and can include standards adopted by the States as well, since in certain circumstances the Clean Air Act allows States to adopt and enforce State standards different from the Federal ones.

[23] 42 FR 63184, 63188 (Dec. 15, 1977). *See* also 42 FR 33534, 33537 (Jun. 30, 1977).

considered under the ''other motor vehicle standards'' provision or other provisions of EPCA in 49 U.S.C. 32902, consistent with NHTSA's independent obligation under EPCA/EISA to issue CAFE standards. The agency has already considered EPA's proposal and the harmonization benefits of the National Program in developing its own proposal.

(4) The Need of the United States To Conserve Energy

''The need of the United States to conserve energy'' means ''the consumer cost, national balance of payments, environmental, and foreign policy implications of our need for large quantities of petroleum, especially imported petroleum.'' [24] Environmental implications principally include reductions in emissions of criteria pollutants and carbon dioxide. Prime examples of foreign policy implications are energy independence and security concerns.

(a) Fuel Prices and the Value of Saving Fuel

Projected future fuel prices are a critical input into the preliminary economic analysis of alternative CAFE standards, because they determine the value of fuel savings both to new vehicle buyers and to society. In this rule, NHTSA relies on fuel price projections from the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) for this analysis. Federal government agencies generally use EIA's projections in their assessments of future energy-related policies.

(b) Petroleum Consumption and Import Externalities

U.S. consumption and imports of petroleum products impose costs on the domestic economy that are not reflected in the market price for crude petroleum, or in the prices paid by consumers of petroleum products such as gasoline. These costs include (1) higher prices for petroleum products resulting from the effect of U.S. oil import demand on the world oil price; (2) the risk of disruptions to the U.S. economy caused by sudden reductions in the supply of imported oil to the U.S.; and (3) expenses for maintaining a U.S. military presence to secure imported oil supplies from unstable regions, and for maintaining the strategic petroleum reserve (SPR) to provide a response option should a disruption in commercial oil supplies threaten the U.S. economy, to allow the United States to meet part of its International Energy Agency obligation to maintain emergency oil stocks, and to provide a national defense fuel reserve. Higher U.S. imports of crude oil or refined petroleum products increase the magnitude of these external economic costs, thus increasing the true economic cost of supplying transportation fuels above the resource costs of producing them. Conversely, reducing U.S. imports of crude petroleum or refined fuels or reducing fuel consumption can reduce these external costs.

(c) Air Pollutant Emissions

While reductions in domestic fuel refining and distribution that result from lower fuel consumption will reduce U.S. emissions of various pollutants, additional vehicle use associated with the rebound effect [25] from higher fuel economy will increase emissions of these pollutants. Thus, the net effect of stricter CAFE standards on emissions of each pollutant depends on the relative magnitudes of its reduced emissions in fuel refining and distribution, and increases in its emissions from vehicle use.

Fuel savings from stricter CAFE standards also result in lower emissions of CO_2, the main greenhouse gas emitted as a result of refining, distribution, and use of transportation fuels. Lower fuel consumption reduces carbon dioxide emissions directly, because the primary source of transportation-related CO_2 emissions is fuel combustion in internal combustion engines.

NHTSA has considered environmental issues, both within the context of EPCA and the National Environmental Policy Act, in making decisions about the setting of standards from the earliest days of the CAFE program. As courts of appeal have noted in three decisions stretching over the last 20 years,[26] NHTSA defined the ''need of the Nation to conserve energy'' in the late 1970s as including ''the consumer cost, national balance of payments, environmental, and foreign policy implications of our need for large quantities of petroleum, especially imported petroleum.'' [27] Pursuant to that view, NHTSA declined in the past to include diesel engines in determining the appropriate level of standards for passenger cars and for light trucks because particulate emissions from diesels were then both a source of concern and unregulated.[28] In 1988, NHTSA included climate change concepts in its CAFE notices and prepared its first environmental assessment addressing that subject.[29] It cited concerns about climate change as one of its reasons for limiting the extent of its reduction of the CAFE standard for MY 1989 passenger cars.[30] Since then, NHTSA has considered the benefits of reducing tailpipe carbon dioxide emissions in its fuel economy rulemakings pursuant to the statutory requirement to consider the nation's need to conserve energy by reducing fuel consumption.

ii. Other Factors Considered by NHTSA

NHTSA considers the potential for adverse safety consequences when in establishing CAFE standards. This practice is recognized approvingly in case law.[31] Under the universal or ''flat'' CAFE standards that NHTSA was previously authorized to establish, the primary risk to safety came from the possibility that manufacturers would respond to higher standards by building smaller, less safe vehicles in order to ''balance out'' the larger, safer vehicles that the public generally preferred to buy. Under the attribute-based standards being proposed in this action, that risk is reduced because building smaller vehicles tends to raise a manufacturer's overall CAFE obligation, rather than only raising its fleet average CAFE. However, even under attribute-based standards, there is still risk that manufacturers will rely on downweighting to improve their fuel economy (for a given vehicle at a given

[24] 42 FR 63184, 63188 (1977).

[25] The ''rebound effect'' refers to the tendency of drivers to drive their vehicles more as the cost of doing so goes down, as when fuel economy improves.

[26] *Center for Auto Safety* v. *NHTSA*, 793 F.2d 1322, 1325 n. 12 (D.C. Cir. 1986); *Public Citizen* v. *NHTSA*, 848 F.2d 256, 262–3 n. 27 (D.C. Cir. 1988) (noting that ''NHTSA itself has interpreted the factors it must consider in setting CAFE standards as including environmental effects''); and *Center for Biological Diversity* v. *NHTSA*, 538 F.3d 1172 (9th Cir. 2007).

[27] 42 FR 63184, 63188 (Dec. 15, 1977) (emphasis added).

[28] For example, the final rules establishing CAFE standards for MY 1981–84 passenger cars, 42 FR 33533, 33540–1 and 33551 (Jun. 30, 1977), and for MY 1983–85 light trucks, 45 FR 81593, 81597 (Dec. 11, 1980).

[29] 53 FR 33080, 33096 (Aug. 29, 1988).

[30] 53 FR 39275, 39302 (Oct. 6, 1988).

[31] See, *e.g., Center for Auto Safety* v. *NHTSA (CAS)*, 793 F.2d 1322 (D.C. Cir. 1986) (Administrator's consideration of market demand as component of economic practicability found to be reasonable); Public Citizen 848 F.2d 256 (Congress established broad guidelines in the fuel economy statute; agency's decision to set lower standard was a reasonable accommodation of conflicting policies). As the United States Court of Appeals pointed out in upholding NHTSA's exercise of judgment in setting the 1987–1989 passenger car standards, ''NHTSA has always examined the safety consequences of the CAFE standards in its overall consideration of relevant factors since its earliest rulemaking under the CAFE program.'' *Competitive Enterprise Institute* v. *NHTSA (CEI I)*, 901 F.2d 107, 120 at n.11 (D.C. Cir. 1990).

footprint target) in ways that may reduce safety.

In addition, the agency considers consumer demand in establishing new standards and in assessing whether already established standards remained feasible. In the 1980's, the agency relied in part on the unexpected drop in fuel prices and the resulting unexpected failure of consumer demand for small cars to develop in explaining the need to reduce CAFE standards for a several year period in order to give manufacturers time to develop alternative technology-based strategies for improving fuel economy.

iii. Factors That NHTSA Is Statutorily Prohibited From Considering in Setting Standards

EPCA provides that in determining the level at which it should set CAFE standards for a particular model year, NHTSA may not consider the ability of manufacturers to take advantage of several EPCA provisions that facilitate compliance with the CAFE standards and thereby reduce the costs of compliance.[32] As noted below in Section IV, manufacturers can earn compliance credits by exceeding the CAFE standards and then use those credits to achieve compliance in years in which their measured average fuel economy falls below the standards. Manufacturers can also increase their CAFE levels through MY 2019 by producing alternative fuel vehicles. EPCA provides an incentive for producing these vehicles by specifying that their fuel economy is to be determined using a special calculation procedure that results in those vehicles being assigned a high fuel economy level.

iv. Weighing and Balancing of Factors

NHTSA has broad discretion in balancing the above factors in determining the average fuel economy level that the manufacturers can achieve. Congress ''specifically delegated the process of setting * * * fuel economy standards with *broad* guidelines concerning the factors that the agency must consider.'' The breadth of those guidelines, the absence of any statutorily prescribed formula for balancing the factors, the fact that the relative weight to be given to the various factors may change from rulemaking to rulemaking as the underlying facts change, and the fact that the factors may often be conflicting with respect to whether they militate toward higher or lower standards give NHTSA discretion to decide what weight to give each of the competing policies and concerns and then determine how to balance them—as long as NHTSA's balancing does not undermine the fundamental purpose of the EPCA: Energy conservation, and as long as that balancing reasonably accommodates ''conflicting policies that were committed to the agency's care by the statute.''

Thus, EPCA does not mandate that any particular number be adopted when NHTSA determines the level of CAFE standards. Rather, any number within a zone of reasonableness may be, in NHTSA's assessment, the level of stringency that manufacturers can achieve. See, *e.g., Hercules Inc.* v. *EPA,* 598 F.2d 91, 106 (D.C. Cir. 1978) (''In reviewing a numerical standard we must ask whether the agency's numbers are within a zone of reasonableness, not whether its numbers are precisely right'').

v. Other Requirements Related to Standard Setting

The standards for passenger cars and those for light trucks must increase ratably each year. This statutory requirement is interpreted, in combination with the requirement to set the standards for each model year at the level determined to be the maximum feasible level that manufacturers can achieve for that model year, to mean that the annual increases should not be disproportionately large or small in relation to each other.

The standards for passenger cars and light trucks must be based on one or more vehicle attributes, like size or weight, that correlate with fuel economy and must be expressed in terms of a mathematical function. Fuel economy targets are set for individual vehicles and increase as the attribute decreases and vice versa. For example, size-based (*i.e.,* size-indexed) standards assign higher fuel economy targets to smaller (and generally, but not necessarily, lighter) vehicles and lower ones to larger (and generally, but not necessarily, heavier) vehicles. The fleet-wide average fuel economy that a particular manufacturer is required to achieve depends on the size mix of its fleet, *i.e.,* the proportion of the fleet that is small-, medium- or large-sized.

This approach can be used to require virtually all manufacturers to increase significantly the fuel economy of a broad range of both passenger cars and light trucks, *i.e.,* the manufacturer must improve the fuel economy of all the vehicles in its fleet. Further, this approach can do so without creating an incentive for manufacturers to make small vehicles smaller or large vehicles larger, with attendant implications for safety.

b. Test Procedures for Measuring Fuel Economy

EPCA provides EPA with the responsibility for establishing CAFE test procedures. Current test procedures measure the effects of nearly all fuel saving technologies. The principal exception is improvements in air conditioning efficiency. By statutory law in the case of passenger cars and by administrative regulation in the case of light trucks, air conditioners are not turned on during fuel economy testing. See Section I.C.2 for details.

The fuel economy test procedures for light trucks could be amended through rulemaking to provide for air conditioner operation during testing and to take other steps for improving the accuracy and representativeness of fuel economy measurements. Comment is sought by the agencies regarding implementing such amendments beginning in MY 2017 and also on the more immediate interim alternative step of providing CAFE program credits under the authority of 49 U.S.C. 32904(c) for light trucks equipped with relatively efficient air conditioners for MYs 2012–2016. These CAFE credits would be earned by manufacturers on the same terms and under the same conditions as EPA is proposing to provide them under the CAA, and additional detail is on this request for comment for early CAFE credits is contained in Section IV of this preamble. Modernizing the passenger car test procedures, or even providing similar credits, would not be possible under EPCA as currently written.

c. Enforcement and Compliance Flexibility

EPA is responsible for measuring automobile manufacturers' CAFE so that NHTSA can determine compliance with the CAFE standards. When NHTSA finds that a manufacturer is not in compliance, it notifies the manufacturer. Surplus credits generated from the five previous years can be used to make up the deficit. The amount of credit earned is determined by multiplying the number of tenths of a mpg by which a manufacturer exceeds a standard for a particular category of automobiles by the total volume of automobiles of that category manufactured by the manufacturer for a given model year. If there are no (or not enough) credits available, then the manufacturer can either pay the fine, or submit a carry back plan to NHTSA. A carry back plan describes what the manufacturer plans to do in the

[32] 49 U.S.C. 32902(h).

following three model years to earn enough credits to make up for the deficit. NHTSA must examine and determine whether to approve the plan.

In the event that a manufacturer does not comply with a CAFE standard, even after the consideration of credits, EPCA provides for the assessing of civil penalties, unless, as provided below, the manufacturer has earned credits for exceeding a standard in an earlier year or expects to earn credits in a later year.[33] The Act specifies a precise formula for determining the amount of civil penalties for such a noncompliance. The penalty, as adjusted for inflation by law, is $5.50 for each tenth of a mpg that a manufacturer's average fuel economy falls short of the standard for a given model year multiplied by the total volume of those vehicles in the affected fleet (*i.e.,* import or domestic passenger car, or light truck), manufactured for that model year. The amount of the penalty may not be reduced except under the unusual or extreme circumstances specified in the statute.

Unlike the National Traffic and Motor Vehicle Safety Act, EPCA does not provide for recall and remedy in the event of a noncompliance. The presence of recall and remedy provisions[34] in the Safety Act and their absence in EPCA is believed to arise from the difference in the application of the safety standards and CAFE standards. A safety standard applies to individual vehicles; that is, each vehicle must possess the requisite equipment or feature that must provide the requisite type and level of performance. If a vehicle does not, it is noncompliant. Typically, a vehicle does not entirely lack an item or equipment or feature. Instead, the equipment or features fails to perform adequately. Recalling the vehicle to repair or replace the noncompliant equipment or feature can usually be readily accomplished.

In contrast, a CAFE standard applies to a manufacturer's entire fleet for a model year. It does not require that a particular individual vehicle be equipped with any particular equipment or feature or meet a particular level of fuel economy. It does require that the manufacturer's fleet, as a whole, comply. Further, although under the attribute-based approach to setting CAFE standards fuel economy targets are established for individual vehicles based on their footprints, the vehicles are not required to comply with those targets. However, as a practical matter, if a manufacturer chooses to design some vehicles that fall below their target levels of fuel economy, it will need to design other vehicles that exceed their targets if the manufacturer's overall fleet average is to meet the applicable standard.

Thus, under EPCA, there is no such thing as a noncompliant vehicle, only a noncompliant fleet. No particular vehicle in a noncompliant fleet is any more, or less, noncompliant than any other vehicle in the fleet.

2. EPA Statutory Authority

Title II of the Clean Air Act (CAA) provides for comprehensive regulation of mobile sources, authorizing EPA to regulate emissions of air pollutants from all mobile source categories. Pursuant to these sweeping grants of authority, 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 consumers; the impacts of standards on the auto 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).[35] Section 202(a)(1) of the Clean Air Act (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.'' If EPA makes the appropriate endangerment and cause or contribute findings, then section 202(a) authorizes EPA to issue standards applicable to emissions of those pollutants.

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 (D.C. 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 (D.C. 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 F.3d 616, 623–624 (D.C. Cir. 1998) (ordinarily permissible for EPA to consider factors not specifically enumerated in the Act). *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 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

[33] EPCA does not provide authority for seeking to enjoin violations of the CAFE standards.

[34] 49 U.S.C. 30120, Remedies for defects and noncompliance.

[35] 42 U.S.C. 7521(a).

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.[36]

This interpretation was upheld as reasonable in *NACAA* v. *EPA,* (489 F.3d 1221, 1230 (D.C. 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 (D.C. 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 (D.C. 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 (D.C. Cir. 1978) ("In reviewing a numerical standard we 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 (D.C. Cir. 2002) (same).

[36] 70 FR 69664, 69676, November 17, 2005.

a. EPA's 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 Federal Test Procedure (FTP or "city" test) and the Highway Fuel Economy Test (HFET or "highway" test) 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)).

Pursuant to EPCA, EPA is required to measure fuel economy for each model and to calculate each manufacturer's average fuel economy.[37] EPA uses the same tests—the FTP and HFET—for fuel economy testing. EPA established the FTP for emissions measurement in the early 1970s. In 1976, in response to the Energy Policy and Conservation Act (EPCA) statute, EPA extended the use of the FTP to fuel economy measurement and added the HFET.[38] The provisions in the 1976 regulation, effective with the 1977 model year, established procedures to calculate fuel economy values both for labeling and for CAFE purposes. Under EPCA, EPA is required to use these procedures (or procedures which yield comparable results) for measuring fuel economy for cars for CAFE purposes, but not for labeling purposes.[39] EPCA does not pose this restriction on CAFE test procedures for light trucks, but EPA does use the FTP and HFET for this purpose. EPA determines fuel economy by measuring the amount of CO_2 and all other carbon compounds (*e.g.* total hydrocarbons (THC) 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." Unlike EPCA, the CAA does not authorize vehicle manufacturers to pay fines in lieu of meeting emission standards.

[37] *See* 49 U.S.C. 32904(c).

[38] *See* 41 FR 38674 (Sept. 10, 1976), which is codified at 40 CFR part 600.

[39] *See* 49 U.S.C. 32904(c).

3. Comparing the Agencies' Authority

As the above discussion makes clear, there are both important differences between the statutes under which each agency is acting as well as several important areas of similarity. One important difference is that EPA's authority addresses various GHGs, while NHTSA's authority addresses fuel economy as measured under specified test procedures. This difference is reflected in this rulemaking in the scope of the two standards: EPA's proposal takes into account air conditioning related reductions, as well as proposed standards for methane and N_2O, but NHTSA's does not. A second important difference is that EPA is proposing certain compliance flexibilities, and takes those flexibilities into account in its technical analysis and modeling supporting its proposal. EPCA places certain limits on compliance flexibilities for CAFE, and expressly prohibits NHTSA from considering the impacts of the compliance flexibilities in setting the CAFE standard so that the manufacturers' election to avail themselves of the permitted flexibilities remains strictly voluntary.[40] The Clean Air Act, on the other hand, contains no such prohibition. These considerations result in some differences in the technical analysis and modeling used to support EPA's and NHTSA's proposed standards.

These differences, however, do not change the fact that in many critical ways the two agencies are charged with addressing the same basic issue of reducing GHG emissions and improving fuel economy. Given the direct relationship between emissions of CO_2 and fuel economy levels, both agencies are looking at the same set of control technologies (with the exception of the air conditioning related technologies). The standards set by each agency will drive the kind and degree of penetration of this set of technologies across the vehicle fleet. As a result, each agency is trying to answer the same basic question—what kind and degree of technology penetration is necessary to achieve the agencies' objectives in the rulemaking time frame, given the

[40] 74 FR 24009 (May 22, 2009).

agencies' respective statutory authorities?

In making the determination of what standards are appropriate under the CAA and EPCA, each agency is to exercise its judgment and balance many similar factors, such as the availability of technologies, the appropriate lead time for introduction of technology, and based on this the feasibility and practicability of their standards; the impacts of their standards on emissions reductions (of both GHGs and non-GHGs); the impacts of their standards on oil conservation; the impacts of their standards on fuel savings by consumers; the impacts of their standards on the auto industry; as well as other relevant factors such as impacts on safety. Conceptually, therefore, each agency is considering and balancing many of the same factors, and each agency is making a decision that at its core is answering the same basic question of what kind and degree of technology penetration is it appropriate to call for in light of all of the relevant factors. Finally, each agency has the authority to take into consideration impacts of the standards of the other agency. EPCA calls for NHTSA to take into consideration the effects of EPA's emissions standards on fuel economy capability (*see* 49 U.S.C. 32902 (f)), and EPA has the discretion to take into consideration NHTSA's CAFE standards in determining appropriate action under section 202(a). This is consistent with the Supreme Court's statement that EPA's mandate to protect public health and welfare is wholly independent from NHTSA's mandate to promote energy efficiency, but there is no reason to think the two agencies cannot both administer their obligations and yet avoid inconsistency. *Massachusetts* v. *EPA*, 549 U.S. 497, 532 (2007).

In this context, it is in the Nation's interest for the two agencies to work together in developing their respective proposed standards, and they have done so. For example, the agencies have committed considerable effort to develop a joint Technical Support Document that provides a technical basis underlying each agency's analyses. The agencies also have worked closely together in developing and reviewing their respective modeling, to develop the best analysis and to promote technical consistency. The agencies have developed a common set of attribute-based curves that each agency supports as appropriate both technically and from a policy perspective. The agencies have also worked closely to ensure that their respective programs will work in a coordinated fashion, and will provide regulatory compatibility that allows auto manufacturers to build a single national light-duty fleet that would comply with both the GHG and the CAFE standards. The resulting overall close coordination of the proposed GHG and CAFE standards should not be surprising, however, as each agency is using a jointly developed technical basis to address the closely intertwined challenges of energy security and climate change. As discussed above, in determining the standards to propose the agencies are called upon to weigh and balance various factors that are relevant under their respective statutory provisions. Each agency is to exercise its judgment and balance many similar factors, such as the availability of technologies, the appropriate lead time for introduction of technology, and based on this, the feasibility and practicability of their standards; and the impacts of their standards on the following: Emissions reductions (of both GHGs and non-GHGs); oil conservation; fuel savings by consumers; the auto industry; as well as other relevant factors such as safety. Conceptually, each agency is considering and balancing many of the same factors, and each agency is making a decision that at its core is answering the same basic question of what kind and degree of technology penetration is appropriate and required in light of all of the relevant factors. Each Administrator is called upon to exercise judgment and propose standards that the Administrator determines are a reasonable balance of these relevant factors.

As set out in detail in Sections III and IV of this notice, both EPA and NHTSA believe the agencies' proposals are fully justified under their respective statutory criteria. The proposed standards can be achieved within the lead time provided, based on a projected increased use of various technologies which in most cases are already in commercial application in the fleet to varying degrees. Detailed modeling of the technologies that could be employed by each manufacturer supports this initial conclusion. The agencies also carefully assessed the costs of the proposed rules, both for the industry as a whole and per manufacturer, as well as the costs per vehicle, and consider these costs to be reasonable and recoverable (from fuel savings). The agencies recognize the significant increase in the application of technology that the proposed standards would require across a high percentage of vehicles, which will require the manufacturers to devote considerable engineering and development resources before 2012 laying the critical foundation for the widespread deployment of upgraded technology across a high percentage of the 2012–2016 fleet. This clearly will be challenging for automotive manufacturers and their suppliers, especially in the current economic climate. However, based on all of the analyses performed by the agencies, our judgment is that it is a challenge that can reasonably be met.

The agencies also evaluated the impacts of these standards with respect to the expected reductions in GHGs and oil consumption and, found them to be very significant in magnitude. The agencies considered other factors such as the impacts on noise, energy, and vehicular congestion. The impact on safety was also given careful consideration. Moreover, the agencies quantified the various costs and benefits of the proposed standards, to the extent practicable. The agencies' analyses to date indicate that the overall quantified benefits of the proposed standards far outweigh the projected costs. All of these factors support the reasonableness of the proposed standards.

The agencies also evaluated alternatives which were less and more stringent than those proposed. Less stringent standards, however, would forego important GHG emission reductions and fuel savings that are technically achievable at reasonable cost in the lead time provided. In addition, less stringent GHG standards would not result in a harmonized National Program for the country. Based on California's letter of May 18, 2009, the GHG emission standards would not result in the State of California revising its regulations such that compliance with EPA's GHG standards would be deemed to be compliance with California's GHG standards for these model years. The substantial cost advantages associated with a single national program discussed at the outset of this section would then be foregone.

The agencies are not proposing any of the more stringent alternatives analyzed largely due to concerns over lead time and economic practicability. The proposed standards already require aggressive application of technologies, and more stringent standards which would require more widespread use (including more substantial implementation of advanced technologies such as strong hybrids) raise serious issues of adequacy of lead time, not only to meet the standards but to coordinate such significant changes with manufacturers' redesign cycles. At a time when the entire industry remains in an economically critical state, the agencies believe that it would be unreasonable to propose more stringent standards. Even in a case where economic factors were not a consideration, there are real-world time constraints which must be considered due to the short lead time available for the early years of this program, in particular for model years 2012 and 2013. The physical processes which the automotive industry must follow in order to introduce reliable, high quality products require certain minimums of time during the product development process. These include time needed for durability testing which requires significant mileage accumulation under a range of conditions (*e.g.*, high and low temperatures, high altitude, *etc.*) in both real-world and laboratory conditions. In addition, the product development cycle includes a number of pre-production gateways on the manufacturing side at both the supplier level and at the automotive manufacturer level that are constrained by time. Thus adequate lead-time is an important factor that the agencies have taken into consideration in evaluating the proposed standards as well as the alternative standards.

As noted, both agencies also considered the overall costs of their respective proposed standards in relation to the projected benefits. The fact that the benefits are estimated to considerably exceed their costs supports the view that the proposed standards represent a reasonable balance of the relevant statutory factors. In drawing this conclusion, the agencies acknowledge the uncertainties and limitations of the analyses. For example, the analysis of the benefits is highly dependent on the estimated price of fuel projected out many years into the future. There is also significant uncertainty in the potential range of values that could be assigned to the social cost of carbon. There are a variety of impacts that the agencies are unable to quantify, such as non-market damages, extreme weather, socially contingent effects, or the potential for longer-term catastrophic events, or the impact on consumer choice. The agencies also note the need to consider factors such as the availability of technology within the lead time provided and many of the other factors discussed above. The cost-benefit analyses are one of the important things the agencies consider in making a judgment as to the appropriate standards to propose under their respective statutes. Consideration of the results of the cost-benefit analyses by the agencies, however, includes careful consideration of the limitations discussed above.

One important area where the two agencies' authorities are similar but not identical involves the transfer of credits between a single firm's car and truck fleets. EISA revised EPCA to allow for such credit transfers, but with a cap on the amount of CAFE credits which can be transferred between the car and truck fleets. 49 U.S.C. 32903(g)(3). Under CAA section 202(a), EPA is proposing to allow CO_2 credit transfers between a single manufacturer's car and truck fleets, with no corresponding limits on such transfers. In general, the EPCA limit on CAFE credit transfers is not expected to have the practical effect of limiting the amount of CO_2 emission credits manufacturers may be able to transfer under the CAA program, recognizing that manufacturers must comply with both the proposed CAFE standards and the proposed EPA standards. However, it is possible that in some specific circumstances the EPCA limit on CAFE credit transfers could constrain the ability of a manufacturer to achieve cost savings through unlimited use of GHG emissions credit transfers under the CAA program.

The agencies request comment on the impact of the EISA credit transfer caps on the implementation of the proposed CAFE and GHG standards, including whether it would impose such a constraint and the impacts of a constraint on costs, emissions, and fuel economy. In addition, the agencies invite comment on approaches that could assist in addressing this issue, recognizing the importance the agencies place on harmonization, and that would be consistent with their respective statutes. For example, any approach must be consistent with both the EISA transfer caps and the EPCA requirement to set annual CAFE standards at the maximum feasible average fuel economy level that NHTSA decides the manufacturers can achieve in that model year, based on the agency's consideration of the four statutory factors. Manufacturers should submit publicly available evidence supporting their position on this issue so that a well informed decision can be made and explained to the public.

D. Summary of the Proposed Standards for the National Program

1. Joint Analytical Approach

NHTSA and EPA have worked closely together on nearly every aspect of this joint proposal. The extent and results of this collaboration is reflected in the elements of the respective NHTSA and EPA proposals, as well as the analytical work contained in the Joint Technical Support Document (Joint TSD). The Joint TSD, in particular, describes important details of the analytical work that are shared, as well as any differences in approach. These includes the build up of the baseline and reference fleets, the derivation of the shape of the curve that defines the standards, a detailed description of the costs and effectiveness of the technology choices that are available to vehicle manufacturers, a summary of the computer models used to estimate how technologies might be added to vehicles, and finally the economic inputs used to calculate the impacts and benefits of the rules, where practicable. Some of these are highlighted below.

EPA and NHTSA have jointly developed attribute curve shapes that each agency is using for its proposed standards. Both agencies reviewed the shape of the attribute-based curve used for the model year 2011 CAFE standards. After a new and thorough analysis of current vehicle data and the comments received from previous two CAFE rules, the two agencies improved upon the constrained logistic curve and developed a similarly shaped piece-wise linear function. Further details of these functions can be found in Sections III and IV of this preamble as well as Chapter 2 of the Joint TSD.

A critical technical underpinning of each agency's proposal is the cost and effectiveness of the various control technologies. These are used to analyze the feasibility and cost of potential GHG and CAFE standards. The technical work reflected in the joint TSD is the culmination of over 3 years of literature research, consultation with experts, detailed computer simulations, vehicle tear-downs and engineering review, all of which will continue into the future as more data becomes available. To promote transparency, the vast majority of this information is collected from publically available sources, and can be found in the docket of this rule. Non-public (*i.e.,* confidential manufacturer) information was used only to the limited extent it was needed to fill a data void. A detailed description of all of the technology information considered can be found in Chapter 3 of the Joint TSD (and for A/C, Chapter 2 of the EPA RIA).

This detailed technology data forms the inputs to computer models that each agency uses to project how vehicle manufacturers may add those technologies in order to comply with new standards. These are the OMEGA and Volpe models for EPA and NHTSA respectively. The Volpe model is tailored for NHTSA's EPCA and EISA needs, while the OMEGA model is tailored for EPA's CAA needs. In developing the National Program, EPA and NHTSA have worked closely to ensure that consistent and reasonable results are achieved from both models. This fruitful collaboration has resulted in the improvement of both approaches and now, far from being redundant, these models serve the purposes of the respective agencies while also maintaining an important validating role. The models and their inputs can also be found in the docket. Further description of the model and outputs can be found in Sections II and IV of this preamble, and Chapter 3 of the Joint TSD.

This comprehensive joint analytical approach has provided a sound and consistent technical basis for each agency in developing its proposed standards, which are summarized in the sections below.

2. Level of the Standards

In this notice, EPA and NHTSA are proposing two separate sets of standards, each under its respective statutory authorities. EPA is proposing national CO_2 emissions standards for light-duty vehicles under section 202 (a) of the Clean Air Act. These standards would require these vehicles to meet an estimated combined average emissions level of 250 grams/mile of CO_2 in model year 2016. NHTSA is proposing CAFE standards for passenger cars and light trucks under 49 U.S.C. 32902. These standards would require them to meet an estimated combined average fuel economy level of 34.1 mpg in model year 2016. The proposed standards for both agencies begin with the 2012 model year, with standards increasing in stringency through model year 2016. They represent a harmonized approach that will allow industry to build a single national fleet that will satisfy both the GHG requirements under the CAA and CAFE requirements under EPCA/EISA.

Given differences in their respective statutory authorities, however, the agencies' proposed standards include some important differences. Under the CO_2 fleet average standard proposed under CAA section 202(a), EPA expects manufacturers to take advantage of the option to generate CO_2-equivalent credits by reducing emissions of hydrofluorocarbons (HFCs) and CO_2 through improvements in their air conditioner systems. EPA accounted for these reductions in developing its proposed CO_2 standard. EPCA does not allow vehicle manufacturers to use air conditioning credits in complying with CAFE standards for passenger cars.[41] CO_2 emissions due to air conditioning operation are not measured by the test procedure mandated by statute for use in establishing and enforcing CAFE standards for passenger cars. As a result, improvements in the efficiency of passenger car air conditioners would not be considered as a possible control technology for purposes of CAFE.

These differences regarding the treatment of air conditioning improvements (related to CO_2 and HFC reductions) affect the relative stringency of the EPA standard and NHTSA standard. The 250 grams per mile of CO_2 equivalent emissions limit is equivalent to 35.5 mpg[42] if the automotive industry were to meet this CO_2 level all through fuel economy improvements. As a consequence of the prohibition against NHTSA's allowing credits for air conditioning improvements for purposes of passenger car CAFE compliance, NHTSA is proposing fuel economy standards that are estimated to require a combined (passenger car and light truck) average fuel economy level of 34.1 mpg by MY 2016.

NHTSA and EPA's proposed standards, like the standards NHTSA promulgated in March 2009 for model year 2011 (MY 2011), are expressed as mathematical functions depending on vehicle footprint. Footprint is one measure of vehicle size, and is determined by multiplying the vehicle's wheelbase by the vehicle's average track width.[43] The standards that must be met by the fleet of each manufacturer would be determined by computing the sales-weighted harmonic average of the targets applicable to each of the manufacturer's passenger cars and light trucks. Under these proposed footprint-based standards, the levels required of individual manufacturers depend, as noted above, on the mix of vehicles sold. NHTSA and EPA's respective proposed standards are shown in the tables below. It is important to note that the standards are the attribute-based curves proposed by each agency. The values in the tables below reflect the agencies' projection of the corresponding fleet levels that would result from these attribute-based curves.

As shown in Table I.D.2–1, NHTSA's proposed fleet-wide CAFE-required levels for passenger cars under the proposed standards are projected to increase from 33.6 to 38.0 mpg between MY 2012 and MY 2016. Similarly, fleet-wide CAFE levels for light trucks are projected to increase from 25.0 to 28.3 mpg. These numbers do not include the effects of other flexibilities and credits in the program. NHTSA has also estimated the average fleet-wide required levels for the combined car and truck fleets. As shown, the overall fleet average CAFE level is expected to be 34.1 mpg in MY 2016. These standards represent a 4.3 percent average annual rate of increase relative to the MY 2011 standards.[44]

TABLE I.D.2–1—AVERAGE REQUIRED FUEL ECONOMY (MPG) UNDER PROPOSED CAFE STANDARDS

	2011-base	2012	2013	2014	2015	2016
Passenger Cars	30.2	33.6	34.4	35.2	36.4	38.0
Light Trucks	24.1	25.0	25.6	26.2	27.1	28.3
Combined Cars & Trucks	27.3	29.8	30.6	31.4	32.6	34.1

[41] There is no such statutory limitation with respect to light trucks.

[42] The agencies are using a common conversion factor between fuel economy in units of miles per gallon and CO_2 emissions in units of grams per mile. This conversion factor is 8,887 grams CO_2 per gallon gasoline fuel. Diesel fuel has a conversion factor of 10,180 grams CO_2 per gallon diesel fuel though for the purposes of this calculation, we are assuming 100% gasoline fuel.

[43] *See* 49 CFR 523.2 for the exact definition of "footprint."

[44] Because required CAFE levels depend on the mix of vehicles sold by manufacturers in a model year, NHTSA's estimate of future required CAFE levels depends on its estimate of the mix of vehicles that will be sold in that model year. NHTSA currently estimates that the MY 2011 standards will require average fuel economy levels of 30.5 mpg for passenger cars, 24.2 mpg for light trucks, and 27.6 mpg for the combined fleet.

Accounting for the expectation that some manufacturers would continue to pay civil penalties rather than achieving required CAFE levels, and the ability to use FFV credits, NHTSA estimates that the proposed CAFE standards would lead to the following average achieved fuel economy levels, based on the projections of what each manufacturer's fleet will comprise in each year of the program:[45]

TABLE I.D.2–2—PROJECTED FLEET-WIDE ACHIEVED CAFE LEVELS UNDER THE PROPOSED FOOTPRINT-BASED CAFE STANDARDS (MPG)

	2012	2013	2014	2015	2016
Passenger Cars	32.5	33.4	34.3	35.3	36.5
Light Trucks	24.1	24.6	25.3	26.3	27.0
Combined Cars & Trucks	28.7	29.6	30.4	31.6	32.7

NHTSA is also required by EISA to set a minimum fuel economy standard for domestically manufactured passenger cars in addition to the attribute-based passenger car standard. The minimum standard ''shall be the greater of (A) 27.5 miles per gallon; or (B) 92 percent of the average fuel economy projected by the Secretary for the combined domestic and non-domestic passenger automobile fleets manufactured for sale in the United States by all manufacturers in the model year * * *.''[46]

Based on NHTSA's current market forecast, the agency's estimates of these minimum standards under the proposed MY 2012–2016 CAFE standards (and, for comparison, the final MY 2011 standard) are summarized below in Table I.D.2–3.[47] For eventual compliance calculations, the final calculated minimum standards will be updated to reflect any changes in the average fuel economy level required under the final standards.

TABLE I.D.2–3—ESTIMATED MINIMUM STANDARD FOR DOMESTICALLY MANUFACTURED PASSENGER CARS UNDER FINAL MY 2011 AND PROPOSED MY 2012–2016 CAFE STANDARDS FOR PASSENGER CARS (MPG)

2011	2012	2013	2014	2015	2016
28.0	30.9	31.6	32.4	33.5	34.9

EPA is proposing GHG emissions standards, and Table I.D.2–4 provides EPA's estimates of their projected overall fleet-wide CO_2 equivalent emission levels.[48] The g/mi values are CO_2 equivalent values because they include the projected use of A/C credits by manufacturers.

TABLE I.D.2–4—PROJECTED FLEET-WIDE EMISSIONS COMPLIANCE LEVELS UNDER THE PROPOSED FOOTPRINT-BASED CO_2 STANDARDS (G/MI)

	2012	2013	2014	2015	2016
Passenger Cars	261	253	246	235	224
Light Trucks	352	341	332	317	302
Combined Cars & Trucks	295	286	276	263	250

As shown in Table I.D.2–4, projected fleet-wide CO_2 emission level requirements for cars under the proposed approach are projected to increase in stringency from 261 to 224 grams per mile between MY 2012 and MY 2016. Similarly, fleet-wide CO_2 equivalent emission level requirements for trucks are projected to increase in stringency from 352 to 302 grams per mile. As shown, the overall fleet average CO_2 level requirements are projected to be 250 g/mile in 2016.

EPA anticipates that manufacturers will take advantage of program flexibilities such as flex fueled vehicle credits, and car/truck credit trading. Due to the credit trading between cars and trucks, the estimated improvements in CO_2 emissions are distributed differently than shown in Table I.D 2–4, where full manufacturer compliance is assumed. Table I.D.2–5 shows EPA projection of the achieved emission levels of the fleet for MY 2012 through 2016, which does consider the impact of car/truck credit transfer and the increase in emissions due to program flexibilities including flex fueled vehicle credits and the temporary leadtime allowance alternative standards. The use of optional air conditioning credits is considered both in this analysis of achieved levels and of the projected levels described above.. As can be seen in Table I.D.2–5, the projected achieved levels are slightly higher for model years 2012–2015 due to the projected use of the proposed flexibilities, but in model

[45] NHTSA's estimates account for availability of CAFE credits for the sale of flexibly-fuel vehicles (FFVs), and for the potential that some manufacturers would pay civil penalties rather than complying with the proposed CAFE standards. This yields NHTSA's estimates of the real-world fuel economy that could be achieved under the proposed CAFE standards. NHTSA has not included any potential impact of car-truck credit transfer in its estimate of the achieved CAFE levels.

[46] 49 U.S.C. 32902(b)(4).

[47] In the March 2009 final rule establishing MY 2011 standards for passenger cars and light trucks, NHTSA estimated that the minimum required CAFE standard for domestically manufactured passenger cars would be 27.8 mpg under the MY 2011 passenger car standard. Based on the agency's current forecast of the MY 2011 passenger car market, NHTSA now estimates that the minimum required CAFE standard will be 28.0 mpg in MY 2011.

[48] These levels do not include the effect of flexible fuel credits, transfer of credits between cars and trucks, temporary lead time allowance, or any other credits with the exception of air conditioning.

year 2016 the achieved value is projected to be 250 g/mi for the fleet.

TABLE I.D.2–5—PROJECTED FLEET-WIDE ACHIEVED EMISSION LEVELS UNDER THE PROPOSED FOOTPRINT-BASED CO_2 STANDARDS (G/MI)

	2012	2013	2014	2015	2016
Passenger Cars	264	254	245	232	220
Light Trucks	365	355	346	332	311
Combined Cars & Trucks	302	291	281	267	250

NHTSA's and EPA's technology assessment indicates there is a wide range of technologies available for manufacturers to consider in upgrading vehicles to reduce GHG emissions and improve fuel economy.[49] As noted, these include improvements to the engines such as use of gasoline direct injection and downsized engines that use turbochargers to provide performance similar to that of larger engines, the use of advanced transmissions, increased use of start-stop technology, improvements in tire performance, reductions in vehicle weight, increased use of hybrid and other advanced technologies, and the initial commercialization of electric vehicles and plug-in hybrids. EPA is also projecting improvements in vehicle air conditioners including more efficient as well as low leak systems. All of these technologies are already available today, and EPA's and NHTSA's assessment is that manufacturers would be able to meet the proposed standards through more widespread use of these technologies across the fleet.

With respect to the practicability of the standards in terms of lead time, during MYs 2012–2016 manufacturers are expected to go through the normal automotive business cycle of redesigning and upgrading their light-duty vehicle products, and in some cases introducing entirely new vehicles not on the market today. This proposal would allow manufacturers the time needed to incorporate technology to achieve GHG reductions and improve fuel economy during the vehicle redesign process. This is an important aspect of the proposal, as it avoids the much higher costs that would occur if manufacturers needed to add or change technology at times other than their scheduled redesigns. This time period would also provide manufacturers the opportunity to plan for compliance using a multi-year time frame, again consistent with normal business practice. Over these five model years, there would be an opportunity for manufacturers to evaluate almost every one of their vehicle model platforms and add technology in a cost effective way to control GHG emissions and improve fuel economy. This includes redesign of the air conditioner systems in ways that will further reduce GHG emissions.

Both agencies considered other standards as part of the rulemaking analyses, both more and less stringent than those proposed. EPA's and NHTSA's analysis of alternative standards are contained in Sections III and IV of this notice, respectively.

The CAFE and GHG standards described above are based on determining emissions and fuel economy using the city and highway test procedures that are currently used in the CAFE program. Both agencies recognize that these test procedures are not fully representative of real world driving conditions. For example EPA has adopted more representative test procedures that are used in determining compliance with emissions standards for pollutants other than GHGs. These test procedures are also used in EPA's fuel economy labeling program. However, as discussed in Section III, the current information on effectiveness of the individual emissions control technologies is based on performance over the two CAFE test procedures. For that reason EPA is proposing to use the current CAFE test procedures for the proposed CO_2 standards and is not proposing to change those test procedures in this rulemaking. NHTSA, as discussed above, is limited by statute in what test procedures can be used for purposes of passenger car testing; however there is no such statutory limitation with respect to test procedures for trucks. However, the same reasons for not changing the truck test procedures apply for CAFE as well.

Both EPA and NHTSA are interested in developing programs that employ test procedures that are more representative of real world driving conditions, to the extent authorized under their respective statutes. This is an important issue, and the agencies intend to address it in the context of a future rulemaking to address standards for model year 2017 and thereafter. This could include a range of test procedure changes to better represent real-world driving conditions in terms of speed, acceleration, deceleration, ambient temperatures, use of air conditioners, and the like. With respect to air conditioner operation, EPA discusses the procedures it intends to use for determining emissions credits for controls on air conditioners in Section III. Comment is also invited in Section IV on the issue of providing air conditioner credits under 49 U.S.C. 32902 and/or 32904 for light-trucks in the model years covered by this proposal.

Finally, based on the information EPA developed in its recent rulemaking that updated its fuel economy labeling program to better reflect average real-world fuel economy, the calculation of fuel savings and CO_2 emissions reductions obtained by the proposed CAFE and GHG standards includes adjustments to account for the difference between the fuel economy level measured in the CAFE test procedure and the fuel economy actually achieved on average under real world driving conditions. These adjustments are industry averages for the vehicles' performance as a whole, however, and are not a substitute for the information on effectiveness of individual control technologies that will be explored for purposes of a future GHG and CAFE rulemaking.

3. Form of the Standards

In this rule, NHTSA and EPA are proposing attribute-based standards for passenger cars and light trucks. NHTSA adopted an attribute standard based on vehicle footprint in its Reformed CAFE program for light trucks for model years 2008–2011,[50] and recently extended this approach to passenger cars in the CAFE rule for MY 2011 as required by EISA.[51] EPA and NHTSA are proposing vehicle footprint as the attribute for the GHG

[49] The close relationship between emissions of CO_2—the most prevalent greenhouse gas emitted by motor vehicles—and fuel consumption, means that the technologies to control CO_2 emissions and to improve fuel economy overlap to a great degree

[50] 71 FR 17566 (Apr. 6, 2006).

[51] 74 FR 14196 (Mar. 30, 2009).

and CAFE standards. Footprint is defined as a vehicle's wheelbase multiplied by its track width—in other words, the area enclosed by the points at which the wheels meet the ground. The agencies believe that the footprint attribute is the most appropriate attribute on which to base the standards under consideration, as further discussed later in this notice and in Chapter 2 of the joint TSD.

Under the proposed footprint-based standards, each manufacturer would have a GHG and CAFE target unique to its fleet, depending on the footprints of the vehicle models produced by that manufacturer. A manufacturer would have separate footprint-based standards for cars and for trucks. Generally, larger vehicles (*i.e.*, vehicles with larger footprints) would be subject to less stringent standards (*i.e.*, higher CO_2 grams/mile standards and lower CAFE standards) than smaller vehicles. This is because, generally speaking, smaller vehicles are more capable of achieving higher standards than larger vehicles. While a manufacturer's fleet average standard could be estimated throughout the model year based on projected production volume of its vehicle fleet, the standard to which the manufacturer must comply would be based on its final model year production figures. A manufacturer's calculation of fleet average emissions at the end of the model year would thus be based on the production-weighted average emissions of each model in its fleet.

In designing the footprint-based standards, the agencies built upon the footprint standard curves for passenger cars and light trucks used in the CAFE rule for MY 2011.[52] EPA and NHTSA worked together to design car and truck footprint curves that followed from logistic curves used in that rule. The agencies started by addressing two main concerns regarding the car curve. The first concern was that the 2011 car curve was relatively steep near the inflection point thus causing concern that small variations in footprint could produce relatively large changes in fuel economy targets. A curve that was directionally less steep would reduce the potential for gaming. The second issue was that the inflection point of the logistic curve was not centered on the distribution of vehicle footprints across the industries' fleet, thus resulting in a flat (universal or unreformed) standard for over half the fleet. The proposed car curve has been shifted and made less steep compared to the car curve adopted by NHTSA for 2011, such that it better aligns the sloped region with higher production volume vehicle models. Finally, both the car and truck curves are defined in terms of a constrained linear function for fuel consumption and, equivalently, a piece-wise linear function for CO_2. NHTSA and EPA include a full discussion of the development of these curves in the joint TSD and a summary is found in Section II below. In addition, a full discussion of the equations and coefficients that define the curves is included in Section III for the CO_2 curves and Section IV for the mpg curves. The following figures illustrate the standards. First Figure I.D.3–1 shows the fuel economy (mpg) car standard curve.

Under an attribute-based standard, every vehicle model has a performance target (fuel economy for the CAFE standards, and CO_2 g/mile for the GHG emissions standards), the level of which depends on the vehicle's attribute (for this proposal, footprint). The manufacturers' fleet average performance is determined by the production-weighed[53] average (for CAFE, harmonic average) of those targets. NHTSA and EPA are proposing CAFE and CO_2 emissions standards defined by constrained linear functions and, equivalently, piecewise linear functions.[54] As a possible option for future rulemakings, the constrained linear form was introduced by NHTSA in the 2007 NPRM proposing CAFE standards for MY 2011–2015.

NHTSA is proposing the attribute curves below for assigning a fuel economy level to an individual vehicle's footprint value, for model years 2012 through 2016. These mpg values would be production weighted to determine each manufacturer's fleet average standard for cars and trucks. Although the general model of the equation is the same for each vehicle category and each year, the parameters of the equation differ for cars and trucks. Each parameter also changes on an annual basis, resulting in the yearly increases in stringency. Figure I.D.3–1 below illustrates the passenger car CAFE standard curves for model years 2012 through 2016 while Figure I.D.3–2 below illustrates the light truck standard curves for model years 2012–2016. The MY 2011 final standards for cars and trucks, which are specified by a constrained logistic function rather than a constrained linear function, are shown for comparison.

BILLING CODE 4910–59–P

[52] 74 FR 14407–14409 (Mar. 30, 2009).

[53] Production for sale in the United States.

[54] The equations are equivalent but are specified differently due to differences in the agencies' respective models.

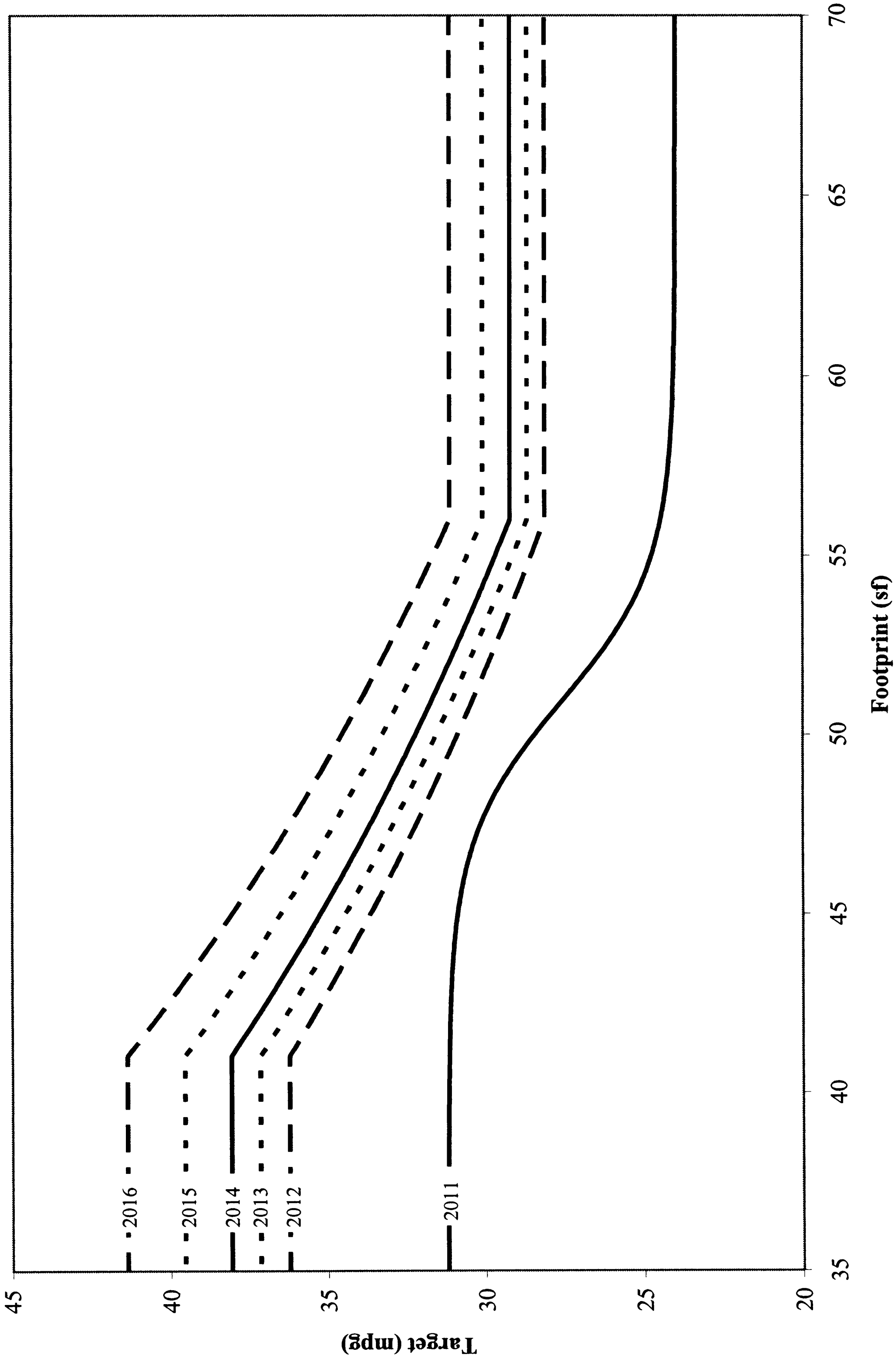


Figure I.D.3-1 Final MY 2011 and Proposed MY 2012-2016 Passenger Car Fuel Economy Targets

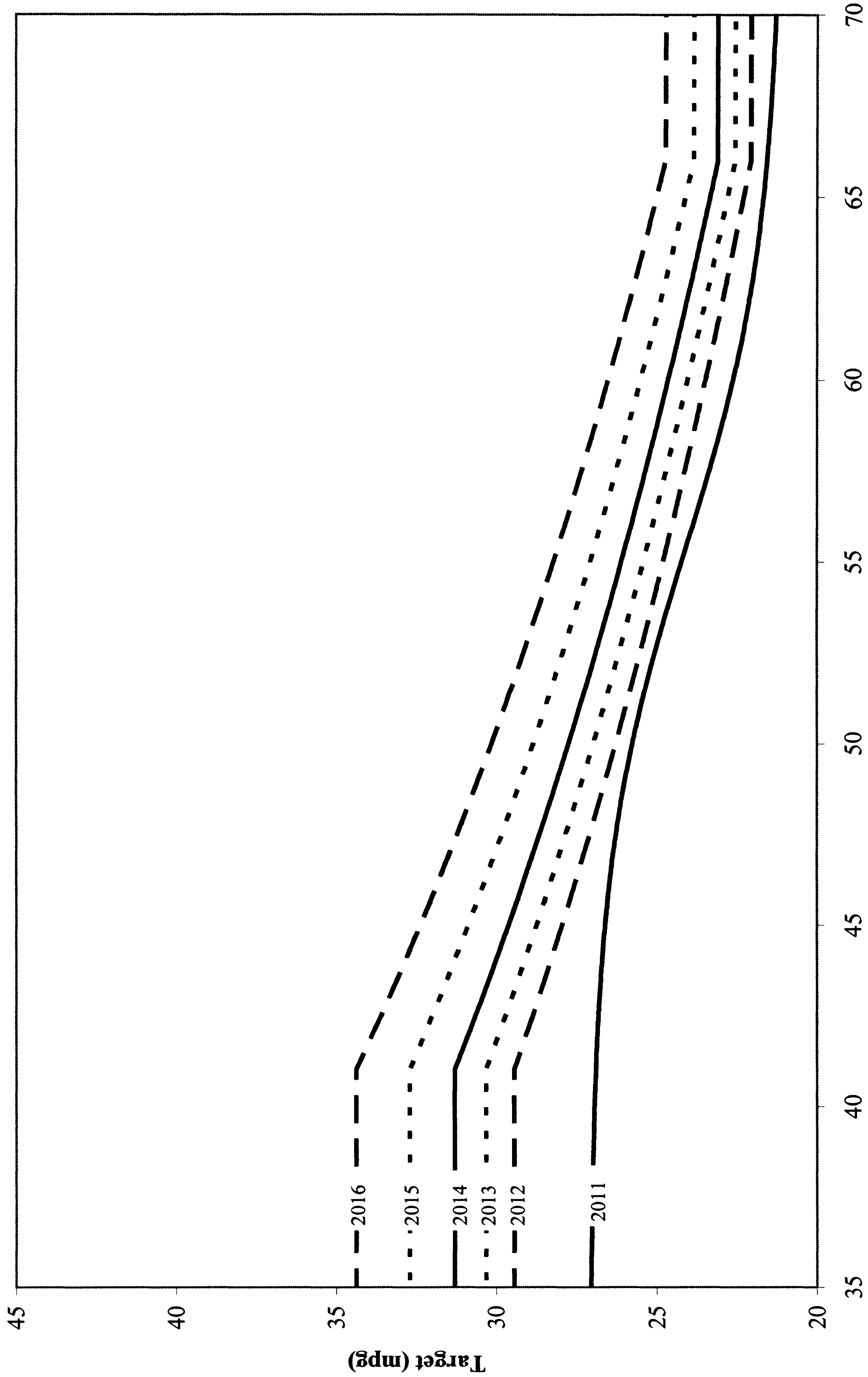


Figure I.D.3-2. Final MY 2011 and Proposed MY 2012-2016 Light Truck Fuel Economy Targets

EPA is proposing the attribute curves below for assigning a CO_2 level to an individual vehicle's footprint value, for model years 2012 through 2016. These CO_2 values would be production weighted to determine each manufacturer's fleet average standard for cars and trucks. Although the general model of the equation is the same for each vehicle category and each year, the parameters of the equation differ for cars and trucks. Each parameter also changes on an annual basis, resulting in the yearly increases in stringency. Figure I.D.3–3 below illustrates the CO_2 car standard curves for model years 2012 through 2016 while Figure I.D.3–4 shows the CO_2 truck standard curves for Model Years 2012–2016.

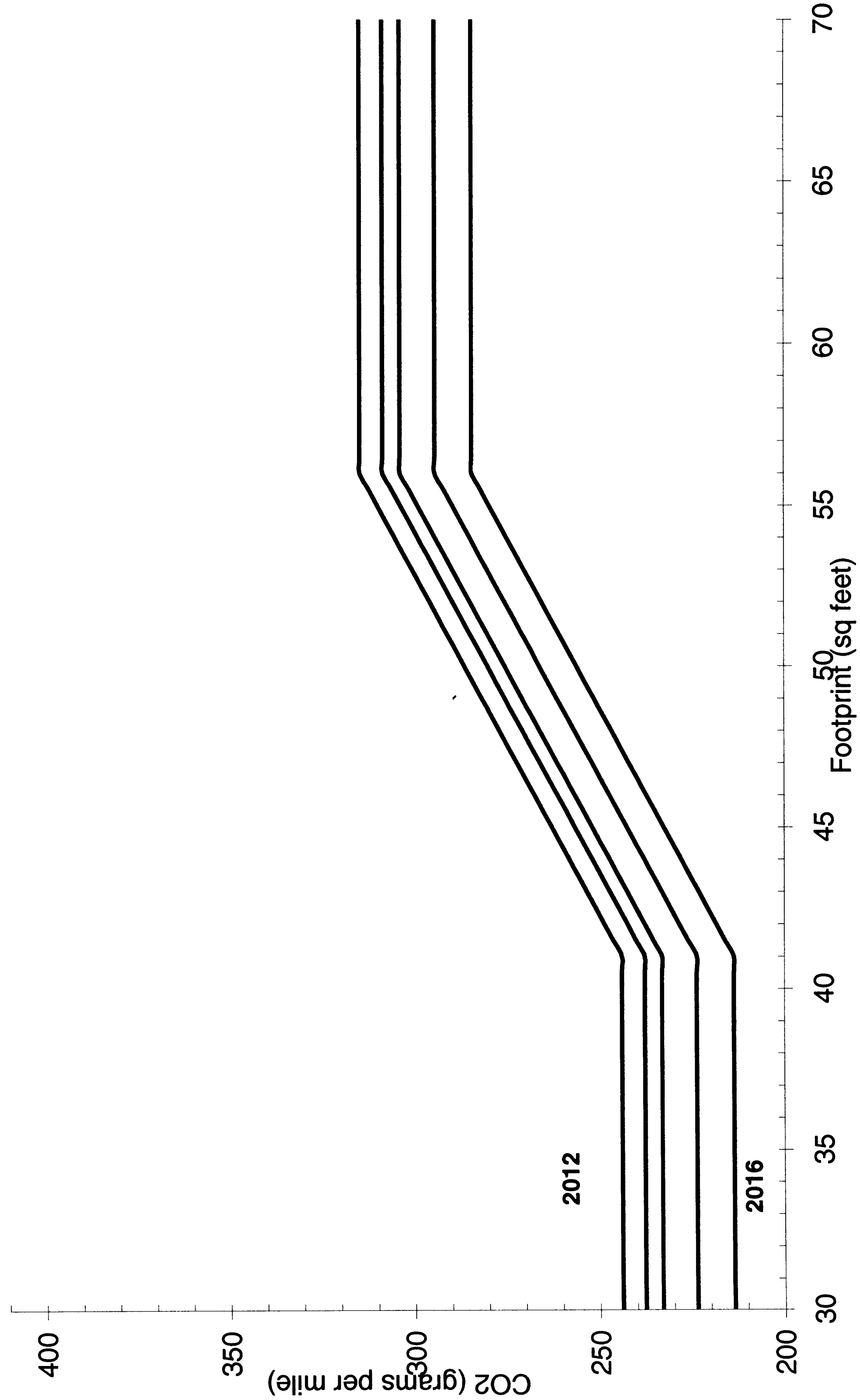


Figure I.D.3-3. CO2 (g/mi) Car standard curves.

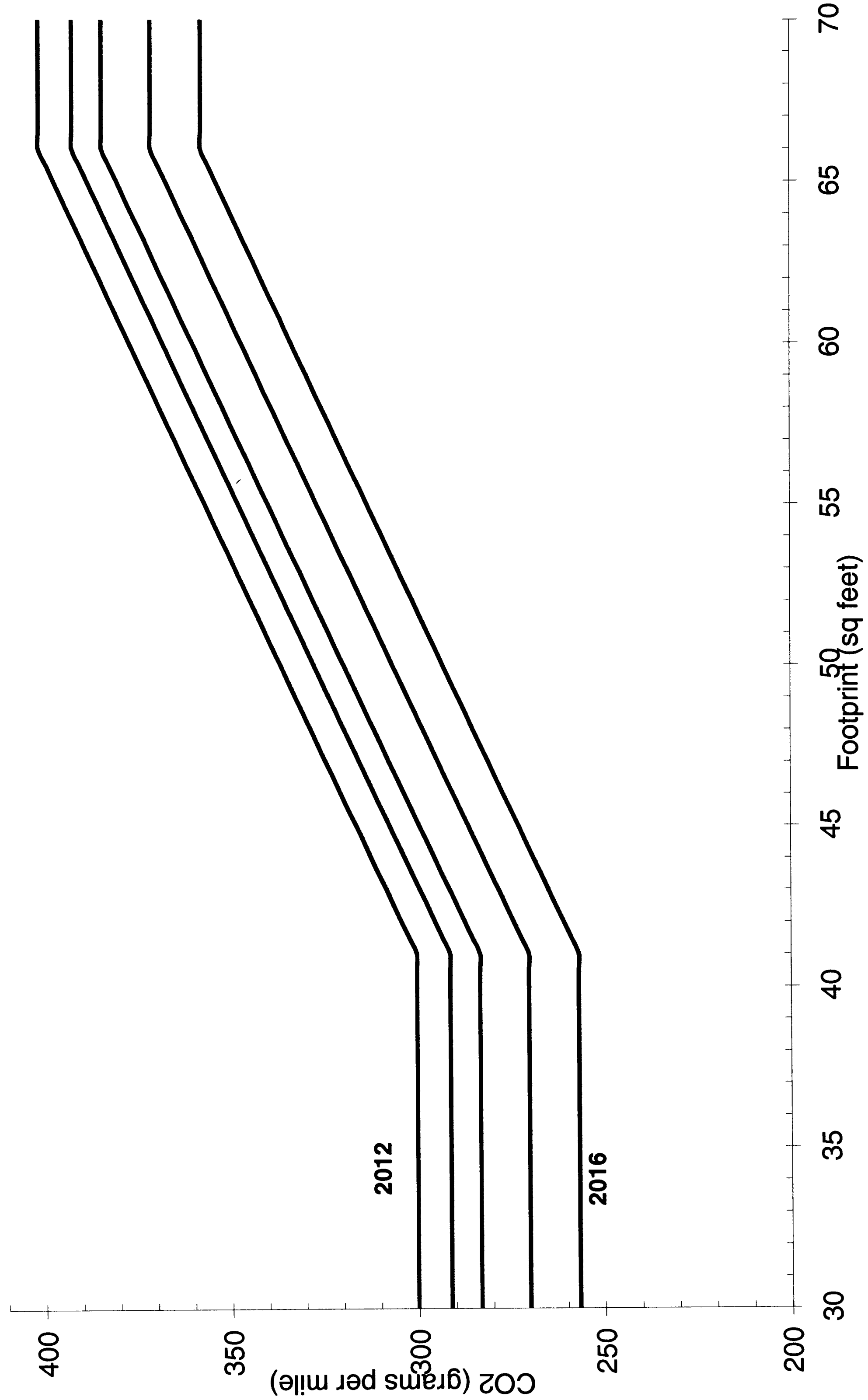


Figure I.D.3-4. CO2 (g/mi) Truck standard curves.

BILLING CODE 4910–59–C

NHTSA and EPA propose to use the same vehicle category definitions for determining which vehicles are subject to the car footprint curves versus the truck curve standards. In other words, a vehicle classified as a car under the NHTSA CAFE program would also be classified as a car under the EPA GHG program, and likewise for trucks. EPA and NHTSA are proposing to employ the same car and truck definitions for the MY 2012–2016 CAFE and GHG standards as those used in the CAFE program for the 2011 model year standards.[55] This proposed approach of using CAFE definitions allows EPA's

[55] 49 CFR part 523.

proposed CO_2 standards and the proposed CAFE standards to be harmonized across all vehicles. EPA is not changing the car/truck definition for the purposes of any other previous rule.

Generally speaking, a smaller footprint vehicle will have lower CO_2 emissions relative to a larger footprint vehicle. A footprint-based CO_2 standard can be relatively neutral with respect to vehicle size and consumer choice. All vehicles, whether smaller or larger, must make improvements to reduce CO_2 emissions, and therefore all vehicles will be relatively more expensive. With the footprint-based standard approach, EPA and NHTSA believe there should be no significant effect on the relative distribution of different vehicle sizes in the fleet, which means that consumers will still be able to purchase the size of vehicle that meets their needs. Table I.D.3–1 illustrates the fact that different vehicle sizes will have varying CO_2 emissions and fuel economy targets under the proposed standards.

TABLE I.D.3–1—MODEL YEAR 2016 CO_2 AND FUEL ECONOMY TARGETS FOR VARIOUS MY 2008 VEHICLE TYPES

Vehicle type	Example models	Example model footprint (sq. ft.)	CO_2 emissions target (g/mi)	Fuel economy target (mpg)
Example Passenger Cars				
Compact car	Honda Fit	40	214	41.4
Midsize car	Ford Fusion	46	237	37.3
Fullsize car	Chrysler 300	53	270	32.8
Example Light-Duty Trucks				
Small SUV	4WD Ford Escape	44	269	32.8
Midsize crossover	Nissan Murano	49	289	30.6
Minivan	Toyota Sienna	55	313	28.2
Large pickup truck	Chevy Silverado	67	358	24.7

E. Summary of Costs and Benefits for the Joint Proposal

This section summarizes the projected costs and benefits of the proposed CAFE and GHG emissions standards. These projections helped inform the agencies' choices among the alternatives considered and provide further confirmation that proposed standards fall within the spectrum of choices allowable under their respective statutory criteria. The costs and benefits projected by NHTSA to result from NHTSA's proposed CAFE standards are presented first, followed by those from EPA's analysis of the proposed GHG emissions standards.

The agencies recognize that there are uncertainties regarding the benefit and cost values presented in this proposal. Some benefits and costs are not quantified. The values of other benefits and costs could be too low or too high.

For several reasons, the estimates for costs and benefits presented by NHTSA and EPA, while consistent, are not directly comparable, and thus should not be expected to be identical. Most important, NHTSA and EPA's proposed standards would require slightly different fuel efficiency improvements. EPA's proposed GHG standard is more stringent in part due to its assumptions about manufacturers' use of air conditioning credits, which result from reductions in air conditioning-related emissions of HFCs and CO_2. In addition, the proposed CAFE and GHG standards offer different program flexibilities, and the agencies' analyses differ in their accounting for these flexibilities (for example, FFVs *etc.*), primarily because NHTSA is statutorily prohibited from considering some flexibilities when establishing CAFE standards, while EPA is not. These differences contribute to differences in the agencies' respective estimates of costs and benefits resulting from the new standards.

Because EPCA prohibits NHTSA from considering the use of FFV credits when *establishing* CAFE standards, the agency's primary analysis of costs, fuel savings, and related benefits from imposing higher CAFE standards does not include them. However, EPCA does not prohibit NHTSA from considering the fact that manufacturers may pay civil penalties rather than complying with CAFE standards, and NHTSA's primary analysis accounts for some manufacturers' tendency to do so. In addition, NHTSA performed a supplemental analysis of the effect of FFV credits on benefits and costs from its proposed CAFE standards, to demonstrate the real-world impacts of FFVs, and the summary estimates presented in Section IV include these effects. Including the use of FFV credits reduces estimated per-vehicle compliance costs of the program. However, as shown below, including FFV credits does not significantly change the projected fuel savings and CO_2 reductions, because FFV credits reduce the fuel economy levels that manufacturers achieve not only under the proposed standards, but also under the baseline MY 2011 CAFE standards.

Also, EPCA, as amended by EISA, allows manufacturers to transfer credits between their passenger car and light truck fleets. However, EPCA also prohibits NHTSA from considering manufacturers' ability to use CAFE credits when determining the stringency of the CAFE standards. Because of this prohibition, NHTSA's primary analysis does not account for the extent to which credit transfers might actually occur. For purposes of its supplemental analysis, NHTSA considered accounting for the fact that EPCA allows some transfer of CAFE credits between the passenger car and light truck fleets, but determined that in NHTSA's year-by-year analysis, manufacturers' likely credit transfers cannot be reasonably estimated at this time.[56]

Therefore, NHTSA's primary analysis shows the estimates the agency considered for purposes of establishing new CAFE standards, and its supplemental analysis including manufacturers' potential use of FFV credits currently reflects the agency's best estimate of the potential real-world effects of the proposed CAFE standards.

[56] NHTSA's analysis estimates multi-year planning effects within a context in which each model year is represented explicitly, and technologies applied in one model year carry forward to future model years. NHTSA does not currently have a basis to estimate how a manufacturer might, for example, weigh the transfer of credits from the passenger car to the light truck fleet in MY 2013 against the potential to carry light truck technologies forward from MY 2013 through MY 2016. The agency is considering the possibility of implementing such analysis for purposes of the final rule.

EPA made explicit assumptions about manufacturers' use of FFV credits under both the baseline and control alternatives, and its estimates of costs and benefits from the proposed GHG standards reflect these assumptions. However, under the proposed GHG standards, FFV credits would be available through MY 2015; starting in MY 2016, EPA proposes to allow FFV credits only based on a manfuacturers's demonstration that the alternative fuel is actually being used in the vehicles and the actual GHG performance for the vehicle run on that alternative fuel.

EPA's analysis also assumes that manufacturers would transfer credits between their car and truck fleets in the MY 2011 baseline subject to the maximum value allowed by EPCA, and that unlimited car-truck credit transfers would occur under the proposed GHG standards. Including these assumptions in EPA's analysis increases the resulting estimates of fuel savings and reductions in GHG emissions, while reducing EPA's estimates of program compliance costs.

Finally, under the proposed EPA GHG program, there is no ability for a manufacturer to intentionally pay fines in lieu of meeting the standard. Under EPCA, however, vehicle manufacturers are allowed to pay fines as an alternative to compliance with applicable CAFE standards. NHTSA's analysis explicitly estimates the level of voluntary fine payment by individual manufacturers, which reduces NHTSA's estimates of both the costs and benefits of its proposed CAFE standards. In contrast, the CAA does not allow for fine payment in lieu of compliance with emission standards, and EPA's analysis of costs and benefits from its proposed standard thus assumes full compliance. This assumption results in higher estimates of fuel savings, reductions in GHG emissions, and manufacturers' compliance costs to sell fleets that comply with both NHTSA's proposed CAFE program and EPA's proposed GHG program.

In summary, the projected costs and benefits presented by NHTSA and EPA are not directly comparable, because the levels being proposed by EPA include air conditioning-related improvements in equivalent fuel efficiency and HFC reductions, because the assumptions incorporated in EPA's analysis regarding car-truck credit transfers, and because of the projection by EPA of complete compliance with the proposed GHG standards. It should also be expected that overall EPA's estimates of GHG reductions and fuel savings achieved by the proposed GHG standards will be slightly higher than those projected by NHTSA only for the CAFE standards because of the reasons described above. For the same reasons, EPA's estimates of manufacturers' costs for complying with the proposed passenger car and light trucks GHG standards are slightly higher than NHTSA's estimates for complying with the proposed CAFE standards.

1. Summary of Costs and Benefits of Proposed NHTSA CAFE Standards

Without accounting for the compliance flexibilities that NHTSA is prohibited from considering when determining the level of new CAFE standards, since manufacturers' decisions to use those flexibilities are voluntary, NHTSA estimates that these fuel economy increases would lead to fuel savings totaling 62 billion gallons throughout the useful lives of vehicles sold in MYs 2012–2016. At a 3% discount rate, the present value of the economic benefits resulting from those fuel savings is $158 billion.

The agency further estimates that these new CAFE standards would lead to corresponding reductions in CO_2 emissions totaling 656 million metric tons (mmt) during the useful lives of vehicles sold in MYs 2012–2016. The present value of the economic benefits from avoiding those emissions is $16.4 billion, based on a global social cost of carbon value of $20 per metric ton,[57] although NHTSA estimated the benefits associated with five different values of a one ton GHG reduction ($5, $10, $20, $34, $56).[58] *See* Section II for a more detailed discussion of the social cost of carbon. It is important to note that NHTSA's CAFE standards and EPA's GHG standards will both be in effect, and each will lead to increases in average fuel economy and CO_2 emissions reductions. The two agencies' standards together comprise the National Program, and this discussion of costs and benefits of NHTSA's CAFE standards does not change the fact that both the CAFE and GHG standards, jointly, are the source of the benefits and costs of the National Program.

TABLE I.E.1–1—NHTSA FUEL SAVED (BILLION GALLONS) AND CO_2 EMISSIONS AVOIDED (MMT) UNDER PROPOSED CAFE STANDARDS (WITHOUT FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Fuel (b. gal.)	4	9	13	16	19	62
CO_2 (mmt)	44	96	137	173	206	656

Considering manufacturers' ability to earn credit toward compliance by selling FFVs, NHTSA estimates very little change in incremental fuel savings and avoided CO_2 emissions, assuming FFV credits would be used toward both the baseline and proposed standards:

[57] We have developed two interim estimates of the global social cost of carbon (SCC) ($/t$CO_2$ in 2007 (2006$)): $33 per t$CO_2$ at a 3% discount rate, and $5 per t$CO_2$ with a 5% discount rate. The 3% and 5% estimates have independent appeal and at this time a clear preference for one over the other is not warranted. Thus, we have also included—and centered our current attention on—the average of the estimates associated with these discount rates, which is $19 (in 2006$) per ton of CO_2 emissions. When converted to 2007$ for consistency with other economic values used in the agency's analysis, this figure corresponds to $20 per metric ton of CO_2 emissions occurring in 2007. This value is assumed to increase at 3% annually for emissions occurring after 2007.

[58] The $10 and $56 figures are alternative interim estimates based on uncertainty about interest rates of long periods of time. They are based on an approach that models discount rate uncertainty as something that evolves over time; in contrast, the preferred approach mentioned in the immediately preceding paragraph assumes that there is a single discount rate with equal probability of 3% and 5%.

TABLE I.E.1–2—NHTSA FUEL SAVED (BILLION GALLONS) AND CO_2 EMISSIONS AVOIDED (MMT) UNDER PROPOSED CAFE STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Fuel (b. gal.)	5	8	12	15	19	59
CO_2 (mmt)	49	90	129	167	204	639

NHTSA estimates that these fuel economy increases would produce other benefits both to drivers (*e.g.,* reduced time spent refueling) and to the U.S. (*e.g.,* reductions in the costs of petroleum imports *beyond* the direct savings from reduced oil purchases, as well as some disbenefits (*e.g.,* increase traffic congestion) caused by drivers' tendency to travel more when the cost of driving declines (as it does when fuel economy increases). NHTSA has estimated the total monetary value to society of these benefits and disbenefits, and estimates that the proposed standards will produce significant net benefits to society. Using a 3% discount rate, NHTSA estimates that the present value of these benefits would total more than $200 billion over the useful lives of vehicles sold during MYs 2012–2016. More discussion regarding monetized benefits can be found in Section IV of this notice and in NHTSA's Regulatory Impact Analysis.

TABLE I.E.1–3—NHTSA DISCOUNTED BENEFITS ($BILLION) UNDER PROPOSED CAFE STANDARDS (BEFORE FFV CREDITS, USING 3 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	7.6	17.0	24.4	31.2	38.7	119.1
Light Trucks	5.5	11.6	17.3	22.2	26.0	82.6
Combined	13.1	28.7	41.8	53.4	64.7	201.7

Using a 7% discount rate, NHTSA estimates that the present value of these benefits would total more than $159 billion over the same time period.

TABLE I.E.1–4—NHTSA DISCOUNTED BENEFITS ($BILLION) UNDER PROPOSED STANDARDS (BEFORE FFV CREDITS, USING 7 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	6.0	13.6	19.5	25.0	31.1	95.3
Light Trucks	4.3	9.1	13.5	17.4	20.4	64.6
Combined	10.3	22.6	33.1	42.4	51.5	159.8

NHTSA estimates that FFV credits could reduce achieved benefits by about 4.5%:

TABLE I.E.1–5a—NHTSA DISCOUNTED BENEFITS ($BILLION) UNDER PROPOSED CAFE STANDARDS (WITH FFV CREDITS, USING A 3 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	7.8	15.9	22.5	28.6	37.1	111.9
Light Trucks	6.1	10.2	15.9	22.1	26.3	80.5
Combined	13.9	26.1	38.4	50.7	63.3	192.5

TABLE I.E.1–5b—NHTSA DISCOUNTED BENEFITS ($BILLION) UNDER PROPOSED CAFE STANDARDS (WITH FFV CREDITS, USING A 7 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	6.2	12.7	18.0	23.0	29.8	89.6
Light Trucks	4.7	7.9	12.4	17.3	20.6	63.0
Combined	10.9	20.6	20.4	40.3	50.4	152.5

NHTSA attributes most of these benefits—about $158 billion (at a 3% discount rate and excluding consideration of FFV credits), as noted above—to reductions in fuel consumption, valuing fuel (for societal purposes) at the future pre-tax prices projected in the Energy Information Administration's (EIA's) reference case forecast from Annual Energy Outlook (AEO) 2009. The Preliminary Regulatory Impact Analysis (PRIA) accompanying this proposed rule presents a detailed analysis of specific benefits of the proposed rule.

TABLE I.E.1–6—SUMMARY OF BENEFITS FUEL SAVINGS AND CO_2 EMISSIONS REDUCTION DUE TO THE PROPOSED RULE (BEFORE FFV CREDITS)

	Amount	Monetized value (discounted)	
		3% Discount rate	7% Discount rate
Fuel savings	61.6 billion gallons	$158.0 billion	$125.3 billion.
CO_2 emissions reductions	656 million metric tons (mmt)	$16.4 billion	$12.8 billion.

NHTSA estimates that the increases in technology application necessary to achieve the projected improvements in fuel economy will entail considerable monetary outlays. The agency estimates that incremental costs for achieving its proposed standards—that is, outlays by vehicle manufacturers over and above those required to comply with the MY 2011 CAFE standards—will total about $60 billion (*i.e.,* during MYs 2012–2016).

TABLE I.E.1–7—NHTSA INCREMENTAL TECHNOLOGY OUTLAYS ($BILLION) UNDER PROPOSED CAFE STANDARDS (BEFORE FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	4.1	6.5	8.4	9.9	11.8	40.8
Light Trucks	1.5	2.8	4.0	5.2	5.9	19.4
Combined	5.7	9.3	12.5	15.1	17.6	60.2

NHTSA estimates that use of FFV credits could significantly reduce these outlays:

TABLE I.E.1–8—NHTSA INCREMENTAL TECHNOLOGY OUTLAYS ($BILLION) UNDER PROPOSED CAFE STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.5	4.4	6.1	7.4	9.3	29.6
Light Trucks	1.3	2.0	3.1	4.3	5.0	15.6
Combined	3.7	6.3	9.2	11.7	14.2	45.2

The agency projects that manufacturers will recover most or all of these additional costs through higher selling prices for new cars and light trucks. To allow manufacturers to recover these increased outlays (and, to a much lesser extent, the civil penalties that some companies are expected to pay for noncompliance), the agency estimates that the proposed standards would lead to increases in average new vehicle prices ranging from $476 per vehicle in MY 2012 to $1,091 per vehicle in MY 2016:

TABLE I.E.1–9—NHTSA INCREMENTAL INCREASES IN AVERAGE NEW VEHICLE COSTS ($) UNDER PROPOSED CAFE STANDARDS (BEFORE FFV CREDITS)

	2012	2013	2014	2015	2016
Passenger Cars	591	735	877	979	1,127
Light Trucks	283	460	678	882	1,020
Combined	476	635	806	945	1,091

NHTSA estimates that use of FFV credits could significantly reduce these costs, especially in earlier model years:

TABLE I.E.1–10—NHTSA INCREMENTAL INCREASES IN AVERAGE NEW VEHICLE COSTS ($) UNDER PROPOSED CAFE STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016
Passenger Cars	295	448	591	695	851
Light Trucks	231	347	533	758	895

TABLE I.E.1–10—NHTSA INCREMENTAL INCREASES IN AVERAGE NEW VEHICLE COSTS ($) UNDER PROPOSED CAFE STANDARDS (WITH FFV CREDITS)—Continued

	2012	2013	2014	2015	2016
Combined	271	411	571	716	866

NHTSA estimates, therefore, that the total benefits of these proposed standards would be more than three times the magnitude of the corresponding costs. As a consequence, its proposed standards would produce net benefits of $142 billion at a 3 percent discount rate (with FFV credits, $147 billion) or $100 billion at a 7 percent discount rate over the useful lives of vehicles sold during MYs 2012–2016.

2. Summary of Costs and Benefits of Proposed EPA GHG Standards

EPA has conducted a preliminary assessment of the costs and benefits of the proposed GHG standards. Table I.E.2–1 shows EPA's estimated lifetime fuel savings and CO_2 equivalent emission reductions for all vehicles sold in the model years 2012–2016. The values in Table I.E.2–1 are projected lifetime totals for each model year and are not discounted. As documented in DRIA Chapter 5, the potential credit transfer between cars and trucks may change the distribution of the fuel savings and GHG emission impacts between cars and trucks. As discussed above with respect to NHTSA's CAFE standards, it is important to note that NHTSA's CAFE standards and EPA's GHG standards will both be in effect, and each will lead to increases in average fuel economy and CO_2 emissions reductions. The two agency's standards together comprise the National Program, and this discussion of costs and benefits of EPA's GHG standards does not change the fact that both the CAFE and GHG standards, jointly, are the source of the benefits and costs of the National Program.

TABLE I.E.2–1—EPA'S ESTIMATED 2012–2016 MODEL YEAR LIFETIME FUEL SAVED AND GHG EMISSIONS AVOIDED

		2012	2013	2014	2015	2016	Total
Cars	Fuel (billion gallons)	4	6	8	11	14	43
	Fuel (billion barrels)	0.1	0.1	0.2	0.3	0.3	1.0
	CO_2 EQ (mmt)	51	74	98	137	179	539
Light Trucks	Fuel (billion gallons)	2	4	6	9	12	33
	Fuel (billion barrels)	0.1	0.1	0.1	0.2	0.3	0.8
	CO_2 EQ (mmt)	30	51	77	107	143	408
Combined	Fuel (billion gallons)	7	10	14	19	26	76
	Fuel (billion barrels)	0.2	0.2	0.3	0.5	0.6	1.8
	CO_2 EQ (mmt)	81	125	174	244	323	947

Table I.E.2–2 shows EPA's estimated lifetime discounted benefits for all vehicles sold in model years 2012–2016. Although EPA estimated the benefits associated with five different values of a one ton GHG reduction ($5, $10, $20, $34, $56), for the purposes of this overview presentation of estimated benefits EPA is showing the benefits associated with one of these marginal values, $20 per ton of CO_2, in 2007 dollars and 2007 emissions, in this joint proposal. Table I.E.2–2 presents benefits based on the $20 value. Section III.H presents the five marginal values used to estimate monetized benefits of GHG reductions and Section III.H presents the program benefits using each of the five 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. These factors are being used on an interim basis while analysis is conducted to generate new estimates. The values in the table are discounted values for each model year throughout their projected lifetimes. The benefits include all benefits considered by EPA such as fuel savings, GHG reductions, PM benefits, energy security and other externalities such as reduced refueling and accidents, congestion and noise. The lifetime discounted benefits are shown for one of five different social cost of carbon (SCC) values considered by EPA. The values in Table I.E.2–2 do not include costs associated with new technology required to meet the proposal.

TABLE I.E.2–2—EPA'S ESTIMATED 2012–2016 MODEL YEAR LIFETIME DISCOUNTED BENEFITS ASSUMING THE $20/TON SCC VALUE [a]

[$Billions of 2007 dollars]

Discount rate	Model year					
	2012	2013	2014	2015	2016	Total
3%	$20.4	$31.7	$44.9	$63.7	$87.2	$248
7	15.8	24.7	34.9	49.3	67.7	193

[a] The benefits include all benefits considered by EPA such as fuel savings, GHG reductions, PM benefits, energy security and other externalities such as reduced refueling and accidents, congestion and noise.

Table I.E.2–3 shows EPA's 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 2012–2016. The estimated fuel savings in billions of barrels and the GHG reductions in million metric tons of CO_2 shown in Table I.E.2–3 are totals for the five model years throughout their projected lifetime and are not discounted. The monetized values shown in Table I.E.2–3 are the summed values of the discounted monetized-fuel savings and monetized-CO_2 reductions for the five model years 2012–2016 throughout their lifetimes. The monetized values in Table I.E.2–3 reflect both a 3 percent and a 7 percent discount rate as noted.

TABLE I.E.2–3—EPA'S ESTIMATED 2012–2016 MODEL YEAR LIFETIME FUEL SAVINGS, CO_2 EMISSION REDUCTIONS, AND DISCOUNTED MONETIZED BENEFITS AT A 3% DISCOUNT RATE

[Monetized values in 2007 dollars]

	Amount	$ value (billions)
Fuel savings	1.8 billion barrels	$193, 3% discount rate. $151, 7% discount rate.
CO_2 emission reductions (valued assuming $20/ton CO_2 in 2007).	947 MMT CO_2e	$21.0, 3% discount rate. $15.0, 7% discount rate.

Table I.E.2–4 shows EPA's estimated incremental technology outlays for cars and trucks for each of the model years 2012–2016. The total outlays are also shown. The technology outlays shown in Table I.E.2–4 are for the industry as a whole and do not account for fuel savings associated with the proposal.

TABLE I.E.2–4—EPA'S ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS
[$BILLIONS OF 2007 DOLLARS]

	2012	2013	2014	2015	2016	Total
Cars	$3.5	$5.3	$7.0	$8.9	$10.7	$35.3
Trucks	2.0	3.1	4.0	5.1	6.8	20.9
Combined	5.4	8.4	10.9	13.9	17.5	56.1

Table I.E.2–5 shows EPA's estimated incremental cost increase of the average new vehicle for each model year 2012–2016. The values shown are incremental to a baseline vehicle and are not cumulative. In other words, the estimated increase for 2012 model year cars is $374 relative to a 2012 model year car absent the proposal. The estimated increase for a 2013 model year car is $531 relative to a 2013 model year car absent the proposal (not $374 plus $531).

TABLE I.E.2–5—EPA'S ESTIMATED INCREMENTAL INCREASE IN AVERAGE NEW VEHICLE COST

[2007 Dollars per unit]

	2012	2013	2014	2015	2016
Cars	$374	$531	$663	$813	$968
Trucks	358	539	682	886	1,213
Combined	368	534	670	838	1,050

F. Program Flexibilities for Achieving Compliance

EPA's and NHTSA's proposed programs provide compliance flexibility to manufacturers, especially in the early years of the National Program. This flexibility is expected to provide sufficient lead time for manufacturers to make necessary technological improvements and reduce the overall cost of the program, without compromising overall environmental and fuel economy objectives. The broad goal of harmonizing the two agencies' proposed standards includes preserving manufacturers' flexibilities in meeting the standards, to the extent appropriate and required by law. The following section provides an overview of the flexibility provisions the agencies are proposing.

1. CO_2/CAFE Credits Generated Based on Fleet Average Performance

Under the NHTSA and EPA proposal the fleet average standards that apply to a manufacturer's car and truck fleets would be based on the applicable footprint-based curves. At the end of each model year, when production of the model year is complete, a production-weighted fleet average would be calculated for each averaging set (cars and trucks). Under this approach, a manufacturer's car and/or truck fleet that achieves a fleet average CO_2/CAFE level better than the standard would generate credits. Conversely, if the fleet average CO_2/CAFE level does not meet the standard the fleet would generate debits (also referred to as a shortfall).

Under the proposed program, a manufacturer whose fleet generates credits in a given model year would have several options for using those credits, including credit carry-back, credit carry-forward, credit transfers, and credit trading. These provisions exist in the MY 2011 CAFE program under EPCA and EISA, 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. EPA is proposing that the manufacturer would be able to carry-back credits to offset any deficit that had accrued in a prior model year and was subsequently carried over to the current model year. EPCA already provides for this. EPCA restricts the carry-back of CAFE credits to three years and EPA is proposing the same limitation, in keeping with the goal of harmonizing both sets of proposed standards.

After satisfying any need to offset pre-existing deficits, remaining credits could be saved (banked) for use in future years. Under the CAFE program, EISA allows manufacturers to apply credits earned in a model year to compliance in any of the five subsequent model years.[59] EPA is also proposing, under the GHG program, to allow manufacturers to use these banked credits in the five years after the year in which they were generated (*i.e.,* five years carry-forward).

EISA required NHTSA to establish by regulation a CAFE credits transferring program, which NHTSA established in a March 2009 final rule codified at 49 CFR part 536, to allow a manufacturer to transfer credits between its vehicle fleets to achieve compliance with the standards. For example, credits earned by over-compliance with a manufacturer's car fleet average standard could be used to offset debits incurred due to that manufacturer's not meeting the truck fleet average standard in a given year. EPA's Tier 2 program also provides for this type of credit transfer. For purposes of this NPRM, EPA proposes unlimited credit transfers across a manufacturer's car-truck fleet to meet the GHG standard. This is based on the expectation that this kind of credit transfer provision will allow the required GHG emissions reductions to be achieved in the most cost effective way, and this flexibility will facilitate the ability of the manufacturers to comply with the GHG standards in the lead time provided. Under the CAA, unlike under EISA, there is no statutory limitation on car-truck credit transfers. Therefore EPA is not proposing to constrain car-truck credit transfers as doing so would increase costs with no corresponding environmental benefit. For the CAFE program, however, EISA limits the amount of credits that may be transferred, and also prohibits the use of transferred credits to meet the statutory minimum level for the domestic car fleet standard.[60] These and other statutory limits would continue to apply to the determination of compliance with the CAFE standard.

Finally, EISA also allowed NHTSA to establish by regulation a CAFE credit trading program, which NHTSA established in the March 2009 final rule at 40 CFR Part 536, to allow credits to be traded (sold) to other vehicle manufacturers. EPA is also proposing to allow credit trading in the GHG program. These sorts of exchanges are typically allowed under EPA's current mobile source emission credit programs, although manufacturers have seldom made such exchanges. Under the NHTSA CAFE program, EPCA also allows these types of credit trades, although, as with transferred credits, traded credits may not be used to meet the minimum domestic car standards specified by statute.[61]

2. Air Conditioning Credits

Air conditioning (A/C) systems contribute to GHG emissions in two ways. Hydrofluorocarbon (HFC) refrigerants, which are powerful GHG pollutants, can leak from the A/C system. Operation of the A/C system also places an additional load on the engine, which results in additional CO_2 tailpipe emissions. EPA is proposing an approach that allows manufacturers to generate credits by reducing GHG emissions related to A/C systems. Specifically, EPA is proposing a test procedure and method to calculate CO_2 equivalent reductions for the full useful life on a grams/mile basis that can be used as credits in meeting the fleet average CO_2 standards. EPA's analysis indicates this approach provides manufacturers with a highly cost-effective way to achieve a portion of GHG emissions reductions under the EPA program. EPA is estimating that manufacturers will on average take advantage of 11 g/mi GHG credit toward meeting the 250 g/mi by 2016 (though some companies may have more). EPA is also proposing to allow manufacturers to earn early A/C credits starting in MY 2009 through 2011, as discussed further in a later section.

Comment is also sought on the approach of providing CAFE credits under 49 U.S.C. 32904(c) for light trucks equipped with relatively efficient air conditioners for MYs 2012–2016. The agencies invite comment on allowing a manufacturer to generate additional CAFE credits from the reduction of fuel consumption through the application of air conditioning efficiency improvement technologies to trucks. Currently, the CAFE program does not induce manufacturers to install more efficient air conditioners because the air conditioners are not turned on during fuel economy testing. The agencies note that if such credits were adopted, it may be necessary to reflect them in the setting of the CAFE standards for light trucks for the same model years and invite comment on that issue.

3. Flex-Fuel and Alternative Fuel Vehicle Credits

EPCA authorizes an incentive under the CAFE program for production of dual-fueled or flexible-fuel vehicles (FFV) and dedicated alternative fuel vehicles. FFVs are vehicles that can run both on an alternative fuel and conventional fuel. Most FFVs are E–85 capable vehicles, which can run on either gasoline or a mixture of up to 85 percent ethanol and 15 percent gasoline. Dedicated alternative fuel vehicles are vehicles that run exclusively on an alternative fuel. EPCA was amended by EISA to extend the period of availability of the FFV incentive, but to begin phasing it out by annually reducing the amount of FFV incentive that can be used toward compliance with the CAFE standards.[62] EPCA does not premise the availability of the FFV credits on actual use of alternative fuel by an FFV vehicle. Under NHTSA's CAFE program, pursuant to EISA, after MY 2019, no FFV credits will be available for CAFE compliance.[63] For dedicated alternative fuel vehicles, there are no limits or phase-out of the credits. Consistent with the statute, NHTSA will continue to allow the use of FFV credits for purposes of compliance with the proposed standards until the end of the phase-out period.

For the GHG program, EPA is proposing to allow FFV credits in line with EISA limits only during the period from MYs 2012 to 2015. After MY 2015, EPA proposes to allow FFV credits only based on a manufacturer's demonstration that the alternative fuel is actually being used in the vehicles. EPA is seeking comments on how that demonstration could be made. EPA discusses this in more detail in Section III.C of the preamble.

[59] 49 U.S.C. 32903(a)(2).

[60] 49 U.S.C. 32903(g)(4).

[61] 49 U.S.C. 32903(f)(2).

[62] EPCA provides a statutory incentive for production of FFVs by specifying that their fuel economy is determined using a special calculation procedure that results in those vehicles being assigned a higher fuel economy level than would otherwise occur. This is typically referred to as an FFV credit.

[63] *Id.*

4. Temporary Lead-Time Allowance Alternative Standards

Manufacturers with limited product lines may be especially challenged in the early years of the proposed program. Manufacturers with narrow product offerings may not be able to take full advantage of averaging or other program flexibilities due to the limited scope of the types of vehicles they sell. For example, some smaller volume manufacturers focus on high performance vehicles with higher CO_2 emissions, above the CO_2 emissions target for that vehicle footprint, but do not have other types of vehicles in their production mix with which to average. Often, these manufacturers pay fines under the CAFE program rather than meeting the applicable CAFE standard. EPA believes that these technological circumstances may call for a more gradual phase-in of standards so that manufacturer resources can be focused on meeting the 2016 levels.

EPA is proposing a temporary lead-time allowance for manufacturers who sell vehicles in the U.S. in MY 2009 whose vehicle sales in that model year are below 400,000 vehicles. EPA proposes that this allowance would be available only during the MY 2012–2015 phase-in years of the program. A manufacturer that satisfies the threshold criteria would be able to treat a limited number of vehicles as a separate averaging fleet, which would be subject to a less stringent GHG standard.[64] Specifically, a standard of 125 percent of the vehicle's otherwise applicable foot-print target level would apply to up to 100,000 vehicles total, spread over the four year period of MY 2012 through 2015. Thus, the number of vehicles to which the flexibility could apply is limited. EPA also is proposing appropriate restrictions on credit use for these vehicles, as discussed further in Section III. By MY 2016, these allowance vehicles must be averaged into the manufacturer's full fleet (*i.e.,* they are no longer eligible for a different standard). EPA discusses this in more detail in Section III.B of the preamble.

5. Additional Credit Opportunities Under the CAA

EPA is proposing additional opportunities for early credits in MYs 2009–2011 through over-compliance with a baseline standard. The baseline standard would be set to be equivalent, on a national level, to the California standards. Potentially, credits could be generated by over-compliance with this baseline in one of two ways—over-compliance by the fleet of vehicles sold in California and the CAA section 177 States (*i.e.,* those States adopting the California program), or over-compliance with the fleet of vehicles sold in the 50 States. EPA is also proposing early credits based on over-compliance with CAFE, but only for vehicles sold in States outside of California and the CAA section 177 States. Under the proposed early credit provisions, no early FFV credits would be allowed, except those achieved by over-compliance with the California program based on California's provisions that manufacturers demonstrate actual use of the alternative fuel. EPA's proposed early credits options are designed to ensure that there would be no double counting of early credits. Consistent with this paragraph, NHTSA notes, however, that credits for overcompliance with CAFE standards during MYs 2009–2011 will still be available for manufacturers to use toward compliance in future model years, just as before.

EPA is proposing additional credit opportunities to encourage the commercialization of advanced GHG/fuel economy control technologies, such as electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles. These proposed advanced technology credits are in the form of a multiplier that would be applied to the number of vehicles sold, such that each eligible vehicle counts as more than one vehicle in the manufacturer's fleet average. EPA is also proposing to allow early advanced technology credits to be generated beginning in MYs 2009 through 2011.

EPA is also proposing an Option for manufacturers to generate credits for employing technologies that achieve GHG reductions that are not reflected on current test procedures. Examples of such ''off-cycle'' technologies might include solar panels on hybrids, adaptive cruise control, and active aerodynamics, among other technologies. EPA is seeking comments on the best ways to quantify such credits to ensure any off-cycle credits applied for by a manufacturer are verifiable, reflect real-world reductions, based on repeatable test procedures, and are developed through a transparent process allowing appropriate opportunities for public comment.

G. Coordinated Compliance

Previous NHTSA and EPA regulations and statutory provisions establish ample examples on which to develop an effective compliance program that achieves the energy and environmental benefits from CAFE and motor vehicle GHG standards. NHTSA and EPA are proposing a program that recognizes, and replicates as closely as possible, the compliance protocols associated with the existing CAA Tier 2 vehicle emission standards, and with CAFE standards. The certification, testing, reporting, and associated compliance activities closely track current practices and are thus familiar to manufacturers. EPA already oversees testing, collects and processes test data, and performs calculations to determine compliance with both CAFE and CAA standards. Under this proposed coordinated approach, the compliance mechanisms for both programs are consistent and non-duplicative. EPA will also apply the CAA authorities applicable to its separate in-use requirements in this program.

The proposed approach allows manufacturers to satisfy the new program requirements in the same general way they comply with existing applicable CAA and CAFE requirements. Manufacturers would demonstrate compliance on a fleet-average basis at the end of each model year, allowing model-level testing to continue throughout the year as is the current practice for CAFE determinations. The proposed compliance program design establishes a single set of manufacturer reporting requirements and relies on a single set of underlying data. This approach still allows each agency to assess compliance with its respective program under its respective statutory authority.

NHTSA and EPA do not anticipate any significant noncompliance under the proposed program. However, failure to meet the fleet average standards (after credit opportunities are exhausted) would ultimately result in the potential for penalties under both EPCA and the CAA. The CAA allows EPA considerable discretion in assessment of penalties. Penalties under the CAA are typically determined on a vehicle-specific basis by determining the number of a manufacturer's highest emitting vehicles that caused the fleet average standard violation. This is the same mechanism used for EPA's National Low Emission Vehicle and Tier 2 corporate average standards, and to date there have been no instances of noncompliance. CAFE penalties are specified by EPCA and would be assessed for the entire noncomplying fleet at a rate of $5.50 times the number of vehicles in the fleet, times the number of tenths of mpg by which the fleet average falls below the standard. In

[64] EPCA does not permit such an allowance. Consequently, manufacturers who may be able to take advantage of a lead-time allowance under the proposed GHG standards would be required to comply with the applicable CAFE standard or be subject to penalties for non-compliance.

the event of a compliance action arising out of the same facts and circumstances, EPA could consider CAFE penalties when determining appropriate remedies for the EPA case.

H. Conclusion

This joint proposal by NHTSA and EPA represents a strong and coordinated National Program to achieve greenhouse gas emission reductions and fuel economy improvements from the light-duty vehicle part of the transportation sector. EPA's proposal for GHG standards under the Clean Air Act is discussed in Section III of this notice; NHTSA's proposal for CAFE standards under EPCA is discussed in Section IV. Each agency includes analyses on a variety of relevant issues under its respective statute, such as feasibility of the proposed standards, costs and benefits of the proposal, and effects on the economy, auto manufacturers, and consumers. This joint rulemaking proposal reflects a carefully coordinated and harmonized approach to developing and implementing standards under the two agencies' statutes and is in accordance with all substantive and procedural requirements required by law.

NHTSA and EPA believe that the MY 2012 through 2016 standards proposed would provide substantial reductions in emissions of GHGs and oil consumption, with significant fuel savings for consumers. The proposed program is technologically feasible at a reasonable cost, based on deployment of available and effective control technology across the fleet, and industry would have the opportunity to plan over several model years and incorporate the vehicle upgrades into the normal redesign cycles. The proposed program would result in enormous societal net benefits, including greenhouse gas emission reductions, fuel economy savings, improved energy security, and cost savings to consumers from reduced fuel utilization.

II. Joint Technical Work Completed for This Proposal

A. Introduction

In this section NHTSA and EPA discuss several aspects of the joint technical analyses the two agencies collaborated on which are common to the development of each agency's proposed standards. Specifically we discuss: The development of the baseline vehicle market forecast used by each agency, the development of the proposed attribute-based standard curve shapes, how the relative stringency between the car and truck fleet standards for this proposal was determined, which technologies the agencies evaluated and their costs and effectiveness, and which economic assumptions the agencies included in their analyses. The joint Technical Support Document (TSD) discusses the agencies' joint technical work in more detail.

B. How Did NHTSA and EPA Develop the Baseline Market Forecast?

1. Why Do the Agencies Establish a Baseline Vehicle Fleet?

In order to calculate the impacts of the EPA and NHTSA proposed regulations, it is necessary to estimate the composition of the future vehicle fleet absent these proposed regulations in order to conduct comparisons. EPA and NHTSA have developed a comparison fleet in two parts. The first step was to develop a baseline fleet based on model year 2008 data. The second step was to project that fleet into 2011–2016. This is called the reference fleet. The third step was to modify that 2011–2016 reference fleet such that it had sufficient technologies to meet the 2011 CAFE standards. This final ''reference fleet'' is the light duty fleet estimated to exist in 2012–2016 if these proposed rules are not adopted. Each agency developed a final reference fleet to use in its modeling. All of the agencies' estimates of emission reductions, fuel economy improvements, costs, and societal impacts are developed in relation to the respective reference fleets.

2. How Do the Agencies Develop the Baseline Vehicle Fleet?

EPA and NHTSA have based the projection of total car and total light truck sales on recent projections made by the Energy Information Administration (EIA). EIA publishes a long-term projection of national energy use annually called the Annual Energy Outlook. This projection utilizes a number of technical and econometric models which are designed to reflect both economic and regulatory conditions expected to exist in the future. In support of its projection of fuel use by light-duty vehicles, EIA projects sales of new cars and light trucks. Due to the state of flux of both energy prices and the economy, EIA published three versions of its 2009 Annual Energy Outlook. The Preliminary 2009 report was published early (in November 2008) in order to reflect the dramatic increase in fuel prices which occurred during 2008 and which occurred after the development of the 2008 Annual Energy Outlook. The official 2009 report was published in March of 2009. A third 2009 report was published a month later which reflected the economic stimulus package passed by Congress earlier this year. We use the sales projections of this latest report, referred to as the updated 2009 Annual Energy Outlook, here.

In their updated 2009 report, EIA projects that total light-duty vehicle sales will gradually recover from their currently depressed levels by roughly 2013. In 2016, car and light truck sales are projected to be 9.5 and 7.1 million units, respectively. While the total level of sales of 16.6 million units is similar to pre-2008 levels, the fraction of car sales is higher than that existing in the 2000–2007 timeframe. This presumably reflects the impact of higher fuel prices and that fact that cars tend to have higher levels of fuel economy than trucks. We note that EIA's definition of cars and trucks follows that used by NHTSA prior to the MY 2011 CAFE final rule published earlier this year. That recent CAFE rule, which established the MY 2011 standards, reclassified a number of 2-wheel drive sport utility vehicles from the truck fleet to the car fleet. This has the impact of shifting a considerable number of previously defined trucks into the car category. Sales projections of cars and trucks for all future model years can be found in the draft Joint TSD for this proposal.

In addition to a shift towards more car sales, sales of segments within both the car and truck markets have also been changing and are expected to continue to change in the future. Manufacturers are introducing more crossover models which offer much of the utility of SUVs but using more car-like designs. In order to reflect these changes in fleet makeup, EPA and NHTSA considered several available forecasts. After review EPA purchased and shared with NHTSA forecasts from two well-known industry analysts, CSM–Worldwide (CSM), and J.D. Powers. NHTSA and EPA decided to use the forecast from CSM, for several reasons. One, CSM agreed to allow us to publish the data, on which our forecast is based, in the public domain.[65] Two, it covered nearly all the timeframe of greatest relevance to this proposed rule (2012–2015 model years). Three, it provided projections of vehicle sales both by manufacturer and by market segment. Four, it utilized market segments similar to those used in the

[65] The CSM data made public includes only the higher level volume projections by market segment and manufacturer. The projections by nameplate and model are strictly the agencies' estimates based on these higher level CSM segment and manufacturer distribution.

EPA emission certification program and fuel economy guide. As discussed further below, this allowed the CSM forecast to be combined with other data obtained by NHTSA and EPA. We also assumed that the breakdowns of car and truck sales by manufacturer and by market segment for 2016 model year and beyond were the same as CSM's forecast for 2015 calendar year. The changes between company market share and industry market segments were most significant from 2011–2014, while for 2014–2015 the changes were relatively small. Therefore, we assumed 2016 market share and market segments to be the same as for 2015. To the extent that the agencies have received CSM forecasts for 2016, we will consider using them for the final rule.

We then projected the CSM forecasts for relative sales of cars and trucks by manufacturer and by market segment on to the total sales estimates of the updated 2009 Annual Energy Outlook. Tables II.B.1–1 and II.B.1–2 show the resulting projections for the 2016 model year and compare these to actual sales which occurred in 2008 model year. Both tables show sales using the traditional or classic definition of cars and light trucks. Determining which classic trucks will be defined as cars using the revised definition established by NHTSA earlier this year and included in this proposed rule requires more detailed information about each vehicle model which is developed next.

TABLE II.B.2–1—ANNUAL SALES OF LIGHT-DUTY VEHICLES BY MANUFACTURER IN 2008 AND ESTIMATED FOR 2016

	Cars		Light trucks		Total	
	2008 MY	2016 MY	2008 MY	2016 MY	2008 MY	2016 MY
BMW	291,796	380,804	61,324	134,805	353,120	515,609
Chrysler	537,808	110,438	1,119,397	133,454	1,657,205	243,891
Daimler	208,052	235,205	79,135	109,917	287,187	345,122
Ford	641,281	990,700	1,227,107	1,713,376	1,868,388	2,704,075
General Motors	1,370,280	1,562,791	1,749,227	1,571,037	3,119,507	3,133,827
Honda	899,498	1,429,262	612,281	812,325	1,511,779	2,241,586
Hyundai	270,293	437,329	120,734	287,694	391,027	725,024
Kia	145,863	255,954	135,589	162,515	281,452	418,469
Mazda	191,326	290,010	111,220	112,837	302,546	402,847
Mitsubishi	76,701	49,697	24,028	10,872	100,729	60,569
Porsche	18,909	37,064	18,797	17,175	37,706	54,240
Nissan	653,121	985,668	370,294	571,748	1,023,415	1,557,416
Subaru	149,370	128,885	49,211	75,841	198,581	204,726
Suzuki	68,720	69,452	45,938	34,307	114,658	103,759
Tata	9,596	41,584	55,584	47,105	65,180	88,689
Toyota	1,143,696	1,986,824	1,067,804	1,218,223	2,211,500	3,205,048
Volkswagen	290,385	476,699	26,999	99,459	317,384	576,158
Total	6,966,695	9,468,365	6,874,669	7,112,689	13,841,364	16,581,055

TABLE II.B.2–2—ANNUAL SALES OF LIGHT-DUTY VEHICLES BY MARKET SEGMENT IN 2008 AND ESTIMATED FOR 2016

Cars				Light trucks	
	2008 MY	2016 MY		2008 MY	2016 MY
Full-Size Car	730,355	466,616	Full-Size Pickup	1,195,073	1,475,881
Mid-Size Car	1,970,494	2,641,739	Mid-Size Pickup	598,197	510,580
Small/Compact Car	1,850,522	2,444,479	Full-Size Van	33,384	284,110
			Mid-Size Van	719,529	615,349
Subcompact/Mini Car	599,643	1,459,138	Mid-Size MAV*	191,448	158,930
			Small MAV	235,524	289,880
Luxury Car	1,057,875	1,432,162	Full-Size SUV*	530,748	90,636
Specialty Car	754,547	1,003,078	Mid-Size SUV	347,026	110,155
Others	3,259	21,153	Small SUV	377,262	124,397
			Full-Size CUV*	406,554	319,201
			Mid-Size CUV	798,335	1,306,770
			Small CUV	1,441,589	1,866,580
Total Sales	6,966,695	9,468,365		6,874,669	7,152,470

* MAV—Multi-Activity Vehicle, SUV—Sport Utility Vehicle, CUV—Crossover Utility Vehicle.

The agencies recognize that CSM forecasts a very significant reduction in market share for Chrysler. This may be a result of the extreme uncertainty surrounding Chrysler in early 2009. The forecast from CSM used in this proposal is CSM's forecast from the 2nd quarter of 2009. CSM also provided to the agencies an updated forecast in the 3rd quarter of 2009, which we were unable to use for this proposal due to time constraints. However, we have placed a copy of the 3rd Quarter CSM forecast in the public docket for this rulemaking, and we will consider its use, and any further updates from CSM or other data received during the comment period when developing the analysis for the final rule.[66] CSM's forecast for Chrysler for the 3rd quarter of 2009 was significantly increased compared to the 2nd quarter, by nearly a factor of two

[66] "CSM North America Sales Forecast Comparison 2Q09 3Q09 For Docket." 2nd and 3rd quarter forecasting results from CSM World Wide (Docket EPA–HQ–OAR–2009–0472).

increase in projected sales over the 2012–2015 time frame.

The forecasts obtained from CSM provided estimates of car and trucks sales by segment and by manufacturer, but not by manufacturer for each market segment. Therefore, we needed other information on which to base these more detailed market splits. For this task, we used as a starting point each manufacturer's sales by market segment from model year 2008. Because of the larger number of segments in the truck market, we used slightly different methodologies for cars and trucks.

The first step for both cars and trucks was to break down each manufacturer's 2008 sales according to the market segment definitions used by CSM. For example, we found that Ford's car sales in 2008 were broken down as shown in Table II.B.2–3:

TABLE II.B.2–3—BREAKDOWN OF FORD'S 2008 CAR SALES

Full-size cars	76,762 units.
Mid-size cars	170,399 units.
Small/Compact cars	180,249 units.
Subcompact/Mini cars	None.
Luxury cars	100,065 units.
Specialty cars	110,805 units.

We then adjusted each manufacturer's sales of each of its car segments (and truck segments, separately) so that the manufacturer's total sales of cars (and trucks) matched the total estimated for each future model year based on EIA and CSM forecasts. For example, as indicated in Table II.B.2–1, Ford's total car sales in 2008 were 641,281 units, while we project that they will increase to 990,700 units by 2016. This represents an increase of 54.5 percent. Thus, we increased the 2008 sales of each Ford car segment by 54.5 percent. This produced estimates of future sales which matched total car and truck sales per EIA and the manufacturer breakdowns per CSM (and exemplified for 2016 in Table II.B.1–1). However, the sales splits by market segment would not necessarily match those of CSM (and exemplified for 2016 in Table II.B.2–2).

In order to adjust the market segment mix for cars, we first adjusted sales of luxury, specialty and other cars. Since the total sales of cars for each manufacturer were already set, any changes in the sales of one car segment had to be compensated by the opposite change in another segment. For the luxury, specialty and other car segments, it is not clear how changes in sales would be compensated. For example, if luxury car sales decreased, would sales of full-size cars increase, mid-size cars, *etc.*? Thus, any changes in the sales of cars within these three segments were assumed to be compensated for by proportional changes in the sales of the other four car segments. For example, for 2016, the figures in Table II.B.2–2 indicate that luxury car sales in 2016 are 1,432,162 units. Luxury car sales are 1,057,875 units in 2008. However, after adjusting 2008 car sales by the change in total car sales for 2016 projected by EIA and a change in manufacturer market share per CSM, luxury car sales increased to 1,521,892 units. Thus, overall for 2016, luxury car sales had to decrease by 89,730 units or 6 percent. We decreased the luxury car sales by each manufacturer by this percentage. The absolute decrease in luxury car sales was spread across sales of full-size, mid-size, compact and subcompact cars in proportion to each manufacturer's sales in these segments in 2008. The same adjustment process was used for specialty cars and the ''other cars'' segment defined by CSM.

A slightly different approach was used to adjust for changing sales of the remaining four car segments. Starting with full-size cars, we again determined the overall percentage change that needed to occur in future year full-size cars sales after (1) adjusting for total sales per EIA, (2) manufacturer sales mix per CSM and (3) adjustments in the luxury, specialty and other car segments, in order to meet the segment sales mix per CSM. Sales of each manufacturer's large cars were adjusted by this percentage. However, instead of spreading this change over the remaining three segments, we assigned the entire change to mid-size vehicles. We did so because, as shown in 2008, higher fuel prices tend to cause car purchasers to purchase smaller vehicles. We are using AEO 2009 for this analysis, which assumes fuel prices similar in magnitude to actual high fuel prices seen in the summer of 2008.[67] However, if a consumer had previously purchased a full-size car, we thought it unlikely that they would jump all the way to a subcompact. It seemed more reasonable to project that they would drop one vehicle size category smaller. Thus, the change in each manufacturer's sales of full-size cars was matched by an opposite change (in absolute units sold) in mid-size cars.

The same process was then applied to mid-size cars, with the change in mid-size car sales being matched by an opposite change in compact car sales. This process was repeated one more time for compact car sales, with changes in sales in this segment being matched by the opposite change in the sales of subcompacts. The overall result was a projection of car sales for 2012–2016 which matched the total sales projections of EIA and the manufacturer and segment splits of CSM. These sales splits can be found in Chapter 1 of the draft Joint Technical Support Document for this proposal.

As mentioned above, a slightly different process was applied to truck sales. The reason for this was we could not confidently project how the change in sales from one segment preferentially went to or came from another particular segment. Some trend from larger vehicles to smaller vehicles would have been possible. However, the CSM forecasts indicated large changes in total sport utility vehicle, multi-activity vehicle and cross-over sales which could not be connected. Thus, we applied an iterative, but straightforward process for adjusting 2008 truck sales to match the EIA and CSM forecasts.

The first three steps were exactly the same as for cars. We broke down each manufacturer's truck sales into the truck segments as defined by CSM. We then adjusted all manufacturers' truck segment sales by the same factor so that total truck sales in each model year matched EIA projections for truck sales by model year. We then adjusted each manufacturer's truck sales by segment proportionally so that each manufacturer's percentage of total truck sales matched that forecast by CSM. This again left the need to adjust truck sales by segment to match the CSM forecast for each model year.

In the fourth step, we adjusted the sales of each truck segment by a common factor so that total sales for that segment matched the combination of the EIA and CSM forecasts. For example, sales of large pickups across all manufacturers were 1,144,166 units in 2016 after adjusting total sales to match EIA's forecast and adjusting each manufacturer's truck sales to match CSM's forecast for the breakdown of sales by manufacturer. Applying CSM's forecast of the large pickup segment of truck sales to EIA's total sales forecast indicated total large pickup sales of 1,475,881 units. Thus, we increased each manufacturer's sales of large pickups by 29 percent. The same type of adjustment was applied to all the other truck segments at the same time. The result was a set of sales projections which matched EIA's total truck sales projection and CSM's market segment forecast. However, after this step, sales

[67] J.D. Power and Associates, Press Release, May 16, 2007. ''Rising Gas Prices Begin to Sway New-Vehicle Owners Toward Smaller Versions of Trucks and Utility Vehicles.''

by manufacturer no longer met CSM's forecast. Thus, we repeated step three and adjusted each manufacturer's truck sales so that they met CSM's forecast. The sales of each truck segment (by manufacturer) were adjusted by the same factor. The resulting sales projection matched EIA's total truck sales projection and CSM's manufacturer forecast, but sales by market segment no longer met CSM's forecast. However, the difference between the sales projections after this fifth step was closer to CSM's market segment forecast than it was after step three. In other words, the sales projection was converging. We repeated these adjustments, matching manufacturer sales mix in one step and then market segment in the next for a total of 19 times. At this point, we were able to match the market segment splits exactly and the manufacturer splits were within 0.1% of our goal, which is well within the needs of this analysis.

The next step in developing the baseline fleet was to characterize the vehicles within each manufacturer-segment combination. In large part, this was based on the characterization of the specific vehicle models sold in 2008. EPA and NHTSA chose to base our estimates of detailed vehicle characteristics on 2008 sales for several reasons. One, these vehicle characteristics are not confidential and can thus be published here for careful review and comment by interested parties. Two, being actual sales data, this vehicle fleet represents the distribution of consumer demand for utility, performance, safety, *etc.*

We gathered most of the information about the 2008 vehicle fleet from EPA's emission certification and fuel economy database. The data obtained from this source included vehicle production volume, fuel economy, engine size, number of engine cylinders, transmission type, fuel type, *etc.* EPA's certification database does not include a detailed description of the types of fuel economy-improving/CO_2-reducing technologies considered in this proposal. Thus, we augmented this description with publicly available data which includes more complete technology descriptions from Ward's Automotive Group.[68] In a few instances when required vehicle information was not available from these two sources (such as vehicle footprint), we obtained this information from publicly accessible Internet sites such as Motortrend.com and Edmunds.com.[69]

The projections of future car and truck sales described above apply to each manufacturer's sales by market segment. The EPA emissions certification sales data are available at a much finer level of detail, essentially vehicle configuration. As mentioned above, we placed each vehicle in the EPA certification database into one of the CSM market segments. We then totaled the sales by each manufacturer for each market segment. If the combination of EIA and CSM forecasts indicated an increase in a given manufacturer's sales of a particular market segment, then the sales of all the individual vehicle configurations were adjusted by the same factor. For example, if the Prius represented 30% of Toyota's sales of compact cars in 2008 and Toyota's sales of compact cars in 2016 was projected to double by 2016, then the sales of the Prius were doubled, and the Prius sales in 2016 remained 30% of Toyota's compact car sales.

NHTSA and EPA request comment on the methodology and data sources used for developing the baseline vehicle fleet for this proposal and the reasonableness of the results.

3. How Is the Development of the Baseline Fleet for This Proposal Different From NHTSA's Historical Approach, and Why Is This Approach Preferable?

NHTSA has historically based its analysis of potential new CAFE standards on detailed product plans the agency has requested from manufacturers planning to produce light vehicles for sale in the United States. Although the agency has not attempted to compel manufacturers to submit such information, most major manufacturers and some smaller manufacturers have voluntarily provided it when requested.

As in this and other prior rulemakings, NHTSA has requested extensive and detailed information regarding the models that manufacturers plan to offer, as well as manufacturers' estimates of the volume of each model they expect to produce for sale in the U.S. NHTSA's recent requests have sought information regarding a range of engineering and planning characteristics for each vehicle model (*e.g.*, fuel economy, engine, transmission, physical dimensions, weights and capacities, redesign schedules), each engine (*e.g.*, fuel type, fuel delivery, aspiration, valvetrain configuration, valve timing, valve lift, power and torque ratings), and each transmission (*e.g.*, type, number of gears, logic).

The information that manufacturers have provided in response to these requests has varied in completeness and detail. Some manufacturers have submitted nearly all of the information NHTSA has requested, have done so for most or all of the model years covered by NHTSA's requests, and have closely followed NHTSA's guidance regarding the structure of the information. Other manufacturers have submitted partial information, information for only a few model years, and/or information in a structure less amenable to analysis. Still other manufacturers have not responded to NHTSA's requests or have responded on occasion, usually with partial information.

In recent rulemakings, NHTSA has integrated this information and estimated missing information based on a range of public and commercial sources (such as those used to develop today's market forecast). For unresponsive manufacturers, NHTSA has estimated fleet composition based on the latest-available CAFE compliance data (the same data used as part of the foundation for today's market forecast). NHTSA has then adjusted the size of the fleet based on AEO's forecast of the light vehicle market and normalized manufacturers' market shares based on the latest-available CAFE compliance data.

Compared to this approach, the market forecast the agencies have developed for this analysis has both advantages and disadvantages.

Most importantly, today's market forecast is much more transparent. The information sources used to develop today's market forecast are all either in the public domain or available commercially. Therefore, NHTSA and EPA are able to make public the market inputs actually used in the agencies' respective modeling systems, such that any reviewer may independently repeat and review the agencies' analyses. Previously, although NHTSA provided this type of information to manufacturers upon request (*e.g.*, GM requested and received outputs specific to GM), NHTSA was otherwise unable to release market inputs and the most detailed model outputs (*i.e.*, the outputs containing information regarding specific vehicle models) because doing so would violate requirements protecting manufacturers' confidential business information from disclosure.[70] Therefore, this approach provides much greater opportunity for the public to

[68] Note that WardsAuto.com is a fee-based service, but all information is public to subscribers.

[69] Motortrend.com and Edmunds.com are free, no-fee Internet sites.

[70] *See* 49 CFR part 512.

review every aspect of the agencies' analyses and comment accordingly.

Another significant advantage of today's market forecast is the agencies' ability to assess more fully the incremental costs and benefits of the proposed standards. In the past two years, NHTSA has requested and received three sets of future product plan submissions from the automotive companies, most recently this past spring. These submissions are intended to be the actual future product plans for the companies. In the most recent submission it is clear that many of the firms have been and are clearly planning for future CAFE standard increases for model years 2012 and later. The results for the product plans for many firms are a significant increase in their projected future application of fuel economy improvement technology. However, for the purposes of assessing the costs of the model year 2012–2016 standards the use of the product plans presents a difficulty, namely, how to assess the increased costs of the proposed future standards if the companies have already anticipated the future standards and the costs are therefore now part of the agencies' baseline. This is a real concern with the most recent product plans received from the companies, and is one of the reasons the agencies have decided not to use the recent product plans to define the baseline market data for assessing our proposed standards. The approach used for this proposal does not raise this concern, as the underlying data comes from model year 2008 production.[71]

In addition, by developing a baseline fleet from common sources, the agencies have been able to avoid some errors—perhaps related to interpretation of requests—that have been observed in past responses to NHTSA's requests. For example, while reviewing information submitted to support the most recent CAFE rulemaking, NHTSA staff discovered that one manufacturer had misinterpreted instructions regarding the specification of vehicle track width, leading to important errors in estimates of vehicle footprints. Although the manufacturer resubmitted the information with corrections, with this approach, the agencies are able to reduce the potential for such errors and inconsistencies by utilizing common data sources and procedures.

An additional advantage of the approach used for this proposal is a consistent projection of the change in fuel economy and CO_2 emissions across the various vehicles from the application of new technology. In the past, company product plans would include the application of new fuel economy improvement technology for a new or improved vehicle model with the resultant estimate from the company of the fuel economy levels for the vehicle. However, companies did not always provide to NHTSA the detailed analysis which showed how they forecasted what the fuel economy performance of the new vehicle was—that is, whether it came from actual test data, from vehicle simulation modeling, from best engineering judgment or some other methodology. Thus, it was not possible for NHTSA to review the methodology used by the manufacturer, nor was it possible to review what approach the different manufacturers utilized from a consistency perspective. With the approach used for this proposal, the baseline market data comes from actual vehicles which have actual fuel economy test data—so there is no question what is the basis for the fuel economy or CO_2 performance of the baseline market data as it is actual measured data.

Another advantage of today's approach is that future market shares are based on a forecast of what will occur in the future, rather than a static value. In the past, NHTSA has utilized a constant market share for each model year, based on the most recent year available, for example from the CAFE compliance data, that is, a forecast of the 2011–2015 time frame where company market shares do not change. In the approach used today, we have utilized the forecasts from CSM of how future market shares among the companies may change over time.[72]

The approach the agencies have taken in developing today's market forecast does, however, have some disadvantages. Most importantly, it produces a market forecast that does not represent some important changes likely to occur in the future.

Some of the changes not captured by today's approach are specific. For example, the agencies' current market forecast includes some vehicles for which manufacturers have announced plans for elimination or drastic production cuts such as the Chevrolet Trailblazer, the Chrysler PT Cruiser, the Chrysler Pacifica, the Dodge Magnum, the Ford Crown Victoria, the Hummer H2, the Mercury Sable, the Pontiac Grand Prix, and the Pontiac G5. These vehicle models appear explicitly in market inputs to NHTSA's analysis, and are among those vehicle models included in the aggregated vehicle types appearing in market inputs to EPA's analysis.

Conversely, the agencies' market forecast does not include some forthcoming vehicle models, such as the Chevrolet Volt, the Chevrolet Camaro, the Ford Fiesta and several publicly announced electric vehicles, including the announcements from Nissan. Nor does it include several MY 2009 or 2010 vehicles, such as the Honda Insight, the Hyundai Genesis and the Toyota Venza, as our starting point for vehicle definitions was Model Year 2008. Additionally, the market forecast does not account for publicly announced technology introductions, such as Ford's EcoBoost system, whose product plans specify which vehicles and how many are planned to have this technology. Were the agencies to rely on manufacturers' product plans (that were submitted), the market forecast would account for not only these specific examples, but also for similar examples that have not yet been announced publicly.

The agencies anticipate that including vehicles after MY 2008 would not significantly impact our estimates of the technology required to comply with the proposed standards. If they were included, these vehicles could make the standards appear to cost less relative to the reference case. First, the projections of sales by vehicle segment and manufacturer include these expected new vehicle models. Thus, to the extent that these new vehicles are expected to change consumer demand, they should be reflected in our reference case. While we are projecting the characteristics of the new vehicles with MY 2008 vehicles, the primary difference between the new vehicles and 2008 vehicles in the same vehicle segment is the use of additional CO_2-reducing and fuel-saving technology. Both the NHTSA and EPA models add such technology to facilitate compliance with the proposed standards. Thus, our future projections of the vehicle fleet generally shift vehicle designs towards those of these newer vehicles. The advantage of our approach is that it helps clarify the costs of this proposal, as the cost of all fuel economy

[71] However, as discussed below, an alternative approach that NHTSA is exploring would be to use only manufacturers' near-term product plans, *e.g.*, from MY 2010 or MY 2011. NHTSA believes manufacturers' near-term plans should be less subject to this concern about missing costs and benefits already included in the baseline. NHTSA is also hopeful that in connection with the agencies' rulemaking efforts, manufacturers will be willing to make their near-term plans available to the public.

[72] We note that market share forecasts like CSM's could, of course, be applied to any data used to create the baseline market forecast. If, as mentioned above, manufacturers do consent to make public MY 2010 or 2011 product plan data for the final rule, the agencies could consider applying market share forecast to that data as well.

improvements beyond those required by the MY 2011 CAFE standards are being assigned to the proposal. In some cases, the new vehicles being introduced by manufacturers are actually in response to their anticipation of this rulemaking. Our approach prevents some of these technological improvements and their associated cost from being assumed in the baseline. Thus, the added technology will not be considered to be free for the purposes of this rule.

We note that, as a result of these issues, the market file may show sales volumes for certain vehicles during MYs 2012–2016 even though they will be discontinued before that time frame. Although the agencies recognize that these specific vehicles will be discontinued, we continue to include them in the market forecast because they are useful for representing successor vehicles that may appear in the rulemaking time frame to replace the discontinued vehicles in that market segment.

Other market changes not captured by today's approach are broader. For example, Chrysler Group LLC has announced plans to offer small- and medium-sized cars using Fiat powertrains. The product plan submitted by Chrysler includes vehicles that appear to reflect these plans. However, none of these specific vehicle models are included in the market forecast the agencies have developed starting with MY 2008 CAFE compliance data. The product plan submitted by Chrysler is also more optimistic with regard to Chrysler's market share during MYs 2012–2016 than the market forecast projected by CSM and used by the agencies for this proposal. Similarly, the agencies' market forecast does not reflect Nissan's plans regarding electric vehicles.

Additionally, some technical information that manufacturers have provided in product plans regarding specific vehicle models is, at least insofar as NHTSA and EPA have been able to determine, not available from public or commercial sources. While such gaps do not bear significantly on the agencies' analysis, the diversity of pickup configurations necessitated utilizing a sales-weighted average footprint value [73] for many manufacturers' pickups. Since our modeling only utilizes footprint in order to estimate each manufacturer's CO_2 or fuel economy standard and all the other vehicle characteristics are available for each pickup configuration, this approximation has no practical impact on the projected technology or cost associated with compliance with the various standards evaluated. The only impact which could arise would be if the relative sales of the various pickup configurations changed, or if the agencies were to explore standards with a different shape. This would necessitate recalculating the average footprint value in order to maintain accuracy.

The agencies have carefully considered these advantages and disadvantages of using a market forecast derived from public and commercial sources rather than from manufacturers' product plans, and we believe that the advantages outweigh the disadvantages for the purpose of proposing standards for model years 2012–2016. NHTSA's inability to release confidential market inputs and corresponding detailed outputs from the CAFE model has raised serious concerns among many observers regarding the transparency of NHTSA's analysis, as well as related concerns that the lack of transparency might enable manufacturers to provide unrealistic information to try to influence NHTSA's determination of the maximum feasible standards. Although NHTSA does not agree with some observers' assertions that some manufacturers have deliberately provided inaccurate or otherwise misleading information, today's market forecast is fully open and transparent, and is therefore not subject to such concerns.

With respect to the disadvantages, the agencies are hopeful that manufacturers will, in the future, agree to make public their plans regarding model years that are very near, such as MY 2010 or perhaps MY 2011, so that this information can be considered for purposes of the final rule analysis and be available for the public. In any event, because NHTSA and EPA are releasing market inputs used in the agencies' respective analyses, manufacturers, suppliers, and other automobile industry observers and participant can submit comments on how these inputs should be improved, as can all other reviewers.

4. How Does Manufacturer Product Plan Data Factor into the Baseline Used in This Proposal?

In the Spring of 2009, many manufacturers submitted product plans in response to NHTSA's request that they do so.[74] NHTSA and EPA both have access to these plans, and both agencies have reviewed them in detail. A small amount of product plan data was used in the development of the baseline. The specific pieces of data are:

- Wheelbase;
- Track Width Front;
- Track Width Rear;
- EPS (Electric Power Steering);
- ROLL (Reduced Rolling Resistance);
- LUB (Advance Lubrication *i.e.*, low weight oil);
- IACC (Improved Electrical Accessories);
- Curb Weight;
- GVWR (Gross Vehicle Weight Rating)

The track widths, wheelbase, curb weight, and GVWR could have been looked up on the Internet (159 were), but were taken from the product plans when available for convenience. To ensure accuracy, a sample from each product plan was used as a check against the numbers available from Motortrend.com. These numbers will be published in the baseline file since they can be easily looked up on the Internet. On the other hand, EPS, ROLL, LUB, and IACC are difficult to determine without using manufacturer's product plans. These items will not be published in the baseline file, but the data has been aggregated into the EPA baseline in the technology effectiveness and cost effectiveness for each vehicle in a way that allows the baseline for the model to be published without revealing the manufacturers' data.

Considering both the publicly-available baseline used in this proposal and the product plans provided recently by manufacturers, however, it is possible that the latter could potentially be used to develop a more realistic forecast of product mix and vehicle characteristics of the near-future light-duty fleet. At the core of concerns about using company product plans are two concerns about doing so: (a) Uncertainty and possible inaccuracy in manufacturers' forecasts and (b) the transparency of using product plan data. With respect to the first concern, the

[73] A full-size pickup might be offered with various combinations of cab style (*e.g.,* regular, extended, crew) and box length (*e.g.,* 5½′, 6½′, 8′) and, therefore, multiple footprint sizes. CAFE compliance data for MY 2008 data does not contain footprint information, and does not contain information that can be used to reliably identify which pickup entries correspond to footprint values estimable from public or commercial sources. Therefore, the agencies have used the known production levels of average values to represent all variants of a given pickup line (*e.g.,* all variants of the F–150 and the Sierra/Silverado) in order to calculate the sales-weighted average footprint value for each pickup family. Again, this has no impact on the results of our modeling effort, although it would require re-estimation if we were to examine light truck standards of a different shape. In the extreme, one single footprint value could be used for every vehicle sold by a single manufacturer as long as the fuel economy standard associated with this footprint value represented the sales-weighted, harmonic average of the fuel economy standards associated with each vehicle's footprint values.

[74] 74 FR 9185 (Mar. 3, 2009)

agencies note that manufacturers' near-term forecasts (*i.e.,* for model years two or three years into the future) should be less uncertain and more amenable to eventual retrospective analysis (*i.e.,* comparison to actual sales) than manufacturers' longer-term forecasts (*i.e.,* for model years more than five years into the future). With respect to the second concern, NHTSA has consulted with most manufacturers and believes that although few, if any, manufacturers would be willing to make public their longer-term plans, many responding manufacturers may be willing to make public their short-term plans. In a companion notice, NHTSA is seeking product plan information from manufacturers for MYs 2008 to 2020, and the agencies will also continue to consult with manufacturers regarding the possibility of releasing plans for MY 2010 and/or MY 2011 for purposes of developing and analyzing the final GHG and CAFE standards for MYs 2012–2016. The agencies are hopeful that manufacturers will agree to do so, and that NHTSA and EPA would therefore be able to use product plans in ways that might aid in increasing the accuracy of the baseline market forecast.

C. Development of Attribute-Based Curve Shapes

NHTSA and EPA are setting attribute-based CAFE and CO_2 standards that are defined by a mathematical function for MYs 2012–2016 passenger cars and light trucks. EPCA, as amended by EISA, expressly requires that CAFE standards for passenger cars and light trucks be based on one or more vehicle attributes related to fuel economy, and be expressed in the form of a mathematical function.[75] The CAA has no such requirement, though in past rules, EPA has relied on both universal and attribute-based standards (*e.g.,* for nonroad engines, EPA uses the attribute of horsepower). However, given the advantages of using attribute-based standards and given the goal of coordinating and harmonizing CO_2 standards promulgated under the CAA and CAFE standards promulgated under EPCA, as expressed in the joint NOI, EPA is also proposing to issue standards that are attribute-based and defined by mathematical functions.

Under an attribute-based standard, every vehicle model has a performance target (fuel economy and GHG emissions for CAFE and GHG emissions standards, respectively), the level of which depends on the vehicle's attribute (for this proposal, footprint). The manufacturers' fleet average performance is determined by the production-weighed[76] average (for CAFE, harmonic average) of those targets. NHTSA and EPA are proposing CAFE and CO_2 emissions standards defined by constrained linear functions and, equivalently, piecewise linear functions.[77] As a possible option for future rulemakings, the constrained linear form was introduced by NHTSA in the 2007 NPRM proposing CAFE standards for MY 2011–2015. Described mathematically, the proposed constrained linear function is defined according to the following formula:[78]

$$TARGET = \frac{1}{MIN\left[MAX\left(c \times FOOTPRINT + d, \frac{1}{a}\right), \frac{1}{b}\right]}$$

Where:

TARGET = the fuel economy target (in mpg) applicable to vehicles of a given footprint (*FOOTPRINT,* in square feet),

a = the function's upper limit (in mpg),

b = the function's lower limit (in mpg),

c = the slope (in gpm per square foot) of the sloped portion of the function,

d = the intercept (in gpm) of the sloped portion of the function (that is, the value the sloped portion would take if extended to a footprint of 0 square feet, and the *MIN* and *MAX* functions take the minimum and maximum, respectively, of the included values; for example, *MIN*(1,2) = 1, *MAX*(1,2) = 2, and *MIN*[*MAX*(1,2),3)] = 2.

Because the format is linear on a gallons-per-mile basis, not on a miles-per-gallon basis, it is plotted as fuel consumption below. Graphically, the constrained linear form appears as shown in Figure II.C.1–1.

BILLING CODE 4910–59–P

[75] 49 U.S.C. 32902(a)(3)(A).

[76] Production for sale in the United States.

[77] The equations are equivalent but are specified differently due to differences in the agencies' respective models.

[78] This function is linear in fuel consumption but not in fuel economy.

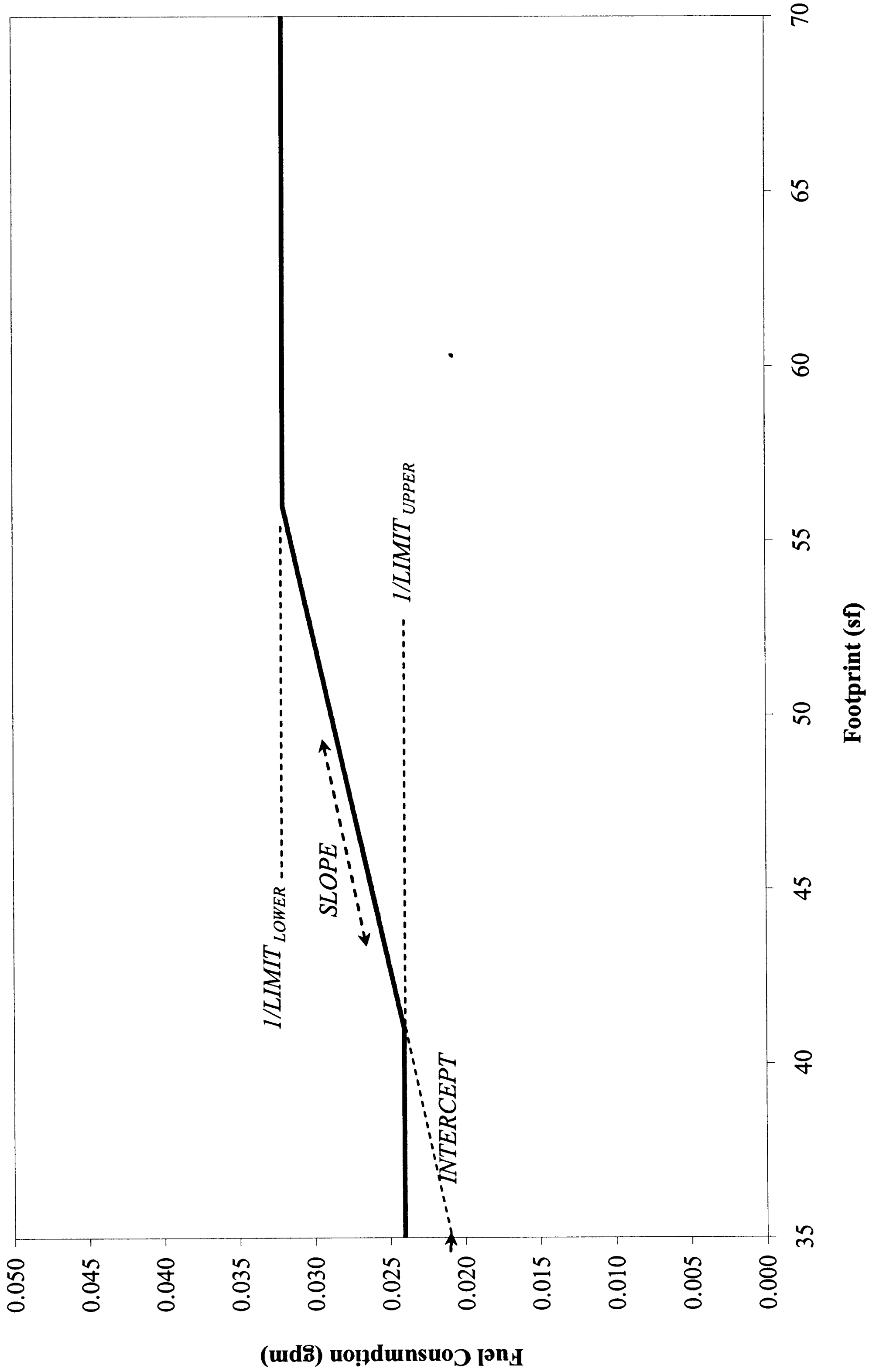


Figure II.C.1-1 The Shape of the Constrained Linear Form

The specific form and stringency for each fleet (passenger cars and light trucks) and model year are defined through specific values for the four coefficients shown above.

EPA is proposing the equivalent equation below for assigning CO_2 targets to an individual vehicle's footprint value. Although the general model of the equation is the same for each vehicle category and each year, the parameters of the equation differ for cars and trucks. Each parameter also changes on an annual basis, resulting in the yearly increases in stringency seen in the tables above. Described mathematically, EPA's proposed piecewise linear function is as follows:

Target = a, if $x \leq l$

Target = $cx + d$, if $l < x \leq h$

Target = b, if $x > h$

In the constrained linear form applied by NHTSA, this equation takes the simplified form:

Target = MIN [MAX (c * x + d, a), b]

Where:

Target = the CO_2 target value for a given footprint (in g/mi)

a = the minimum target value (in g/mi CO_2)

b = the maximum target value (in g/mi CO_2)

c = the slope of the linear function (in g/mi per sq ft CO_2)

d = is the intercept or zero-offset for the line (in g/mi CO_2)

x = footprint of the vehicle model (in square feet, rounded to the nearest tenth)

l & h are the lower and higher footprint limits or constraints or (''kinks'') or the boundary between the flat regions and the intermediate sloped line (in sq ft)

Graphically, piecewise linear form, like the constrained linear form, appears as shown in Figure II.C.1–2.

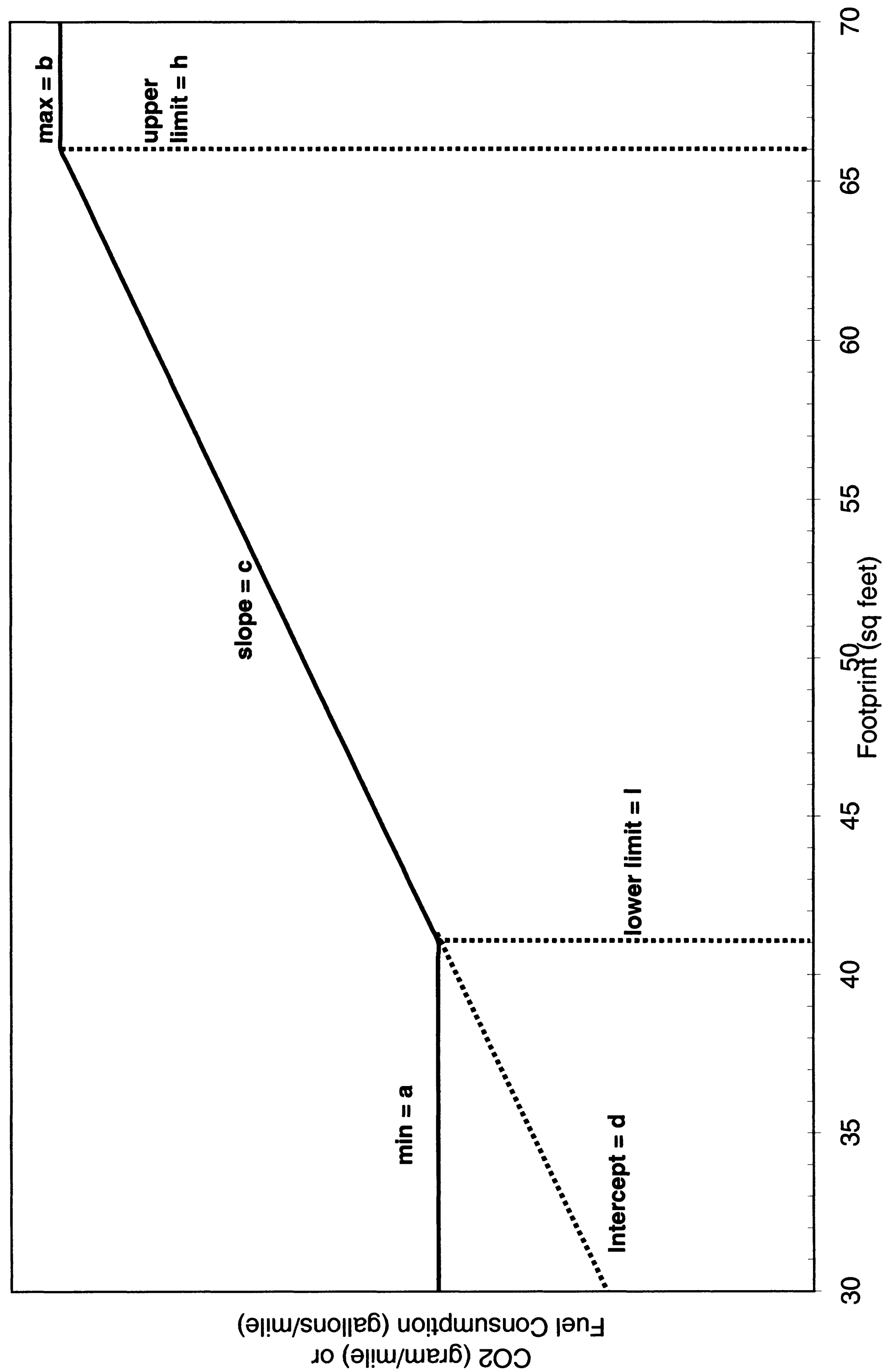


Figure II.C.1-2 The Shape of the Piecewise Linear Form

BILLING CODE 4910–59–C

As for the constrained linear form, the specific form and stringency for each fleet (passenger car and light trucks) and model year are defined through specific values for the four coefficients shown above.

For purposes of this rule, NHTSA and EPA developed the basic curve shapes using methods similar to those applied by NHTSA in fitting the curves defining the MY 2011 standards. The first step is defining the reference market inputs (in the form used by NHTSA's CAFE model) described in Section II.B of this preamble and in Chapter 1 of the joint TSD. However, because the baseline fleet is technologically heterogeneous, NHTSA used the CAFE model to develop a fleet to which nearly all the technologies discussed in Chapter 3 of the joint TSD [79] were applied, by taking the following steps: (1) Treating all manufacturers as unwilling to pay civil penalties rather than applying technology, (2) applying any technology at any time, irrespective of scheduled vehicle redesigns or freshening, and (3) ignoring ''phase-in caps'' that constrain the overall amount of technology that can be applied by the model to a given manufacturer's fleet. These steps helped to increase technological parity among vehicle models, thereby providing a better basis (than the baseline or reference fleets) for estimating the statistical relationship between vehicle size and fuel economy.

In fitting the curves, NHTSA also continued to apply constraints to limit the function's value for both the smallest and largest vehicles. Without a limit at the smallest footprints, the function—whether logistic or linear—can reach values that would be unfairly burdensome for a manufacturer that elects to focus on the market for small vehicles; depending on the underlying data, an unconstrained form could apply to the smallest vehicles targets that are simply unachievable. Limiting the function's value for the smallest vehicles ensures that the function remains technologically achievable at small footprints, and that it does not unduly burden manufacturers focusing on small vehicles. On the other side of the function, without a limit at the largest footprints, the function may provide no floor on required fuel economy. Also, the safety considerations that support the provision of a disincentive for downsizing as a compliance strategy apply weakly—if at all—to the very largest vehicles. Limiting the function's value for the largest vehicles leads to a function with an inherent absolute minimum level of performance, while remaining consistent with safety considerations.

Before fitting the sloped portion of the constrained linear form, NHTSA selected footprints above and below which to apply constraints (*i.e.,* minimum and maximum values) on the function. For passenger cars, the agency noted that several manufacturers offer small and, in some cases, sporty coupes below 41 square feet, examples including the BMW Z4 and Mini, Saturn Sky, Honda Fit and S2000, Hyundai Tiburon, Mazda MX–5 Miata, Suzuki SX4, Toyota Yaris, and Volkswagen New Beetle. Because such vehicles represent a small portion (less than 10 percent) of the passenger car market, yet often have characteristics that could make it infeasible to achieve the very challenging targets that could apply in the absence of a constraint, NHTSA is proposing to ''cut off'' the linear portion of the passenger car function at 41 square feet. For consistency, the agency is proposing to do the same for the light truck function, although no light trucks are currently offered below 41 square feet. The agency further noted that above 56 square feet, the only passenger car model present in the MY 2008 fleet were four luxury vehicles with extremely low sales volumes—the Bentley Arnage and three versions of the Rolls Royce Phantom. NHTSA is therefore proposing to ''cut off'' the linear portion of the passenger car function at 56 square feet. Finally, the agency noted that although public information is limited regarding the sales volumes of the many different configurations (cab designs and bed sizes) of pickup trucks, most of the largest pickups (*e.g.,* the Ford F–150, GM Sierra/Silverado, Nissan Titan, and Toyota Tundra) appear to fall just above 66 square feet in footprint. NHTSA is therefore proposing to ''cut off'' the linear portion of the light truck function at 66 square feet.

NHTSA and EPA seek comment on this approach to fitting the curves. We note that final decisions on this issue will play an important role in determining the form and stringency of the final CAFE and CO_2 standards, the incentives those standards will provide (*e.g.,* with respect to downsizing small vehicles), and the relative compliance burden faced by each manufacturer.

For purposes of the CAFE and CO_2 standards proposed in this NPRM, NHTSA and EPA recognize that there is some possibility that low fuel prices during the years in which MY 2012–2016 vehicles are in service might lead to less than currently anticipated fuel savings and emissions reductions. One way to assure that emission reductions are achieved in fact is through the use of explicit backstops, fleet average standards established at an absolute level. For purposes of the CAFE program, EISA requires a backstop for domestically-manufactured passenger cars—a universal minimum, non-attribute-based standard of either ''27.5 mpg or 92 percent of the average fuel economy projected by the Secretary of Transportation for the combined domestic and non-domestic passenger automobile fleets manufactured for sale in the United States by all manufacturers in the model year * * *,'' whichever is greater.[80] In the MY 2011 final rule, the first rule setting standards since EISA added the backstop provision to EPCA, NHTSA considered whether the statute permitted the agency to set backstop standards for the other regulated fleets of imported passenger cars and light trucks. Although commenters expressed support both for and against a more permissive reading of EISA, NHTSA concluded in that rulemaking that its authority was likely limited to setting only the backstop standard that Congress expressly provided, *i.e.,* the one for domestic passenger cars. A backstop, however, could be adopted under section 202(a) of the CAA assuming it could be justified under the relevant statutory criteria. EPA and NHTSA also note that the flattened portion of the car curve directionally addresses the issue of a backstop (*i.e.*, a flat curve is itself a backstop). The agencies seek comment on whether backstop standards, or any other method within the agencies' statutory authority, should and can be implemented in order to guarantee a level of CO_2 emissions reductions and fuel savings under the attribute-based standards.

Having developed a set of baseline data to which to fit the mathematical fuel consumption function, the initial values for parameters *c* and *d* were determined for cars and trucks separately. *c* and *d* were initially set at the values for which the average (equivalently, sum) of the absolute values of the differences was minimized between the ''maximum technology'' fleet fuel consumption (within the footprints between the upper and lower

[79] The agencies excluded diesel engines and strong hybrid vehicle technologies from this exercise (and only this exercise) because the agencies expect that manufacturers would not need to rely heavily on these technologies in order to comply with the proposed standards. NHTSA and EPA did include diesel engines and strong hybrid vehicle technologies in all other portions of their analyses.

[80] 49 U.S.C. 32902(b)(4).

limits) and the straight line the function defined above at the same corresponding vehicle footprints. That is, *c* and *d* were determined by minimizing the average absolute residual, commonly known as the MAD (Mean Absolute Deviation) approach, of the corresponding straight line.

Finally, NHTSA calculated the values of the upper and lower values (*a* and *b*) based on the corresponding footprints discussed above (41 and 56 square feet for passenger cars, and 41 and 66 square feet for light trucks).

The result of this methodology is shown below in Figures II.A.2–2 and II.A.2–3 for passenger cars and light trucks, respectively. The fitted curves are shown with the underlying ''maximum technology'' passenger car and light truck fleets. For passenger cars, the mean absolute deviation of the sloped portion of the function was 14 percent. For trucks, the corresponding MAD was 10 percent.

BILLING CODE 4910–59–P

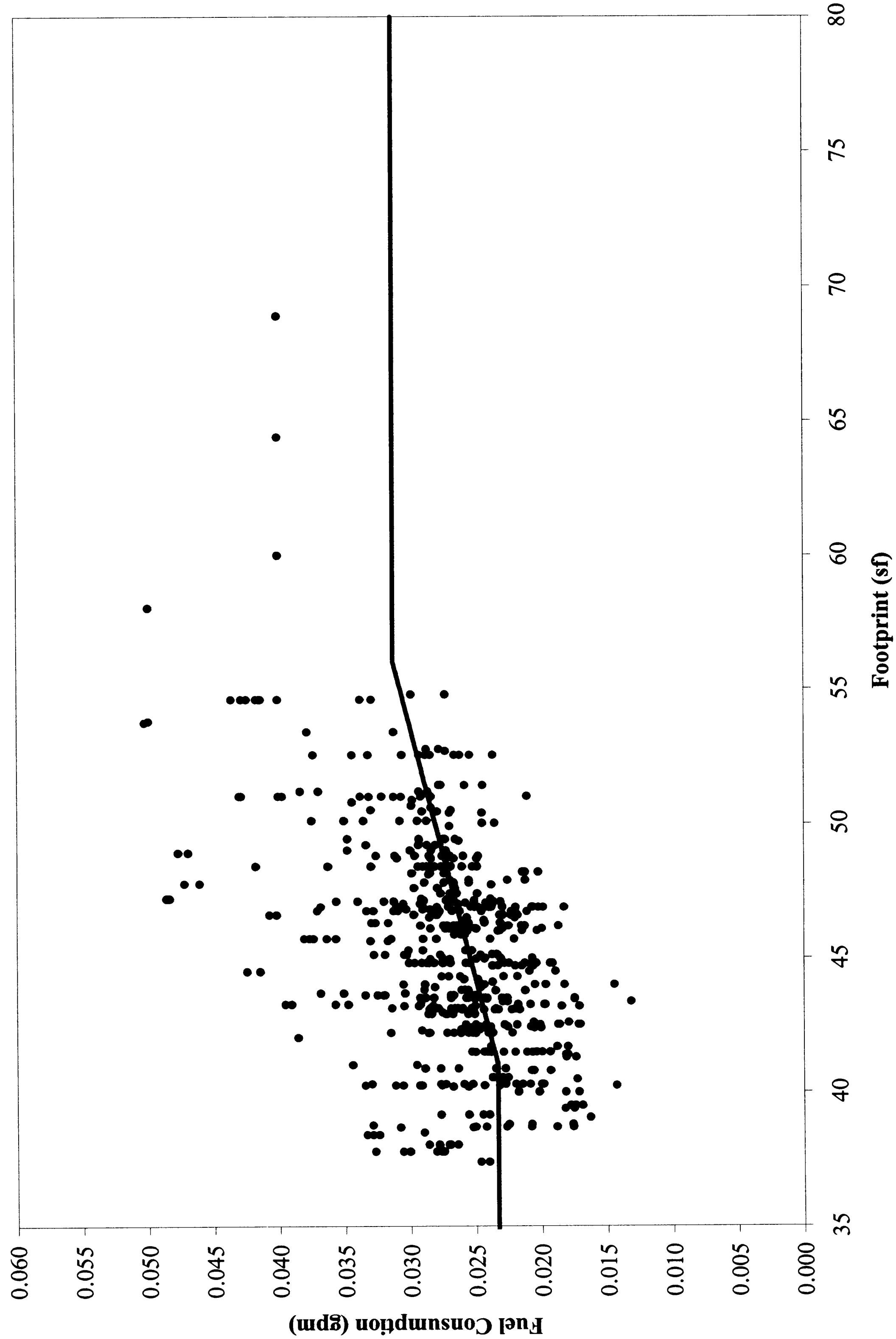


Figure II.C.1-3 "Maximum Technology" Passenger Fleet with Fitted Constrained Linear Function

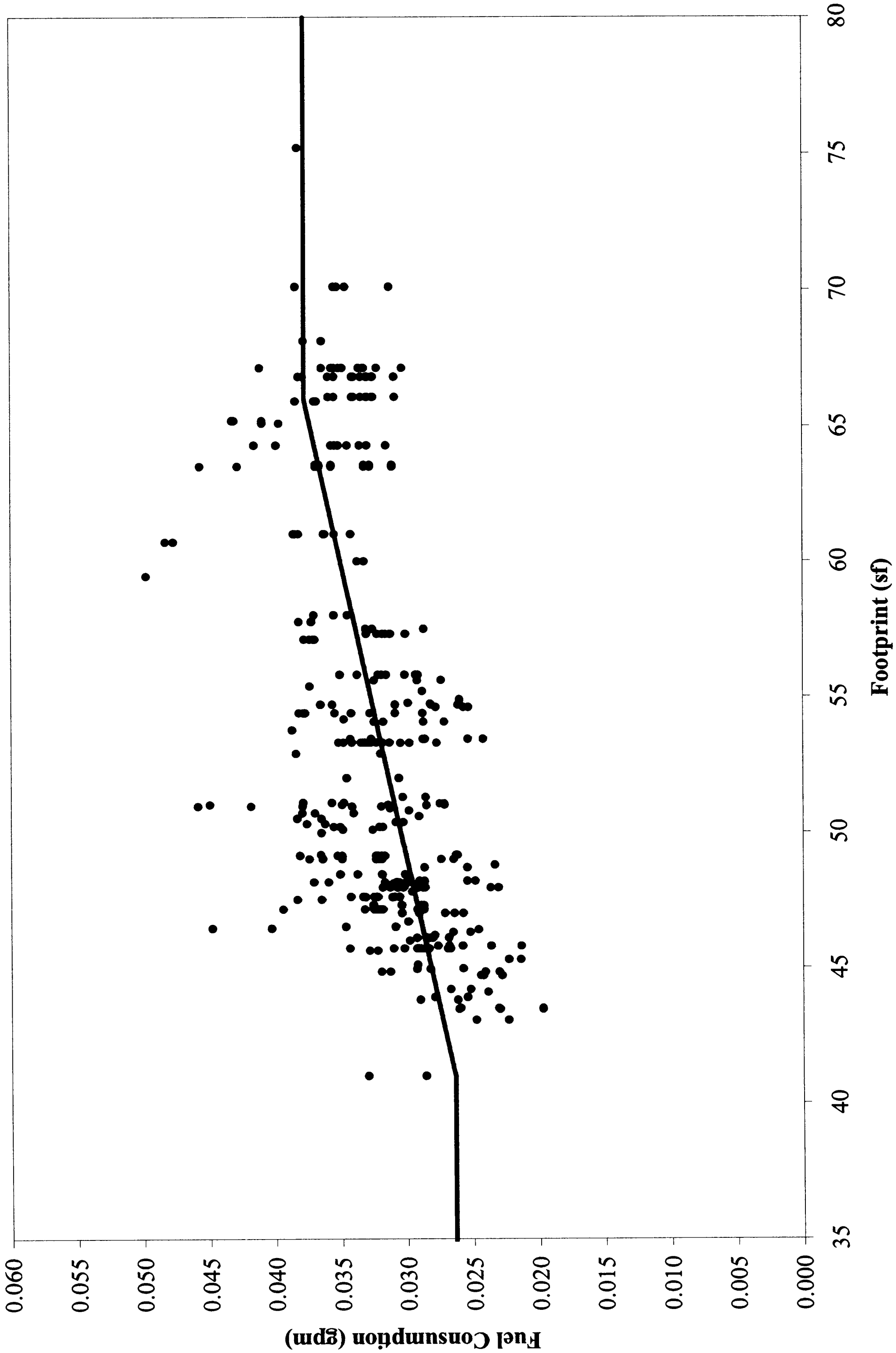


Figure II.C.1-4 “Maximum Technology” Light Truck with Fitted Constrained Linear Function

The agencies used these functional forms as a starting point to develop mathematical functions defining the actual proposed standards as discussed above. The agencies then transposed these functions vertically (*i.e.,* on a gpm or CO_2 basis, uniformly downward) to produce the relative car and light truck standards described in the next section.

D. Relative Car-Truck Stringency

The agencies have determined, under their respective statutory authorities, that it is appropriate to propose fleetwide standards with the projected levels of stringency of 34.1 mpg or 250 g/mi (as well as the corresponding intermediate year fleetwide standards) for NHTSA and EPA respectively. To determine the relative stringency of passenger car and light truck standards, the agencies are concerned that increasing the difference between the car and truck standards (either by raising the car standards or lowering the truck standards) could encourage manufacturers to build fewer cars and more trucks, likely to the detriment of fuel economy and CO_2 reductions.[81] In order to maintain consistent car/truck standards, the agencies applied a constant ratio between the estimated average required performance under the passenger car and light truck standards, in order to maintain a stable set of incentives regarding vehicle classification.

To calculate relative car-truck stringency in this proposal, the agencies explored a number of possible alternatives. In the interest of harmonization, the agencies agree to use the Volpe model in order to estimate stringencies at which net benefits would be maximized. Further details of the development of this scenario approach can be found in Section IV of this preamble as well as in NHTSA's PRIA and DEIS. NHTSA examined passenger car and light truck standards that would produce the proposed combined average fuel economy levels from Table I.B.2–2 above. NHTSA did so by shifting downward the curves that maximize net benefits, holding the relative stringency of passenger car and light truck standards constant at the level determined by maximizing net benefits, such that the average fuel economy required of passenger cars remains 34 percent higher than the average fuel economy required of light trucks. This methodology resulted in the average fuel economy levels for passenger cars and light trucks during MYs 2012–2016 as shown in Table I.D.2–1. The following chart illustrates this methodology of shifting the standards from the levels maximizing net benefits to the levels consistent with the combined fuel economy standards in this rule.

[81] For example, since many 2WD SUVs are classified as passenger cars, manufacturers have already warned that high car standards relative to truck standards could create an incentive for them to drop the 2WD version and sell only the 4WD version.

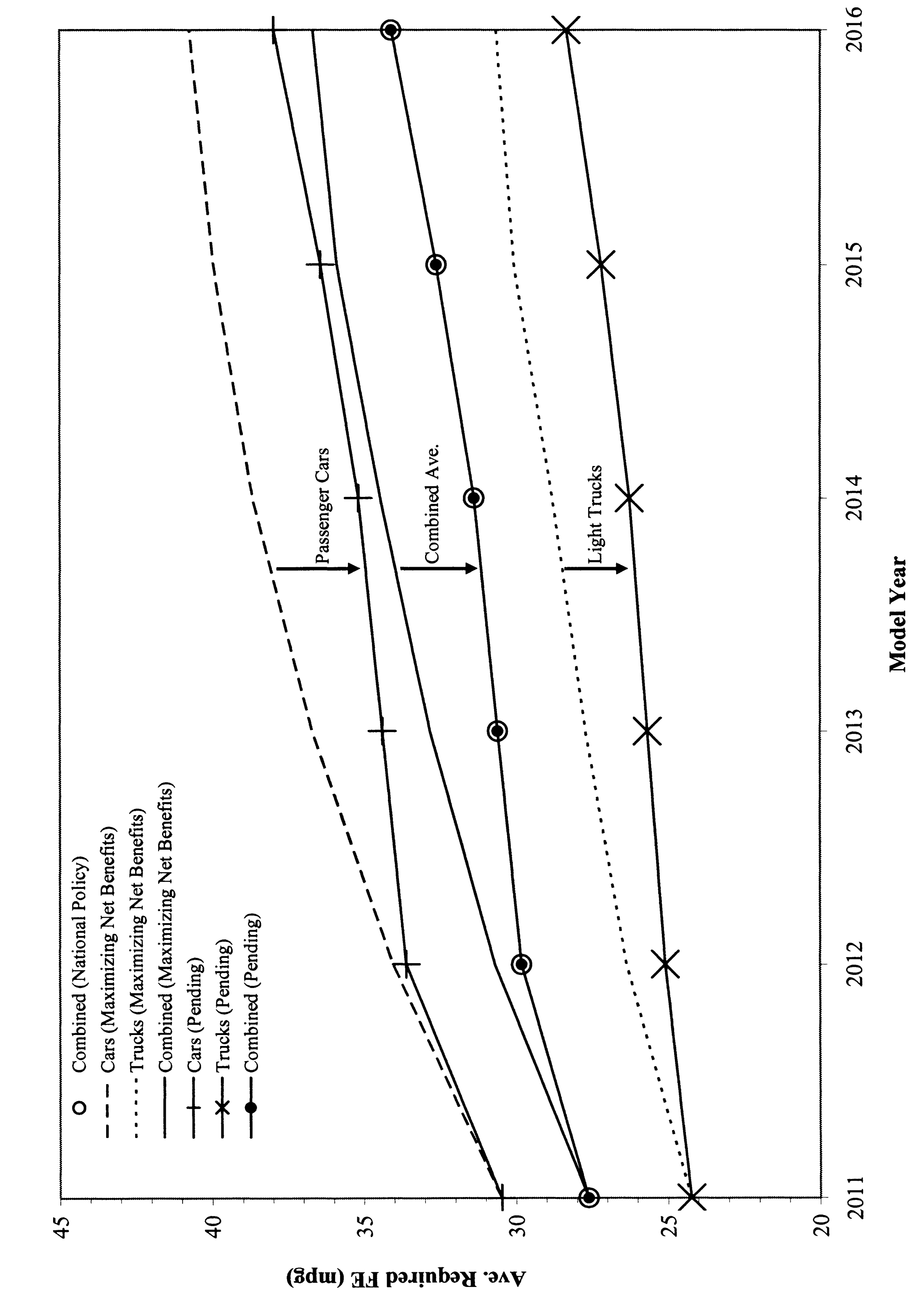


Figure II.D.1-1 Shifting the Standards from the Maximizing Net Benefit Levels to the Levels Consistent with the Combined Fuel Economy Standards in this Rule

After this analysis was completed, EPA examined two alternative approaches to determine whether they would lead to significantly different outcomes. First, EPA analyzed the relative stringencies using a 10-year payback analysis (with the OMEGA model). This analysis sets the relative stringencies if increased technology cost is to be paid back out of fuel savings over a 10-year period (assuming a 3% discount rate). Second, EPA also conducted a technology maximized analysis, which sets the relative stringencies if all technologies (with the exception of strong hybrids and diesels) are assumed to be utilized in the fleet. (This is the same methodology that was used to determine the curve shape as explained in the section above and in Chapter 2 of the joint TSD section).

Compared to NHTSA's approach based on stringencies estimated to maximize net benefits, EPA staff found that these two other approaches produced very similar results to NHTSA's, *i.e.,* similar ratios of car-truck relative stringency (the ratio being within a range of 1.34 to 1.37 relative stringency of the car to the truck fuel economy standard). EPA believes that this similarity supports the proposed relative stringency of the two standards.

The car and truck standards for EPA (Table I.D. 2–4 above) were subsequently determined by first converting the average required fuel economy levels to average required CO_2 emission rates, and then applying the expected air conditioning credits for 2012–2016. These A/C credits are shown in the following table. Further details of the derivation of these factors can be found in Section III of this preamble or in the EPA RIA.

TABLE II.D.1–1 EXPECTED FLEET A/C CREDITS (IN CO_2 EQUIVALENT G/MI) FROM 2012–2016

	Average technology penetration (percent)	Average credit for cars	Average credit for trucks	Average credit for combined fleet
2012	25	3.0	3.4	3.1
2013	40	4.8	5.4	5.0
2014	55	7.2	8.1	7.5
2015	75	9.6	10.8	10.0
2016	85	10.2	11.5	10.6

The agencies seek comment on the use of this methodology for apportioning the fleet stringencies to relative car and truck standards for 2012–2016.

E. Joint Vehicle Technology Assumptions

Vehicle technology assumptions, *i.e.,* assumptions about their cost, effectiveness, and the rate at which they can be incorporated into new vehicles, are often very controversial as they have a significant impact on the levels of the standards. Agencies must, therefore, take great care in developing and justifying these assumptions. In developing technology inputs for MY 2012–2016 standards, the agencies reviewed the technology assumptions that NHTSA used in setting the MY 2011 standards and the comments that NHTSA received in response to its May 2008 Notice of Proposed Rulemaking. This review is consistent with the request by President Obama in his January 26 memorandum to DOT. In addition, the agencies reviewed the technology input estimates identified in EPA's July 2008 Advanced Notice of Proposed Rulemaking. The review of these documents was supplemented with updated information from more current literature, new product plans and from EPA certification testing.

As a general matter, the best way to derive technology cost estimates is to conduct real-world tear down studies. These studies break down each technology into its respective components, evaluate the costs of each component, and build up the costs of the entire technology based on the contribution of each component. As such, tear down studies require a significant amount of time and are very costly. EPA has begun conducting tear down studies to assess the costs of 4–5 technologies under a contract with FEV. To date, only two technologies (stoichiometeric gasoline direct injection and turbo charging with engine downsizing for a 4 cylinder engine to a 4 cylinder engine) have been evaluated. The agencies relied on the findings of FEV for estimating the cost of these technologies in this rulemaking—directly for the 4 cylinder engines, and extrapolated for the 6 and 8 cylinder engines. The agencies request comment on the use of these estimated costs from the FEV study. For the other technologies, because tear down studies were not yet available, the agencies decided to pursue, to the extent possible, the Bill of Materials (BOM) approach as outlined in NHTSA's MY 2011 final rule. A similar approach was used by EPA in the EPA 2008 Staff Technical Report. This approach was recommended to NHTSA by Ricardo, an international engineering consulting firm retained by NHTSA to aid in the analysis of public comments on its proposed standards for MYs 2011–2015 because of its expertise in the area of fuel economy technologies. A BOM approach is one element of the process used in tear down studies. The difference is that under a BOM approach, the build up of cost estimates is conducted based on a review of cost and effectiveness estimates for each component from available literature, while under a tear down study, the cost estimates which go into the BOM come from the tear down study itself. To the extent that the agencies departed from the MY 2011 CAFE final rule estimates, the agencies explained the reasons and provided supporting analyses. As tear down studies are concluded by FEV during the rulemaking process, the agencies will make them available in the joint rulemaking docket of this rulemaking. The agencies will consider these studies and any comments received on them, as practicable and appropriate, as well as any other new information pertinent to the rulemaking of which the agencies become aware, in developing technology cost assumptions for the final rule.

Similarly, the agencies followed a BOM approach for developing its effectiveness estimates, insofar as the BOM developed for the cost estimates helped to inform the appropriate effectiveness values derived from the literature review. The agencies supplemented the information with results from available simulation work and real world EPA certification testing.

The agencies would also like to note that per the Energy Independence and Security Act (EISA), the National Academies of Sciences is conducting an updated study to update Chapter 3 of the 2002 NAS Report, which outlines technology estimates. The update will take a fresh look at that list of technologies and their associated cost and effectiveness values.

The report is expected to be available on September 30, 2009. As soon as the update to the NAS Report is received, it will be placed in the joint rulemaking docket for the public's review and comment. Because this will occur during the comment period, the public is encouraged to check the docket regularly and provide comments on the updated NAS Report by the closing of the comment period of this notice. NHTSA and EPA will consider the updated NAS Report and any comments received, as practicable and appropriate, on it when considering revisions to the technology cost and effectiveness estimates for the final rule.

Consideration of this report is consistent with the request by President Obama in his January 26 memorandum to DOT.

1. What Technologies Do the Agencies Consider?

The agencies considered over 35 vehicle technologies that manufacturers could use to improve the fuel economy and reduce CO_2 emissions of their vehicles during MYs 2012–2016. The majority of the technologies described in this section are 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 the next few years. These are technologies which can, for the most part, be applied both to cars and trucks, and 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 the leadtime available for this rule is not sufficient to move such technologies from research to production.

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. For a more detailed description of each technology and their costs and effectiveness, we refer the reader to Chapter 3 of the joint TSD, Chapter III of NHTSA's PRIA, and Chapter 1 of EPA's DRIA. Technologies to reduce CO_2 and HFC emissions from air conditioning systems are discussed in Section III of this preamble and in EPA's DRIA.

Types of engine technologies that improve fuel economy and reduce CO_2 emissions include the following:

• *Low-friction lubricants*—low viscosity and advanced low friction lubricants 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.

• *Conversion to dual overhead cam with dual cam phasing*—as applied to overhead valves designed to increase the air flow with more than two valves per cylinder and reduce pumping losses.

• *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.

• *Discrete variable valve lift*—increases efficiency by optimizing air flow over a broader range of engine operation which reduces pumping losses. Accomplished by controlled switching between two or more cam profile lobe heights.

• *Continuous variable valve lift*—is an electromechanically controlled system in which valve timing is changed as lift height is controlled. This yields a wide range of performance optimization and volumetric efficiency, including enabling the engine to be valve throttled.

• *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.

• *Combustion restart*—can be used in conjunction with gasoline direct-injection systems to enable idle-off or start-stop functionality. Similar to other start-stop technologies, additional enablers, such as electric power steering, accessory drive components, and auxiliary oil pump, might be required.

• *Turbocharging and downsizing*—increases the available airflow and specific power level, allowing a reduced engine size while maintaining performance. This reduces pumping losses at lighter loads in comparison to a larger engine.

• *Exhaust-gas recirculation boost*—increases the exhaust-gas recirculation used in the combustion process to increase thermal efficiency and reduce pumping losses.

• *Diesel engines*—have several characteristics that give superior fuel efficiency, including reduced pumping losses due to lack of (or greatly reduced) throttling, and a combustion cycle that operates at a higher compression ratio, with a very lean air/fuel mixture, relative to an equivalent-performance gasoline engine. This technology requires additional enablers, such as NO_x trap catalyst after-treatment or selective catalytic reduction NO_x after-treatment. The cost and effectiveness estimates for the diesel engine and aftertreatment system utilized in this proposal have been revised from the NHTSA MY 2011 CAFE final rule, and the agencies request comment on these diesel cost estimates.

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.

• *Dual clutch or automated shift manual transmissions*—are similar to manual transmissions, but the vehicle controls shifting and launch functions. A dual-clutch automated shift manual transmission uses separate clutches for even-numbered and odd-numbered gears, so the next expected gear is pre-selected, which allows for faster and smoother shifting.

• *Continuously variable transmission*—commonly uses V-shaped pulleys connected by a metal belt rather than gears to provide ratios for operation. Unlike manual and automatic transmissions with fixed transmission ratios, continuously variable transmissions can provide fully variable transmission ratios with an infinite number of gears, enabling finer optimization of transmission torque multiplication under different operating conditions so that the engine can operate at higher efficiency.

• *Manual 6-speed transmission*—offers an additional gear ratio, often with a higher overdrive gear ratio, than a 5-speed manual transmission.

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 economy and reducing CO_2 emissions.

• *Low-drag brakes*—reduce the sliding friction of disc brake pads on rotors when the brakes are not engaged because the brake pads are pulled away from the rotors.

• *Front or secondary axle disconnect for four-wheel drive systems*—provides a torque distribution disconnect between front and rear axles when torque is not required for the non-driving axle. This results in the reduction of associated parasitic energy losses.

• *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. The agencies seek comments on the methods, costs, and effectiveness estimates associated with mass reduction and material substitution techniques that manufacturers intend to employ for reducing fuel consumption and CO_2 emissions during the rulemaking time frame.

Types of electrification/accessory and hybrid technologies considered include:

• *Electric power steering (EPS)*—is an electrically-assisted steering system that has advantages over traditional hydraulic power steering because it replaces a continuously operated hydraulic pump, thereby reducing parasitic losses from the accessory drive.

• *Improved accessories (IACC)*—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. These technologies are covered separately in the EPA RIA.

• *12-volt micro-hybrid (MHEV)*—also known as idle-stop or start stop and commonly implemented as a 12-volt belt-driven integrated starter-generator, this is the most basic hybrid system that facilitates idle-stop capability. Along with other enablers, this system replaces a common alternator with a belt-driven enhanced power starter-alternator, and a revised accessory drive system.

• *Higher Voltage Stop-Start/Belt Integrated Starter Generator (BISG)*—provides idle-stop capability and uses a high voltage battery with increased energy capacity over typical automotive batteries. The higher system voltage allows the use of a smaller, more powerful electric motor. This system replaces a standard alternator with an enhanced power, higher voltage, higher efficiency starter-alternator, that is belt driven and that can recover braking energy while the vehicle slows down (regenerative braking).

• *Integrated Motor Assist (IMA)/Crank integrated starter generator (CISG)*—provides idle-stop capability and uses a high voltage battery with increased energy capacity over typical automotive batteries. The higher system voltage allows the use of a smaller, more powerful electric motor and reduces the weight of the wiring harness. This system replaces a standard alternator with an enhanced power, higher voltage, higher efficiency starter-alternator that is crankshaft mounted and can recover braking energy while the vehicle slows down (regenerative braking).

• *2-mode hybrid (2MHEV)*—is a hybrid electric drive system that uses an adaptation of a conventional stepped-ratio automatic transmission by replacing some of the transmission clutches with two electric motors that control the ratio of engine speed to vehicle speed, while clutches allow the motors to be bypassed. This improves both the transmission torque capacity for heavy-duty applications and reduces fuel consumption and CO_2 emissions at highway speeds relative to other types of hybrid electric drive systems.

• *Power-split hybrid (PSHEV)*—a hybrid electric drive system that replaces the traditional transmission with a single planetary gearset and a motor/generator. This motor/generator uses the engine to either charge the battery or supply additional power to the drive motor. A second, more powerful motor/generator is permanently connected to the vehicle's final drive and always turns with the wheels. The planetary gear splits engine power between the first motor/generator and the drive motor to either charge the battery or supply power to the wheels.

• *Plug-in hybrid electric vehicles (PHEV)*—are hybrid electric vehicles with the means to charge their battery packs from an outside source of electricity (usually the electric grid). These vehicles have larger battery packs with more energy storage and a greater capability to be discharged. They also use a control system that allows the battery pack to be substantially depleted under electric-only or blended mechanical/electric operation.

• *Electric vehicles (EV)*—are vehicles with all-electric drive and with vehicle systems powered by energy-optimized batteries charged primarily from grid electricity.

The cost estimates for the various hybrid systems have been revised from the estimates used in the MY 2011 CAFE final rule, in particular with respect to estimated battery costs. The agencies request comment on the hybrid cost estimates detailed in the draft Joint Technical Support Document.

2. How Did the Agencies Determine the Costs and Effectiveness of Each of These Technologies?

Building on NHTSA's estimates developed for the MY 2011 CAFE final rule and EPA's Advanced Notice of Proposed Rulemaking, which relied on the 2008 Staff Technical Report,[82] the agencies took a fresh look at technology cost and effectiveness values for purposes of the joint proposal under the National Program. 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 in NHTSA's MY 2011 final rule based on recommendation from Ricardo, Inc. EPA used a similar approach in the 2008 EPA Staff Technical Report. 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 fuel economy-improving technology. 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. The objective was to use those sources of information considered to be most credible for projecting the costs of individual vehicle technologies. For example, while NHTSA and Ricardo engineers had relied considerably in the

[82] EPA Staff Technical Report: Cost and Effectiveness Estimates of Technologies Used to Reduce Light-Duty Vehicle Carbon Dioxide Emissions. EPA420–R–08–008, March 2008.

MY 2011 final rule on the 2008 Martec Report for costing contents of some technologies, upon further joint review and for purposes of the MY 2012–2016 standards, the agencies decided that some of the costing information in that report was no longer accurate due to downward trends in commodity prices since the publication of that report. The agencies reviewed, then revalidated or updated cost estimates for individual components based on new information. Thus, while NHTSA and EPA found that much of the cost information used in NHTSA's MY 2011 final rule and EPA's staff report was consistent to a great extent, the agencies, in reconsidering information from many sources,[83,84,85,86,87,88,89] revised several component costs of several major technologies: turbocharging with engine downsizing, mild and strong hybrids, diesels, stoichiometric gasoline direct injection fuel systems, and valve train lift technologies. These are discussed at length in the joint TSD and in NHTSA's PRIA.

For two technologies (stoichiometric gasoline direct injection and turbocharging with engine downsizing), the agencies relied, to the extent possible, on the tear down data available and scaling methodologies used in EPA's ongoing study with FEV. 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.[90] The confidential information provided by manufacturers as part of their product plan submissions to the agencies or discussed in meetings between the agencies and the manufacturers and suppliers served largely as a check on publicly-available data.

For the other technologies, considering all sources of information and using the BOM approach, the agencies worked together intensively during the summer of 2009 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 2007 dollars using a ratio of GDP values for the associated calendar years,[91] and indirect costs were accounted for using the new approach developed by EPA and explained in Chapter 3 of the draft joint TSD, rather than using the traditional Retail Price Equivalent (RPE) multiplier approach. A report explaining how EPA developed this approach can be found in the docket for this notice. 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. In previous rulemakings, NHTSA has used the Producer Price Index (PPI) to adjust vehicle technology costs to consistent price levels, since the PPI measures the effects of cost changes that are specific to the vehicle manufacturing industry. For purposes of this NPRM, NHTSA and EPA chose to use the GDP deflator, which accounts for the effect of economy-wide price inflation on technology cost estimates, in order to express those estimates in comparable terms with forecasts of fuel prices and other economic values used in the analysis of costs and benefits from the proposed standards. Because it is specific to the automotive sector, the PPI tends to be highly volatile from year to year, reflecting rapidly changing balances between supply and demand for specific components, rather than longer-term trends in the real cost of producing a broad range of powertrain components. NHTSA and EPA seek comment on whether the agencies should use a GDP deflator or a PPI inflator for purposes of developing technology cost estimates for the final rule.

Regarding estimates for technology effectiveness, NHTSA and EPA also reexamined the estimates from NHTSA's MY 2011 final rule and EPA's ANPRM and 2008 Staff Technical Report, which were largely consistent with NHTSA's 2008 NPRM estimates. The agencies also reconsidered other sources such as the 2002 NAS Report, the 2004 NESCCAF report, recent CAFE compliance data (by comparing similar vehicles with different technologies against each other in fuel economy testing, such as a Honda Civic Hybrid versus a directly comparable Honda Civic conventional drive), 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, they compared the multiple estimates and assessed their validity, taking care to ensure that common BOM definitions and other vehicle attributes such as performance, refinement, and drivability were taken into account. However, because the agencies' respective models employ different numbers of vehicle subclasses and use different modeling techniques to arrive at the standards, direct comparison of BOMs was somewhat more complicated. To address this and to confirm that the outputs from the different modeling techniques produced the same result, NHTSA and EPA developed mapping techniques, devising technology packages and mapping them to corresponding incremental technology estimates. This approach helped compare the outputs from the incremental modeling technique to those produced by the technology packaging approach to ensure results that are consistent and could be translated into the respective models of the agencies.

In general, most effectiveness estimates used in both the MY 2011 final rule and the 2008 EPA staff report were determined to be accurate and were carried forward without significant change into this proposal. When NHTSA and EPA's estimates for effectiveness diverged slightly due to

[83] National Research Council, ''Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards,'' National Academy Press, Washington, DC (2002) (the ''2002 NAS Report''), available at *http://www.nap.edu/openbook.php?isbn=0309076013* (last accessed August 7, 2009).

[84] Northeast States Center for a Clean Air Future (NESCCAF), ''Reducing Greenhouse Gas Emissions from Light-Duty Motor Vehicles,'' 2004 (the ''2004 NESCCAF Report''), available at *http://www.nesccaf.org/documents/rpt040923ghglightduty.pdf* (last accessed August 7, 2009).

[85] ''Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles,'' California Environmental Protection Agency, Air Resources Board, August 6, 2004.

[86] Energy and Environmental Analysis, Inc., ''Technology to Improve the Fuel Economy of Light Duty Trucks to 2015,'' 2006 (the ''2006 EEA Report''), Docket EPA–HQ–OAR–2009–0472.

[87] Martec, ''Variable Costs of Fuel Economy Technologies,'' June 1, 2008, (the ''2008 Martec Report'') available at Docket No. NHTSA–2008–0089–0169.1

[88] Vehicle fuel economy certification data.

[89] Confidential data submitted by manufacturers in response to the March 2009 and other requests for product plans.

[90] 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.

[91] 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.

differences in how agencies apply technologies to vehicles in their respective models, we report the ranges for the effectiveness values used in each model. While the agencies believe that the ideal estimates for the final rule would be based on tear down studies or BOM approach and subjected to a transparent peer-reviewed process, NHTSA and EPA are confident that the thorough review conducted, led to the best available conclusion regarding technology costs and effectiveness estimates for the current rulemaking and resulted in excellent consistency between the agencies' respective analyses for developing the CAFE and CO_2 standards.

The agencies note that the effectiveness values estimated for the technologies considered in the modeling analyses 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. Similarly, the reduction in rolling resistance (and thus the improvement in fuel economy and the reduction in CO_2 emissions) due to the application of low rolling resistance 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 economy 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, as adjusted depending on vehicle subclass, is an appropriate way of recognizing the potential variation in the specific benefits that individual manufacturers (and individual vehicles) might obtain from adding a fuel-saving technology. However, the agencies seek comment on whether additional levels of specificity beyond that already provided would improve the analysis for the final rule, and if so, how those levels of specificity should be analyzed.

Chapter 3 of the draft Joint Technical Support Document 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 warranty costs, and maintenance and replacement costs such as replacement costs for low rolling resistance tires, low friction lubricants, and hybrid batteries, and maintenance on diesel aftertreatment components.

F. Joint Economic Assumptions

The agencies' preliminary analysis of alternative CAFE and GHG standards for the model years covered by this proposed rulemaking rely on a range of forecast information, economic estimates, and input parameters. This section briefly describes the agencies' preliminary choices of specific parameter values. These proposed economic values play a significant role in determining the benefits of both CAFE and GHG standards.

In reviewing these variables and the agency's estimates of their values for purposes of this NPRM, NHTSA and EPA reconsidered previous comments that NHTSA had received and reviewed newly available literature. As a consequence, the agencies elected to revise some economic assumptions and parameter estimates, while retaining others. Some of the most important changes, which are discussed in greater detail in the agencies' respective sections below, as well as in Chapter 4 of the joint TSD and in Chapter VIII of NHTSA's PRIA and Chapter 8 of EPA's DRIA, include significant revisions to the markup factors for technology costs; reducing the rebound effect from 15 to 10 percent; and revising the value of reducing CO_2 emissions based on recent interagency efforts to develop estimates of this value for government-wide use. The agencies seek comment on the economic assumptions described below.

- *Costs of fuel economy-improving technologies*—These estimates are presented in summary form above and in more detail in the agencies' respective sections of this preamble, in Chapter 3 of the joint TSD, and in the agencies' respective RIAs. The technology cost estimates used in this analysis are intended to represent manufacturers' direct costs for high-volume production of vehicles with these technologies and sufficient experience with their application so that all cost reductions due to "learning curve" effects have been fully realized. Costs are then modified by applying near-term indirect cost multipliers ranging from 1.11 to 1.64 to the estimates of vehicle manufacturers' direct costs for producing or acquiring each technology to improve fuel economy, depending on the complexity of the technology and the time frame over which costs are estimated.

- *Potential opportunity costs of improved fuel economy*—This estimate addresses the possibility that achieving the fuel economy improvements required by alternative CAFE or GHG standards would require manufacturers to compromise the performance, carrying capacity, safety, or comfort of their vehicle models. If it did so, the resulting sacrifice in the value of these attributes to consumers would represent an additional cost of achieving the required improvements, and thus of manufacturers' compliance with stricter standards. Currently the agencies assume that these vehicle attributes do not change, and include the cost of maintaining these attributes as part of the cost estimates for technologies. However, it is possible that the technology cost estimates do not include adequate allowance for the necessary efforts by manufacturers to maintain vehicle performance, carrying capacity, and utility while improving fuel economy and reducing GHG emissions. While, in principle, consumer vehicle demand models can measure these effects, these models do not appear to be robust across specifications, since authors derive a wide range of willingness-to-pay values for fuel economy from these models, and there is not clear guidance from the literature on whether one specification is clearly preferred over another. Thus, the agencies seek comment on how to estimate explicitly the changes in vehicle buyers' welfare from the combination of higher prices for new vehicle models, increases in their fuel economy, and any accompanying changes in vehicle attributes such as performance, passenger- and cargo-carrying capacity, or other dimensions of utility.

- *The on-road fuel economy "gap"*—Actual fuel economy levels achieved by light-duty vehicles in on-road driving fall somewhat short of their levels measured under the laboratory-like test conditions used by NHTSA and EPA to establish compliance with the proposed CAFE and GHG standards. The agencies use an on-road fuel economy gap for light-duty vehicles of 20 percent lower than published fuel economy levels. For example, if the measured CAFE fuel economy value of a light truck is 20 mpg, the on-road fuel economy actually achieved by a typical driver of that vehicle is expected to be 16 mpg

(20*.80).[92] NHTSA previously used this estimate in its MY 2011 final rule, and the agencies confirmed it based on independent analysis for use in this NPRM.

• *Fuel prices and the value of saving fuel*—Projected future fuel prices are a critical input into the preliminary economic analysis of alternative standards, because they determine the value of fuel savings both to new vehicle buyers and to society. The agencies relied on the most recent fuel price projections from the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) for this analysis. Specifically, the agencies used the AEO 2009 (April 2009 release) Reference Case forecasts of inflation-adjusted (constant-dollar) retail gasoline and diesel fuel prices, which represent the EIA's most up-to-date estimate of the most likely course of future prices for petroleum products.[93]

EIA's Updated Reference Case reflects the effects of the American Reinvestment and Recovery Act of 2009, as well as the most recent revisions to the U.S. and global economic outlook. In addition, it also reflects the provisions of the Energy Independence and Security Act of 2007 (EISA), including the requirement that the combined mpg level of U.S. cars and light trucks reach 35 miles per gallon by model year 2020. Because this provision would be expected to reduce future U.S. demand for gasoline and other fuels, there is some concern about whether the AEO 2009 forecast of fuel prices already partly reflects the increases in CAFE standards considered in this rule, and thus whether it is suitable for valuing the projected reductions in fuel use. In response to this concern, the agencies note that EIA issued a revised version of AEO 2008 in June 2008, which modified its previous December 2007 Early Release of AEO 2008 to reflect the effects of the recently-passed EISA legislation.[94] The fuel price forecasts reported in EIA's Revised Release of AEO 2008 differed by less than one cent per gallon over the entire forecast period (2008–230) from those previously issued as part of its initial release of AEO 2008. Thus, the agencies are reasonably confident that the fuel price forecasts presented in AEO 2009 and used to analyze the value of fuel savings projected to result from this rule are not unduly affected by the CAFE provisions of EISA, and therefore do not cause a baseline problem. Nevertheless, the agencies request comment on the use of the AEO 2009 fuel price forecasts, and particularly on the potential impact of the EISA-mandated CAFE improvements on these projections.

• *Consumer valuation of fuel economy and payback period*—In estimating the value of fuel economy improvements that would result from alternative CAFE and GHG standards to potential vehicle buyers, the agencies assume that buyers value the resulting fuel savings over only part of the expected lifetime of the vehicles they purchase. Specifically, we assume that buyers value fuel savings over the first five years of a new vehicle's lifetime, and that buyers discount the value of these future fuel savings using rates of 3% and 7%. The five-year figure represents the current average term of consumer loans to finance the purchase of new vehicles.

• *Vehicle sales assumptions*—The first step in estimating lifetime fuel consumption by vehicles produced during a model year is to calculate the number that are expected to be produced and sold.[95] The agencies relied on the AEO 2009 Reference Case for forecasts of total vehicle sales, while the baseline market forecast developed by the agencies (*see* Section II.B) divided total projected sales into sales of cars and light trucks.

• *Vehicle survival assumptions*—We then applied updated values of age-specific survival rates for cars and light trucks to these adjusted forecasts of passenger car and light truck sales to determine the number of these vehicles remaining in use during each year of their expected lifetimes.

• *Total vehicle use*—We then calculated the total number of miles that cars and light trucks produced in each model year will be driven during each year of their lifetimes using estimates of annual vehicle use by age tabulated from the Federal Highway Administration's 2001 National Household Transportation Survey (NHTS),[96] adjusted to account for the effect on vehicle use of subsequent increases in fuel prices. In order to insure that the resulting mileage schedules imply reasonable estimates of future growth in *total* car and light truck use, we calculated the rate of growth in annual car and light truck mileage at each age that is necessary for total car and light truck travel to increase at the rates forecast in the AEO 2009 Reference Case. The growth rate in average annual car and light truck use produced by this calculation is approximately 1.1 percent per year.[97] This rate was applied to the mileage figures derived from the 2001 NHTS to estimate annual mileage during each year of the expected lifetimes of MY 2012–2016 cars and light trucks.[98]

• *Accounting for the rebound effect of higher fuel economy*—The rebound effect refers to the fraction of fuel savings expected to result from an increase in vehicle fuel economy—particularly an increase required by the adoption of higher CAFE and GHG standards—that is offset by additional vehicle use. The increase in vehicle use occurs because higher fuel economy reduces the fuel cost of driving, typically the largest single component of the monetary cost of operating a vehicle, and vehicle owners respond to this reduction in operating costs by driving slightly more. For purposes of this NPRM, the agencies have elected to use a 10 percent rebound effect in their analyses of fuel savings and other benefits from higher standards.

• *Benefits from increased vehicle use*—The increase in vehicle use from the rebound effect provides additional benefits to their owners, who may make more frequent trips or travel farther to reach more desirable destinations. This

[92] U.S. Environmental Protection Agency, Final Technical Support Document, Fuel Economy Labeling of Motor Vehicle Revisions to Improve Calculation of Fuel Economy Estimates, EPA420–R–06–017, December 2006.

[93] Energy Information Administration, Annual Energy Outlook 2009, Revised Updated Reference Case (April 2009), Table 12. Available at *http://www.eia.doe.gov/oiaf/servicerpt/stimulus/excel/aeostimtab_12.xls* (last accessed July 26, 2009).

[94] Energy Information Administration, Annual Energy Outlook 2008, Revised Early Release (June 2008), Table 12. Available at *http://www.eia.doe.gov/oiaf/archive/aeo08/excel/aeotab_12.xls* (last accessed September 12, 2009).

[95] Vehicles are defined to be of age 1 during the calendar year corresponding to the model year in which they are produced; thus for example, model year 2000 vehicles are considered to be of age 1 during calendar year 2000, age 2 during calendar year 2001, and to reach their maximum age of 26 years during calendar year 2025. NHTSA considers the maximum lifetime of vehicles to be the age after which less than 2 percent of the vehicles originally produced during a model year remain in service. Applying these conventions to vehicle registration data indicates that passenger cars have a maximum age of 26 years, while light trucks have a maximum lifetime of 36 years. *See* Lu, S., NHTSA, Regulatory Analysis and Evaluation Division, ''Vehicle Survivability and Travel Mileage Schedules,'' DOT HS 809 952, 8–11 (January 2006). Available at *http://www-nrd.nhtsa.dot.gov/Pubs/809952.pdf* (last accessed July 27, 2009).

[96] For a description of the Survey, *see http://nhts.ornl.gov/quickStart.shtml* (last accessed July 27, 2009).

[97] It was not possible to estimate separate growth rates in average annual use for cars and light trucks, because of the significant reclassification of light truck models as passenger cars discussed previously.

[98] While the adjustment for future fuel prices reduces average mileage at each age from the values derived from the 2001 NHTS, the adjustment for expected future growth in average vehicle use increases it. The net effect of these two adjustments is to increase expected lifetime mileage by about 18 percent for passenger cars and about 16 percent for light trucks.

additional travel provides benefits to drivers and their passengers by improving their access to social and economic opportunities away from home. The benefits from increased vehicle use include both the fuel expenses associated with this additional travel, and the consumer surplus it provides. We estimate the economic value of the consumer surplus provided by added driving using the conventional approximation, which is one half of the product of the decline in vehicle operating costs per vehicle-mile and the resulting increase in the annual number of miles driven. Because it depends on the extent of improvement in fuel economy, the value of benefits from increased vehicle use changes by model year and varies among alternative standards.

- *The value of increased driving range*—By reducing the frequency with which drivers typically refuel their vehicles, and by extending the upper limit of the range they can travel before requiring refueling, improving fuel economy and reducing GHG emissions thus provides some additional benefits to their owners. No direct estimates of the value of extended vehicle range are readily available, so the agencies' analysis calculates the reduction in the annual number of required refueling cycles that results from improved fuel economy, and applies DOT-recommended values of travel time savings to convert the resulting time savings to their economic value.[99] The agencies invite comment on the assumptions used in this analysis. Please see the Chapter 4 of the draft Joint TSD for details.
- *Added costs from congestion, crashes and noise*—Although it provides some benefits to drivers, increased vehicle use associated with the rebound effect also contributes to increased traffic congestion, motor vehicle accidents, and highway noise. Depending on how the additional travel is distributed over the day and 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. The agencies rely on estimates of congestion, accident, and noise costs caused by automobiles and light trucks developed by the Federal Highway Administration to estimate the increased external costs caused by added driving due to the rebound effect.[100]
- *Petroleum consumption and import externalities*—U.S. consumption and imports of petroleum products also impose costs on the domestic economy that are not reflected in the market price for crude petroleum, or in the prices paid by consumers of petroleum products such as gasoline. In economics literature on this subject, these costs include (1) higher prices for petroleum products resulting from the effect of U.S. oil import demand on the world oil price (''monopsony costs''); (2) the risk of disruptions to the U.S. economy caused by sudden reductions in the supply of imported oil to the U.S.; and (3) expenses for maintaining a U.S. military presence to secure imported oil supplies from unstable regions, and for maintaining the strategic petroleum reserve (SPR) to cushion against resulting price increases.[101] Reducing U.S. imports of crude petroleum or refined fuels can reduce the magnitude of these external costs. Any reduction in their total value that results from lower fuel consumption and petroleum imports represents an economic benefit of setting more stringent standards over and above the dollar value of fuel savings itself. The agencies do not include a value for monopsony costs in order to be consistent with their use of a global value for the social cost of carbon. Based on a recently-updated ORNL study, we estimate that each gallon of fuel saved that results in a reduction in U.S. petroleum imports (either crude petroleum or refined fuel) will reduce the expected costs of oil supply disruptions to the U.S. economy by $0.169 (2007$). The agencies do not include savings in budgetary outlays to support U.S. military activities among the benefits of higher fuel economy and the resulting fuel savings. Each gallon of fuel saved as a consequence of higher standards is anticipated to reduce total U.S. imports of crude petroleum or refined fuel by 0.95 gallons.[102]
- *Air pollutant emissions*
  - *Impacts on criteria air pollutant emissions*—While reductions in domestic fuel refining and distribution that result from lower fuel consumption will reduce U.S. emissions of criteria pollutants, additional vehicle use associated with the rebound effect will increase emissions of these pollutants. Thus the net effect of stricter standards on emissions of each criteria pollutant depends on the relative magnitudes of reduced emissions from fuel refining and distribution, and increases in emissions resulting from added vehicle use. Criteria air pollutants emitted by vehicles and during fuel production include carbon monoxide (CO), hydrocarbon compounds (usually referred to as ''volatile organic compounds,'' or VOC), nitrogen oxides (NO_X), fine particulate matter ($PM_{2.5}$), and sulfur oxides (SO_X). It is assumed that the emission rates (per mile) stay constant for future year vehicles.
  - EPA and NHTSA estimate the economic value of the human health benefits associated with reducing exposure to $PM_{2.5}$ using a ''benefit-per-ton'' method. These $PM_{2.5}$-related benefit-per-ton estimates provide the total monetized benefits to human health (the sum of reductions in premature mortality and premature morbidity) that result from eliminating one ton of directly emitted $PM_{2.5}$, or one ton of a pollutant that contributes to secondarily-formed $PM_{2.5}$ (such as NO_X, SO_X, and VOCs), from a specified source. Chapter 4.2.9 of the Technical Support Document that accompanies this proposal includes a description of these values.

Reductions in GHG emissions—Emissions of carbon dioxide and other greenhouse gases (GHGs) occur throughout the process of producing and distributing transportation fuels, as well as from fuel combustion itself. By reducing the volume of fuel consumed by passenger cars and light trucks, higher standards will thus reduce GHG emissions generated by fuel use, as well as throughout the fuel supply cycle. The agencies estimated the increases of GHGs other than CO_2, including

[99] Department of Transportation, Guidance Memorandum, ''The Value of Saving Travel Time: Departmental Guidance for Conducting Economic Evaluations,'' Apr. 9, 1997. *http://ostpxweb.dot.gov/policy/Data/VOT97guid.pdf* (last accessed October 20, 2007); update *available at http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2-11-03.pdf* (last accessed October 20, 2007).

[100] These estimates were developed by FHWA for use in its 1997 *Federal Highway Cost Allocation Study; http://www.fhwa.dot.gov/policy/hcas/final/index.htm* (last accessed July 29, 2009).

[101] *See, e.g.,* Bohi, Douglas R. and W. David Montgomery (1982). Oil Prices, Energy Security, and Import Policy Washington, DC: Resources for the Future, Johns Hopkins University Press; Bohi, D. R., and M. A. Toman (1993). ''Energy and Security: Externalities and Policies,'' Energy Policy 21:1093–1109; and Toman, M. A. (1993). ''The Economics of Energy Security: Theory, Evidence, Policy,'' in A. V. Kneese and J. L. Sweeney, eds. (1993). Handbook of Natural Resource and Energy Economics, Vol. III. Amsterdam: North-Holland, pp. 1167–1218.

[102] Each gallon of fuel saved is assumed to reduce imports of refined fuel by 0.5 gallons, and the volume of fuel refined domestically by 0.5 gallons. Domestic fuel refining is assumed to utilize 90% imported crude petroleum and 10% domestically-produced crude petroleum as feedstocks. Together, these assumptions imply that each gallon of fuel saved will reduce imports of refined fuel and crude petroleum by 0.50 gallons + 0.50 gallons*90% = 0.50 gallons + 0.45 gallons = 0.95 gallons.

methane and nitrous oxide, from additional vehicle use by multiplying the increase in total miles driven by cars and light trucks of each model year and age by emission rates per vehicle-mile for these GHGs. These emission rates, which differ between cars and light trucks as well as between gasoline and diesel vehicles, were estimated by EPA using its recently-developed Motor Vehicle Emission Simulator (Draft MOVES 2009).[103] Increases in emissions of non-CO_2 GHGs are converted to equivalent increases in CO_2 emissions using estimates of the Global Warming Potential (GWP) of methane and nitrous oxide.

○ *Economic value of reductions in CO_2 emissions*—EPA and NHTSA assigned a dollar value to reductions in CO_2 emissions using the marginal dollar value (*i.e.,* cost) of climate-related damages resulting from carbon emissions, also referred to as ''social cost of carbon'' (SCC). The SCC is intended to measure the monetary value society places on impacts resulting from increased GHGs, such as property damage from sea level rise, forced migration due to dry land loss, and mortality changes associated with vector-borne diseases. Published estimates of the SCC vary widely as a result of uncertainties about future economic growth, climate sensitivity to GHG emissions, procedures used to model the economic impacts of climate change, and the choice of discount rates. EPA and NHTSA's coordinated proposals present a set of interim SCC values reflecting a *Federal* interagency group's interpretation of the relevant climate economics literature. Sections III.H and IV.C.3 provide more detail about SCC.

• *Discounting future benefits and costs*—Discounting future fuel savings and other benefits is intended to account for the reduction in their value to society when they are deferred until some future date, rather than received immediately. The discount rate expresses the percent decline in the value of these benefits—as viewed from today's perspective—for each year they are deferred into the future. In evaluating the non-climate related benefits of the proposed standards, the agencies have employed discount rates of both 3 percent and 7 percent.

For the reader's reference, Table II.F.1–1 below summarizes the values used to calculate the impacts of each proposed standard. The values presented in this table are summaries of the inputs used for the models; specific values used in the agencies' respective analyses may be aggregated, expanded, or have other relevant adjustments. See the respective RIAs for details. The agencies seek comment on the economic assumptions presented in the table and discussed below.

In addition, the agencies have conducted a range of sensitivities and present them in their respective RIAs. For example, NHTSA has conducted a sensitivity analysis on several assumptions including (1) forecasts of future fuel prices, (2) the discount rate applied to future benefits and costs, (3) the magnitude of the rebound effect, (4) the value to the U.S. economy of reducing carbon dioxide emissions, (5) the monopsony effect, and (6) the reduction in external economic costs resulting from lower U.S. oil imports. This information is provided in NHTSA's PRIA. The agencies will consider additional sensitivities for the final rule as appropriate, including sensitivities on the markup factors applied to direct manufacturing costs to account for indirect costs (*i.e.,* the Indirect Cost Markups (ICMs) which are discussed in Sections III and IV), and the learning curve estimates used in this analysis.

TABLE II.F.1–1—ECONOMIC VALUES FOR BENEFITS COMPUTATIONS (2007$)

Fuel Economy Rebound Effect	10%
''Gap'' between test and on-road MPG	20%
Value of refueling time per ($ per vehicle-hour)	24.64
Annual growth in average vehicle use	1.1%
Fuel Prices (2012–50 average, $/gallon):	
Retail gasoline price	3.77
Pre-tax gasoline price	3.40
Economic Benefits from Reducing Oil Imports ($/gallon):	
''Monopsony'' Component	0.00
Price Shock Component	0.17
Military Security Component	0.00
Total Economic Costs ($/gallon)	0.17
Emission Damage Costs (2020, $/ton or $/metric ton):	
Carbon monoxide	0
Volatile organic compounds (VOC)	1,283
Nitrogen oxides (NO_X)—vehicle use	5,116
Nitrogen oxides (NO_X)—fuel production and distribution	5,339
Particulate matter ($PM_{2.5}$)—vehicle use	238,432
Particulate matter ($PM_{2.5}$)—fuel production and distribution	292,180
Sulfur dioxide (SO_2)	30,896
	5
	10
	20
	34
Carbon dioxide (CO_2)	56
Annual Increase in CO_2 Damage Cost	3%
External Costs from Additional Automobile Use ($/vehicle-mile):	
Congestion	0.054
Accidents	0.023
Noise	0.001
Total External Costs	0.078
External Costs from Additional Light Truck Use ($/vehicle-mile):	....

[103] The MOVES model assumes that the per-mile rates at which cars and light trucks emit these GHGs are determined by the efficiency of fuel combustion during engine operation and chemical reactions that occur during catalytic after-treatment of engine exhaust, and are thus independent of vehicles' fuel consumption rates. Thus MOVES' emission factors for these GHGs, which are expressed per mile of vehicle travel, are assumed to be unaffected by changes in fuel economy.

TABLE II.F.1–1—ECONOMIC VALUES FOR BENEFITS COMPUTATIONS (2007$)—Continued

Congestion	0.048
Accidents	0.026
Noise	0.001
Total External Costs	0.075
Discount Rates Applied to Future Benefits	3%, 7%

III. EPA Proposal for Greenhouse Gas Vehicle Standards

A. Executive Overview of EPA Proposal

1. Introduction

The Environmental Protection Agency (EPA) is proposing to establish greenhouse gas emissions standards for the largest sources of transportation greenhouse gases—light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles (hereafter light vehicles). These vehicle categories, which include cars, sport utility vehicles, minivans, and pickup trucks used for personal transportation, are responsible for almost 60% of all U.S. transportation related greenhouse gas emissions. This action represents the first-ever proposal by EPA to regulate vehicle greenhouse gas emissions under the Clean Air Act (CAA) and would establish standards for model years 2012 and later light vehicles sold in the U.S.

EPA is proposing three separate standards. The first and most important is a set of fleet-wide average carbon dioxide (CO_2) emission standards for cars and trucks. These standards are based on CO_2 emissions-footprint curves, where each vehicle has a different CO_2 emissions compliance target depending on its footprint value. Vehicle CO_2 emissions would be measured over the EPA city and highway tests. The proposed standard allows for credits based on demonstrated improvements in vehicle air conditioner systems, including both efficiency and refrigerant leakage improvement, which are not captured by the EPA tests. The EPA projects that the average light vehicle tailpipe CO_2 level in model year 2011 will be 326 grams per mile while the average vehicle tailpipe CO_2 emissions compliance level for the proposed model year 2016 standard will be 250 grams per mile, an average reduction of 23 percent from today's CO_2 levels.

EPA is also proposing standards that will cap tailpipe nitrous oxide (N_2O) and methane (CH_4) emissions at 0.010 and 0.030 grams per mile, respectively. Even after adjusting for the higher relative global warming potencies of these two compounds, nitrous oxide and methane emissions represent less than one percent of overall vehicle greenhouse gas emissions from new vehicles. Accordingly, the goal of these two proposed standards is to limit any potential increases in the future and not to force reductions relative to today's low levels.

This proposal represents the second-phase of EPA's response to the Supreme Court's 2007 decision in *Massachusetts* v. *EPA*[104] which found that greenhouse gases were air pollutants for purposes of the Clean Air Act. The Court held that the Administrator must determine whether or not emissions from new motor vehicles cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, or whether the science is too uncertain to make a reasoned decision. The Court further ruled that, in make these decisions, the EPA Administrator is required to follow the language of section 202(a) of the CAA. The Court remanded the case back to the Agency for reconsideration in light of its finding.

The Administrator responded to the Court's remand by issuing two proposed findings under section 202(a) of the Clean Air Act.[105] First, the Administrator proposed to find that the science supports a positive endangerment finding that a mix of certain greenhouse gases in the atmosphere endangers the public health and welfare of current and future generations. This is referred to as the endangerment finding. Second, the Administrator proposed to find that the emissions of four of these gases—carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons—from new motor vehicles and new motor vehicle engines contribute to the atmospheric concentrations of these key greenhouse gases and hence to the threat of climate change. This is referred to as the cause and contribute finding. Finalizing this proposed light vehicle regulations is contingent upon EPA finalizing both the endangerment finding and cause or contribute finding. Sections III.B.1 through III.B.4 below provide more details on the legal and scientific bases for this proposal.

As discussed in Section I, this GHG proposal is part of a joint National Program such that a large majority of the projected benefits are achieved jointly with NHTSA's proposed CAFE rule which is described in detail in Section IV of this preamble. EPA's proposal projects total carbon dioxide emissions savings of nearly 950 million metric tons, and oil savings of 1.8 billion barrels over the lifetimes of the vehicles sold in model years 2012–2016. EPA projects net societal benefits of $192 billion at a 3 percent discount rate for these same vehicles, or $136 billion at a 7 percent discount rate (both values assume a $20/ton SCC value). Accordingly, these proposed light vehicle greenhouse gas emissions standards would make an important ''first step'' contribution as part of the National Program toward meeting long-term greenhouse gas emissions and import oil reduction goals, while providing important economic benefits as well.

2. Why is EPA Proposing this Rule?

This proposal addresses only light vehicles. EPA is addressing light vehicles as a first step in control of greenhouse gas emissions under the Clean Air Act for four reasons. First, light vehicles are responsible for almost 60% of all mobile source greenhouse gas emissions, a share three times larger than any other mobile source subsector, and represent about one-sixth of all U.S. greenhouse gas emissions. Second, technology exists that can be readily and cost-effectively applied to these vehicles to reduce greenhouse gas emissions in the near term. Third, EPA already has an existing testing and compliance program for these vehicles, refined since the mid-1970s for emissions certification and fuel economy compliance, which would require only minor modifications to accommodate greenhouse gas emissions regulations. Finally, this proposal is an important first step in responding to the Supreme Court's ruling in *Massachusetts* vs. *EPA*. In addition, EPA is currently evaluating controls for motor vehicles other than those covered

[104] 549 U.S. 497 (2007). For further information on *Massachusetts* v. *EPA* see the July 30, 2008 Advance Notice of Proposed Rulemaking, ''Regulating Greenhouse Gas Emissions under the Clean Air Act'', 73 FR 44354 at 44397. There is a comprehensive discussion of the litigation's history, the Supreme Court's findings, and subsequent actions undertaken by the Bush Administration and the EPA from 2007–2008 in response to the Supreme Court remand.

[105] 74 FR 18886, April 24, 2009.

by this proposal, and is reviewing seven petitions submitted by various States and organizations requesting that EPA use its Clean Air Act authorities to take action to reduce greenhouse gas emissions from aircraft (under § 231(a)(2)), ocean-going vessels (under § 213(a)(4)), and other nonroad engines and vehicle sources (also under § 213(a)(4)).

a. Light Vehicle Emissions Contribute to Greenhouse Gases and the Threat of Climate Change

Greenhouse gases are gases in the atmosphere that effectively trap some of the Earth's heat that would otherwise escape to space. Greenhouse gases are both naturally occurring and anthropogenic. The primary greenhouse gases of concern are directly emitted by human activities and include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

These gases, once emitted, remain in the atmosphere for decades to centuries. Thus, they become well mixed globally in the atmosphere and their concentrations accumulate when emissions exceed the rate at which natural processes remove greenhouse gases from the atmosphere. The heating effect caused by the human-induced buildup of greenhouse gases in the atmosphere is very likely[106] the cause of most of the observed global warming over the last 50 years. The key effects of climate change observed to date and projected to occur in the future include, but are not limited to, more frequent and intense heat waves, more severe wildfires, degraded air quality, heavier and more frequent downpours and flooding, increased drought, greater sea level rise, more intense storms, harm to water resources, continued ocean acidification, harm to agriculture, and harm to wildlife and ecosystems. A detailed explanation of observed and projected changes in greenhouse gases and climate change and its impact on health, society, and the environment is included in EPA's technical support document for the recently released Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act.[107]

Transportation sources represent a large and growing share of United States greenhouse gases and include automobiles, highway heavy duty trucks, airplanes, railroads, marine vessels and a variety of other sources. In 2006, all transportation sources emitted 31.5% of all U.S. greenhouse gases, and were the fastest-growing source of greenhouse gases in the U.S., accounting for 47% of the net increase in total U.S. greenhouse gas emissions from 1990–2006.[108] The only sector with larger greenhouse gas emissions was electricity generation which emitted 33.7% of all U.S. greenhouse gases.

Light vehicles emit four greenhouse gases: carbon dioxide, methane, nitrous oxide and hydrofluorocarbons. Carbon dioxide (CO_2) is the end product of fossil fuel combustion. During combustion, the carbon stored in the fuels is oxidized and emitted as CO_2 and smaller amounts of other carbon compounds.[109] Methane (CH_4) emissions are a function of the methane content of the motor fuel, the amount of hydrocarbons passing uncombusted through the engine, and any post-combustion control of hydrocarbon emissions (such as catalytic converters).[110] Nitrous oxide (N_2O) (and nitrogen oxide (NO_X)) emissions from vehicles and their engines are closely related to air-fuel ratios, combustion temperatures, and the use of pollution control equipment. For example, some types of catalytic converters installed to reduce motor vehicle NO_X, carbon monoxide (CO) and hydrocarbon emissions can promote the formation of N_2O.[111] Hydrofluorocarbons (HFC) emissions are progressively replacing chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFC) in these vehicles' cooling and refrigeration systems as CFCs and HCFCs are being phased out under the Montreal Protocol and Title VI of the CAA. There are multiple emissions pathways for HFCs with emissions occurring during charging of cooling and refrigeration systems, during operations, and during decommissioning and disposal.[112]

b. Basis for Action Under Clean Air Act

Section 202(a)(1) of the Clean Air Act (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.'' As noted above, the Administrator has proposed to find that the air pollution of elevated levels of greenhouse gas concentrations may reasonably be anticipated to endanger public health and welfare.[113] The Administrator has proposed to define the air pollution to be the elevated concentrations of the mix of six GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The Administrator has further proposed to find under CAA section 202(a) that CO_2, methane, N_2O and HFC emissions from new motor vehicles and engines contribute to this air pollution. This preamble describes proposed standards that would control emissions of CO_2, HFCs, nitrous oxide, and methane. Standards for these GHGs would only be finalized if EPA determines that the criteria have been met for endangerment by the air pollution, and that emissions of GHGs from new motor vehicles or engines ''cause or contribute'' to that air pollution. In that case, section 202(a) would authorize EPA to issue standards applicable to emissions of those pollutants. For further discussion of EPA's authority under section 202(a), see Section I.C.2 of the proposal.

There are a variety of other CAA Title II provisions that are relevant to standards established under section 202(a). As noted above, the standards are applicable to motor vehicles for their useful life. EPA has the discretion in determining what standard applies over the useful life. For example, EPA may set a single standard that applies both when the vehicles are new and throughout the useful life, or where appropriate may set a standard that varies during the term of useful life, such as a standard that is more stringent in the early years of the useful life and less stringent in the later years.

---

[106] According to Intergovernmental Panel on Climate Change (IPCC) terminology, ''very likely'' conveys a 90 to 99 percent probability of occurrence. ''Virtually certain'' conveys a greater than 99 percent probability, ''likely'' conveys a 66 to 90 percent probability, and ''about as likely as not'' conveys a 33 to 66 percent probability.

[107] 74 FR18886, April 24, 2009. Both the **Federal Register** Notice and the Technical Support Document for this rulemaking are found in the public docket for this rulemaking. Docket is EPA–OAR–2009–0171.

[108] Inventory of U.S. Greenhouse Gases and Sinks: 1990–2006.

[109] Mobile source carbon dioxide emissions in 2006 equaled 26 percent of total U.S. CO_2 emissions.

[110] In 2006, methane emissions equaled 0.32 percent of total U.S. methane emissions Nitrous oxide is a product of the reaction that occurs between nitrogen and oxygen during fuel combustion.

[111] In 2006, nitrous oxide emissions for these sources accounted for 8 percent of total U.S. nitrous oxide emissions.

[112] In 2006 HFC from these source categories equaled 56 percent of total U.S. HFC emissions, making it the single largest source category of U.S. HFC emissions.

[113] 74 FR18886, April 24, 2009.

The standards established under CAA section 202(a) are implemented and enforced through various mechanisms. Manufacturers are required to obtain an EPA certificate of conformity with the section 202 regulations before they may sell or introduce their new motor vehicle into commerce, according to CAA section 206(a). The introduction into commerce of vehicles without a certificate of conformity is a prohibited act under CAA section 203 that may subject a manufacturer to civil penalties and injunctive actions (*see* CAA sections 204 and 205). Under CAA section 206(b), EPA may conduct testing of new production vehicles to determine compliance with the standards. For in-use vehicles, if EPA determines that a substantial number of vehicles do not conform to the applicable regulations then the manufacturer must submit and implement a remedial plan to address the problem (*see* CAA section 207(c)). There are also emissions-based warranties that the manufacturer must implement under CAA section 207(a).

c. EPA's Greenhouse Gas Proposal Under Section 202(a) Concerning Endangerment and Cause or Contribute Findings

EPA's Administrator recently signed a proposed action with two distinct findings regarding greenhouse gases under section 202(a) of the Clean Air Act. This action is called the Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Clean Air Act (Endangerment Proposal).[114] The Administrator proposed an affirmative endangerment finding that the current and projected concentrations of a mix of six key greenhouse gases—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride(SF_6)—in the atmosphere threaten the public health and welfare of current and future generations. She also proposed to find that the combined emissions of four of the gases—carbon dioxide, methane, nitrous oxide and hydrofluorocarbons from new motor vehicles and motor vehicle engines—contribute to the atmospheric concentrations of these greenhouse gases and therefore to the climate change problem.

Specifically, the Administrator proposed, after a thorough examination of the scientific evidence on the causes and impact of current and future climate change, to find that the science compellingly supports a positive finding that atmospheric concentrations of these greenhouse gases result in air pollution which may reasonably be anticipated to endanger both public health and welfare. In her proposed finding, the Administrator relied heavily upon the major findings and conclusions from the recent assessments of the U.S. Climate Change Science Program and the U.N. Intergovernmental Panel on Climate Change.[115] The Administrator proposed a positive endangerment finding after considering both observed and projected future effects of climate change, key uncertainties, and the full range of risks and impacts to public health and welfare occurring within the United States. In addition, the proposed finding noted that the evidence concerning risks and impacts occurring outside the U.S. provided further support for the proposed finding.

The key scientific findings supporting the proposed endangerment finding are that:

—Concentrations of greenhouse gases are at unprecedented levels compared to recent and distant past. These high concentrations are the unambiguous result of anthropogenic emissions and are very likely the cause of the observed increase in average temperatures and other climatic changes.

—The effects of climate change observed to date and projected to occur in the future include more frequent and intense heat waves, more severe wildfires, degraded air quality, heavier downpours and flooding, increasing drought, greater sea level rise, more intense storms, harm to water resources, harm to agriculture, and harm to wildlife and ecosystems. These impacts are effects on public health and welfare within the meaning of the Clean Air Act.

With regard to new motor vehicles and engines, the Administrator also proposed a finding that the combined emissions of four greenhouse gases—carbon dioxide, methane, nitrous oxide and hydrofluorocarbons—from new motor vehicles and engines contributes to this air pollution, *i.e.,* the atmospheric concentrations of the mix of six greenhouse gases which create the threat of climate change and its impacts. Key facts supporting the proposed cause and contribute finding for on-highway vehicles regulated under section 202(a) of the Clean Air Act are that these sources are responsible for 24% of total U.S. greenhouse gas emissions, and more than 4% of total global greenhouse gas emissions.[116] The Administrator also considered whether emissions of each greenhouse gas individually, as a separate air pollutant, would contribute to this air pollution.

If the Administrator makes affirmative findings under section 202(a) on both endangerment and cause or contribute, then EPA is to issue standards ''applicable to emission'' of the air pollutant or pollutants that EPA finds causes or contributes to the air pollution that endangers public health and welfare. The Endangerment Proposal invited public comment on whether the air pollutant should be considered the group of GHGs, or whether each GHG should be treated as a separate air pollutant. Either way, the emissions standards proposed today would satisfy the requirements of section 202(a) as the Administrator has significant discretion in how to structure the standards that apply to the emission of the air pollutant or air pollutants at issue. For example, under either approach EPA would have the discretion under section 202(a) to adopt separate standards for each GHG, a single composite standard covering various gases, or any combination of these. In this rulemaking EPA is proposing separate standards for nitrous oxide and methane, and a CO_2 standard that provides for credits based on reductions of HFCs, as the appropriate way to issue standards applicable to emissions of these GHGs.

3. What is EPA Proposing?

a. Proposed Light-Duty Vehicle, Light-Duty Truck, and Medium-Duty Passenger Vehicle Greenhouse Gas Emission Standards and Projected Compliance Levels

The CO_2 emissions standards are by far the most important of the three standards and are the primary focus of this summary. EPA is proposing an attribute-based approach for the CO_2 fleet-wide standard (one for cars and one for trucks), based on vehicle footprint as the attribute. These curves establish different CO_2 emissions targets for each unique car and truck footprint. Generally, the larger the vehicle footprint, the higher the corresponding vehicle CO_2 emissions target. Table III.A.3–1 shows the greenhouse gas standards for light vehicles that EPA is proposing for model years (MY) 2012 and later:

[114] 74 FR 18886 (April 24, 2009).

[115] The U.S. Climate Change Science Program (CCSP) is now called the U.S. Global Change Research Program (GCRP).

[116] This figure includes the greenhouse gas contributions of light vehicles, heavy duty vehicles, and remaining on-highway mobile sources.

TABLE III.A.3–1—PROPOSED INDUSTRY-WIDE GREENHOUSE GAS EMISSIONS STANDARDS

Standard/covered pollutants	Form of standard	Level of standard	Credits	Test cycles
CO_2 Standard [117]: Tailpipe CO_2	Fleetwide average footprint CO_2-curves for cars and trucks.	See footprint—CO_2 curves in Figure I.C–1 for cars and Figure I.C–2 for trucks.	CO_2-e credits [118]	EPA 2-cycle (FTP and HFET test cycles), with separate mechanisms for A/C credits.[119]
N_2O Standard: Tailpipe N_2O	Cap per vehicle	0.010 g/mi	None	EPA FTP test.
CH_4 Standard: Tailpipe CH_4	Cap per vehicle	0.030 g/mi	None	EPA FTP test.

One important flexibility associated with the proposed CO_2 standard is the proposed option for manufacturers to obtain credits associated with improvements in their air conditioning systems. As will be discussed in greater detail in later sections, EPA is establishing test procedures and design criteria by which manufacturers can demonstrate improvements in both air conditioner efficiency (which reduces vehicle tailpipe CO_2 by reducing the load on the engine) and air conditioner refrigerants (using lower global warming potency refrigerants and/or improving system design to reduce GHG emissions associated with leaks). Neither of these strategies to reduce GHG emissions from air conditioners would be reflected in the EPA FTP or HFET tests. These improvements would be translated to a g/mi CO_2-equivalent credit that can be subtracted from the manufacturer's tailpipe CO_2 compliance value. EPA expects a high percentage of manufacturers to take advantage of this flexibility to earn air conditioning-related credits for MY2012–2016 vehicles such that the average credit earned is about 11 grams per mile CO_2–equivalent in 2016.

A second flexibility being proposed is CO_2 credits for flexible and dual fuel vehicles, similar to the CAFE credits for such vehicles which allow manufacturers to gain up to 1.2 mpg in their overall CAFE ratings. The Energy Independence and Security Act of 2007 (EISA) mandated a phase-out of these flexible fuel vehicle CAFE credits beginning in 2015, and ending after 2019. EPA is proposing to allow comparable CO_2 credits for flexible fuel vehicles through MY 2015, but for MY 2016 and beyond, EPA is proposing to treat flexible and dual fuel vehicles on a CO_2-performance basis, calculating the overall CO_2 emissions for flexible and dual fuel vehicles based on a fuel use-weighted average of the CO_2 levels on gasoline and on a manufacturer's demonstrated actual usage of the alternative fuel in its vehicle fleet.

Table III.A.3–2 summarizes EPA projections of industry-wide 2-cycle CO_2 emissions and fuel economy levels that would be achieved by manufacturer compliance with the proposed GHG standards for MY2012–2016.

For MY2011, Table III.A.3–2 uses the projected NHTSA compliance values for its MY2011 CAFE standards of 30.2 mpg for cars and 24.1 mpg for trucks, converted to an equivalent combined car and truck CO_2 level of 325 grams per mile.[120] EPA believes this is a reasonable estimate with which to compare the proposed MY2012–2016 CO_2 emission standards. Identifying the proper MY2011 estimate is complicated for many reasons, among them being the turmoil in the current automotive market for consumers and manufacturers, uncertain and volatile oil and gasoline prices, the ability of manufacturers to use flexible fuel vehicle credits to meet MY2011 CAFE standards, and the fact that most manufacturers have been surpassing CAFE standards (particularly the car standard) in recent years. Taking all of these considerations into account, EPA believes that the MY2011 projected CAFE compliance values, converted to CO_2 emissions levels, represent a reasonable estimate.

Table III.A.3–2 shows projected industry-wide average CO_2 emissions values. The Projected CO_2 Emissions for the Footprint-Based Standard column shows the CO_2 g/mi level corresponding with the footprint standard that must be met. It is based on the proposed CO_2-footprint curves and projected footprint values, and will decrease each year to 250 grams per mile (g/mi) in MY2016. For MY2012–2015, the emissions impact of the projected utilization of flexible fuel vehicle (FFV) credits and the temporary lead-time allowance alternative standard (TLAAS, discussed below) are shown in the next two columns. Neither of these programs is proposed to be available in MY2016. The Projected CO_2 Emissions column gives the CO_2 emissions levels projected to be achieved given use of the flexible fuel credits and temporary lead-time allowance program. This column shows that, relative to the MY 2011 estimate, EPA projects that MY2016 CO_2 emissions will be reduced by 23 percent over five years. The Projected A/C Credit column represents the industry wide average air conditioner credit manufacturers are expected to earn on an equivalent CO_2 gram per mile basis in a given model year. In MY2016, the projected A/C credit of 10.6 g/mi represents 14 percent of the 75 g/mi CO_2 emissions reductions associated with the proposed standards. The Projected 2-cycle CO_2 Emissions column shows the projected CO_2 emissions as measured over the EPA 2-cycle tests, which would allow compliance with the standard assuming utilization of the projected FFV, TLAAS, and A/C credits.

[117] While over 99 percent of the carbon in automotive fuels is converted to CO_2 in a properly functioning engine, compliance with the CO_2 standard will also account for the very small levels of carbon associated with vehicle tailpipe hydrocarbon (HC) and carbon monoxide (CO) emissions, converted to CO_2 on a mass basis, as discussed further in section x.

[118] CO_2-e refers to CO_2-equivalent, and is a metric that allows non-CO_2 greenhouse gases (such as hydrofluorocarbons used as automotive air conditioning refrigerants) to be expressed as an equivalent mass (i.e., corrected for relative global warming potency) of CO_2 emissions.

[119] FTP is the Federal Test Procedure which uses what is commonly referred to as the ''city'' driving schedule, and HFET is the Highway Fuel Economy Test which uses the ''highway'' driving schedule. Compliance with the CO_2 standard will be based on the same 2-cycle values that are currently used for CAFE standards compliance; EPA projects that fleet-wide in-use or real world CO_2 emissions are approximately 25 percent higher, on average, than 2-cycle CO_2 values.

[120] 74 FR 14196.

TABLE III.A.3–2—PROJECTED FLEETWIDE CO_2 EMISSIONS VALUES (GRAMS PER MILE)

Model year	Projected CO_2 emissions for the footprint-based standard	Projected FFV credit	Projected TLAAS credit	Projected CO_2 emissions	Projected A/C credit	Projected 2-cycle CO_2 emissions
2011				(325)		(325)
2012	295	6	0.3	302	3.1	305
2013	286	5.7	0.2	291	5.0	296
2014	276	5.4	0.2	281	7.5	289
2015	263	4.1	0.1	267	10.0	277
2016	250	0	0	250	10.6	261

EPA is also proposing a series of flexibilities for compliance with the CO_2 standard which are not expected to significantly affect the projected compliance and achieved values shown above, but which should significantly reduce the costs of achieving those reductions. These flexibilities include the ability to earn: annual credits for a manufacturer's over-compliance with its unique fleet-wide average standard, early credits from MY2009–2011, credits for early introduction of advanced technology vehicles, credit for ''off-cycle'' CO_2 reductions not reflected in CO_2/fuel economy tests, as well as the carry-forward and carry-backward of credits, the ability to transfer credits between a manufacturer's car and truck fleets, and a temporary lead-time allowance alternative standard (included in the tables above) that will permit manufacturers with less than 400,000 vehicles produced in MY 2009 to designate a fraction of their vehicles to meet a 25% higher CO_2 standard for MY 2012–2015. All of these proposed flexibilities are discussed in greater detail in later sections.

EPA is also proposing caps on the tailpipe emissions of nitrous oxide (N_2O) and methane (CH_4)—0.010 g/mi for N_2O and 0.030 g/mi for CH_4—over the EPA FTP test. While N_2O and CH_4 can be potent greenhouse gases on a relative mass basis, their emission levels from modern vehicle designs are extremely low and represent only about 1% of total light vehicle GHG emissions. These cap standards are designed to ensure that N_2O and CH_4 emissions levels do not rise in the future, rather than to force reductions in the already low emissions levels. Accordingly, these standards are not designed to require automakers to make any changes in current vehicle designs, and thus EPA is not projecting any environmental or economic impacts associated with these proposed standards.

EPA has attempted to build on existing practice wherever possible in designing a compliance program for the proposed GHG standards. In particular, the program structure proposed will streamline the compliance process for both manufacturers and EPA by enabling manufacturers to use a single data set to satisfy both the new GHG and CAFE testing and reporting requirements. Timing of certification, model-level testing, and other compliance activities also follow current practices established under the Tier 2 and CAFE programs.

b. Environmental and Economic Benefits and Costs of EPA's Proposed Standards

In Table III.A.3–3 EPA presents estimated annual net 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 a 3% and a 7% discount rate. As discussed previously, EPA recognizes that much of these same costs and benefits are also attributed to the proposed CAFE standard contained in this joint proposal.

TABLE III.A.3–3—PROJECTED QUANTIFIABLE BENEFITS AND COSTS FOR PROPOSED CO_2 STANDARD

[(In million 2007 $s) [Note: B = unquantified benefits]

	2020	2030	2040	2050	NPV, 3%	NPV, 7%
Quantified Annual Costs [a]	−$25,100	−$72,500	−$105,700	−$146,100	−$1,287,600	−$529,500
Benefits from Reduced GHG Emissions at each assumed SCC value:						
SCC 5%	1,200	3,300	5,700	9,500	69,200	28,600
SCC 5% Newell-Pizer	2,500	6,600	11,000	19,000	138,400	57,100
SCC from 3% and 5%	4,700	12,000	22,000	36,000	263,000	108,500
SCC 3%	8,200	22,000	38,000	63,000	456,900	188,500
SCC 3% Newell-Pizer	14,000	36,000	63,000	100,000	761,400	314,200
Other Quantified Externalities						
$PM_{2.5}$ Related Benefits [b c d]	1,400	3,000	4,600	6,700	59,800	26,300
Energy Security Impacts (price shock)	2,300	4,800	6,200	7,800	85,800	38,800
Reduced Refueling	2,500	4,900	6,400	8,000	89,600	41,000
Value of Increased Driving [e]	4,900	10,000	13,600	18,000	184,700	82,700
Accidents, Noise, Congestion	−2,400	−4,900	−6,300	−7,900	−88,200	−40,200
Quantified Net Benefits at each assumed SCC value:						
SCC 5%	35,000	93,600	135,900	188,200	1,688,500	706,700
SCC 5% Newell-Pizer	36,300	96,900	141,200	197,700	1,757,700	735,200
SCC from 3% and 5%	38,500	102,300	152,200	214,700	1,882,300	786,600

TABLE III.A.3–3—PROJECTED QUANTIFIABLE BENEFITS AND COSTS FOR PROPOSED CO_2 STANDARD—Continued

[(In million 2007 $s) [Note: B = unquantified benefits]

	2020	2030	2040	2050	NPV, 3%	NPV, 7%
SCC 3%	42,000	112,300	168,200	241,700	2,076,200	866,600
SCC 3% Newell-Pizer	47,800	126,300	193,200	278,700	2,380,700	992,300

[a] Quantified annual costs are negative because fuel savings are included as negative costs (*i.e.*, positive savings). Since the fuel savings outweigh the vehicle technology costs, the costs of as presented here are actually negative (*i.e.*, they represent savings).

[b] Note that the co-pollutant impacts associated with the standards presented here do not include the full complement of endpoints that, if quantified and monetized, would change the total monetized estimate of rule-related impacts. Instead, the co-pollutant benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in $PM_{2.5}$ exposure. Ideally, human health and environmental benefits would be based on changes in ambient $PM_{2.5}$ and ozone as determined by full-scale air quality modeling. However, EPA was unable to conduct a full-scale air quality modeling analysis in time for the proposal. EPA does intend to more fully capture the co-pollutant benefits for the analysis of the final standards.

[c] The $PM_{2.5}$-related benefits (derived from benefit-per-ton values) presented in this table are based on an estimate of premature mortality derived from the ACS study (Pope *et al.*, 2002). If the benefit-per-ton estimates were based on the Six Cities study (Laden *et al.*, 2006), the values would be approximately 145% (nearly two-and-a-half times) larger.

[d] The $PM_{2.5}$-related benefits (derived from benefit-per-ton values) presented in this table assume a 3% discount rate in the valuation of premature mortality to account for a twenty-year segmented cessation lag. If a 7% discount rate had been used, the values would be approximately 9% lower.

[e] Calculated using pre-tax fuel prices.

4. Basis for the Proposed GHG Standards Under Section 202(a)

EPA statutory authority under section 202(a)(1) of the Clean Air Act (CAA) is discussed in more detail in Section I.C.2. The following is a summary of the basis for the proposed standards under section 202(a), which is discussed in more detail in the following portions of Section III.

With respect to CO_2 and HFCs, EPA is proposing attribute-based light-duty car and truck standards that achieve large and important emissions reductions of GHGs. EPA has evaluated the technological feasibility of the proposed standards, and the information and analysis performed by EPA indicates that these standards are feasible in the lead time provided. EPA and NHTSA have carefully evaluated the effectiveness of individual technologies as well as the interactions when technologies are combined. EPA's projection of the technology that would be used to comply with the proposed standards indicates that manufacturers will be able to meet the proposed standards by employing a wide variety of technology that is already commercially available and can be incorporated into their vehicle at the time of redesign. In addition to the use of the manufacturers' redesign cycle, EPA's analysis also takes into account certain flexibilities that will facilitate compliance especially in the early years of the program when potential lead time constraints are most challenging. These flexibilities include averaging, banking, and trading of various types of credits. For the industry as a whole, EPA's projections indicate that the proposed standards can be met using technology that will be available in the lead-time provided.

To account for additional lead-time concerns for various manufacturers of typically higher performance vehicles, EPA is proposing a Temporary Lead-time Allowance that will further facilitate compliance for limited volumes of such vehicles in the program's initial years. For a few very small volume manufacturers, EPA projects that manufacturers will likely comply using a combination of credits and technology.

EPA has also carefully considered the cost to manufacturers of meeting the standards, estimating piece costs for all candidate technologies, direct manufacturing costs, cost markups to account for manufacturers' indirect costs, and manufacturer cost reductions attributable to learning. In estimating manufacturer costs, EPA took into account manufacturers' own standard practices such as making major changes to model technology packages during a planned redesign cycle. EPA then projected the average cost across the industry to employ this technology, as well as manufacturer-by-manufacturer costs. EPA considers the per vehicle costs estimated from this analysis to be well within a reasonable range in light of the emissions reductions and benefits received. EPA projects, for example, that the fuel savings over the life of the vehicles will more than offset the increase in cost associated with the technology used to meet the standards.

EPA has also evaluated the impacts of these standards with respect to reductions in GHGs and reductions in oil usage. For the lifetime of the model year 2012–2016 vehicles we estimate GHG reductions of approximately 950 million metric tons CO_2 eq. and fuel reductions of 1.8 billion barrels of oil. These are important and significant reductions that would be achieved by the proposed standards. EPA has also analyzed a variety of other impacts of the standards, ranging from the standards' effects on emissions of non-GHG pollutants, impacts on noise, energy, safety and congestion. EPA has also quantified the cost and benefits of the proposed standards, to the extent practicable. Our analysis to date indicates that the overall quantified benefits of the proposed standards far outweigh the projected costs. Utilizing a 3% discount rate and a $20 per ton social cost of carbon we estimate the total net social benefits over the life of the model year 2012–2016 vehicles is $192 billion, and the net present value of the net social benefits of the standards through the year 2050 is $1.9 trillion dollars. These values are estimated at $136 billion and $787 billion, respectively, using a 7% discount rate and the $20 per ton SCC value.

Under section 202(a) EPA is called upon to set standards that provide adequate lead-time for the development and application of technology to meet the standards. EPA's proposed standards satisfy this requirement, as discussed above. In setting the standards, EPA is called upon to weigh and balance various factors, and to exercise judgment in setting standards that are a reasonable balance of the relevant factors. In this case, EPA has considered many factors, such as cost, impacts on emissions (both GHG and non-GHG), impacts on oil conservation, impacts on noise, energy, safety, and other factors, and has where practicable quantified the costs and benefits of the rule. In summary, given the technical feasibility of the standard, the moderate cost per vehicle in light of the savings in fuel costs over the life time of the vehicle, the very significant reductions in emissions and in oil usage, and the significantly greater quantified benefits compared to quantified costs, EPA is confident that the proposed standards are an appropriate and reasonable balance of the factors to consider under section 202(a). See *Husqvarna AB* v. *EPA*, 254 F.3d 195, 200 (D.C. 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 (D.C. Cir. 1978) (''In reviewing a numerical standard we 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 (D.C. Cir. 2002) (same).

EPA recognizes that the vast majority of technology which we are considering for purposes of setting standards under section 202(a) is commercially available and already being utilized to a limited extent across the fleet. The vast majority of the emission reductions which would result from this proposed rule would result from the increased use of these technologies. EPA also recognizes that this proposed rule would enhance the development and limited use of more advanced technologies, such as PHEVs and EVs. In this technological context, there is no clear cut line that indicates that only one projection of technology penetration could potentially be considered feasible for purposes of section 202(a), or only one standard that could potentially be considered a reasonable balancing of the factors relevant under section 202(a). EPA has therefore evaluated two sets of alternative standards, one more stringent than the proposed standards and one less stringent.

The alternatives are 4% per year increase in standards which would be less stringent than our proposal and a 6% per year increase in the standards which would be more stringent than our proposal. EPA is not proposing either of these. As discussed in Section III.D.7, the 4% per year compared to the proposal forgoes CO_2 reductions which can be achieved at reasonable costs and are achievable by the industry within the rule's timeframe. The 6% per year alternative requires a significant increase in the projected required technology which may not be achievable in this timeframe due to the limited available lead time and the current difficult financial condition of the automotive industry. (*See* Section III.D.7 for a detailed discussion of why EPA is not proposing either of the alternatives.) EPA thus believes that it is appropriate to propose the CO_2 standards discussed above. EPA invites comment on all aspects of this judgment, as well as comment on the alternative standards.

EPA is also proposing standards for N_2O and CH_4. EPA has designed these standards to act as emission rate (*i.e.*, gram per mile) caps and to avoid future increases in light duty vehicle emissions. As discussed in Section III.B.6, N_2O and CH_4 emissions are already generally well controlled by current emissions standards, and EPA has not identified clear technological steps available to manufacturers today that would significantly reduce current emission levels for the vast majority of vehicles manufactured today (*i.e.*, stoichiometric gasoline vehicles). However, for both N_2O and CH_4, some vehicle technologies (and, for CH_4, use of natural gas fuel) could potentially increase emissions of these GHGs in the future, and EPA believes it is important that this be avoided. EPA expects that, almost universally across current car and truck designs, manufacturers will be able to meet the ''cap'' standards with little if any technological improvements or cost. EPA has designed the level of the N_2O and CH_4 standards with the intent that manufacturers would be able to meet them without the need for technological improvement; in other words, these emission standards are designed to be ''anti-backsliding'' standards.

B. Proposed GHG Standards for Light-Duty Vehicles, Light-Duty Trucks, and Medium-Duty Passenger Vehicles

EPA is proposing new emission standards to control greenhouse gases (GHGs) from light-duty vehicles. First, EPA is proposing emission standards for carbon dioxide (CO_2) on a gram per mile (g/mile) basis that would apply to a manufacturer's fleet of cars, and a separate standard that would apply to a manufacturer's fleet of trucks. CO_2 is the primary pollutant resulting from the combustion of vehicular fuels, and the amount of CO_2 emitted is directly correlated to the amount of fuel consumed. Second, EPA is providing auto manufacturers with the opportunity to earn credits toward the fleet-wide average CO_2 standards for improvements to air conditioning systems, including both hydrofluorocarbon (HFC) refrigerant losses (*i.e.*, system leakage) and indirect CO_2 emissions related to the increased load on the engine. Third, EPA is proposing separate emissions standards for two other GHG pollutants: Methane (CH_4) and nitrous oxide (N_2O). 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 a cap that would limit emissions increases and prevent backsliding from current emission levels. The proposed standards described below would apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles (MDPVs). As an overall group, they are referred to in this preamble as light vehicles or simply as vehicles. In this preamble section passenger cars may be referred to simply as ''cars'', and light-duty trucks and MDPVs as ''light trucks'' or ''trucks.''[121]

EPA is establishing a system of averaging, banking, and trading of credits integral to the fleet averaging approach, based on manufacturer fleet average CO_2 performance, as discussed in Section III.B.4. This approach is similar to averaging, banking, and trading (ABT) programs EPA has established in other programs and is also similar to provisions in the CAFE program. In addition to traditional ABT credits based on the fleet emissions average, EPA is also proposing to include A/C credits as an aspect of the standards, as mentioned above. EPA is also proposing several additional credit provisions that apply only in the initial model years of the program. These include flex fuel vehicle credits, credits based on the use of advanced technologies, and generation of credits prior to model year 2012. The proposed A/C credits and additional credit opportunities are described in Section III.C. These credit programs would provide flexibility to manufacturers, which may be especially important during the early transition years of the program. EPA is also proposing to allow a manufacturer to carry a deficit into the future for a limited number of model years. A parallel provision, referred to as credit carry-back, is proposed as part of the CAFE program.

1. What Fleet-Wide Emissions Levels Correspond to the CO_2 Standards?

The proposed attribute-based CO_2 standards, if made final, are projected to achieve a national fleet-wide average, covering both light cars and trucks, of

[121] As described in Section III.B.2., EPA is proposing for purposes of GHG emissions standards to use the same vehicle category definitions as are used in the CAFE program.

250 grams/mile of CO_2 in model year (MY) 2016. This includes CO_2-equivalent emission reductions from A/C improvements, reflected as credits in the standard. The standards would begin with MY 2012, with a generally linear increase in stringency from MY 2012 through MY 2016. EPA is proposing separate standards for cars and light trucks. The tables in this section below provide overall fleet average levels that are projected for both cars and light trucks over the phase-in period which is estimated to correspond with the proposed standards. The actual fleet-wide average g/mi level that will be achieved in any year for cars and trucks will depend on the actual production for that year, as well as the use of the various credit and averaging, banking, and trading provisions. For example, in any year, manufacturers may generate credits from cars and use them for compliance with the truck standard. Such transfer of credits between cars and trucks is not reflected in the table below. In Section III.F, the year-by-year estimate of emissions reductions that are projected to be achieved by the proposed standards are discussed.

In general, the proposed schedule of standards acts as a phase-in to the MY 2016 standards, and reflects consideration of the appropriate lead-time for each manufacturer to implement the requisite emission reductions technology across its product line.[122] Note that 2016 is the final model year in which standards become more stringent. The 2016 CO_2 standards would remain in place for 2017 and later model years, until revised by EPA in a future rulemaking.

EPA estimates that, on a combined fleet-wide national basis, the proposed 2016 MY standards would achieve a level of 250 g/mile CO_2, including CO_2-equivalent credits from A/C related reductions. The derivation of the 250 g/mile estimate is described in Section III.B.2.

EPA has estimated the overall fleet-wide CO_2-equivalent emission levels that correspond with the proposed attribute-based standards, based on the projections of the composition of each manufacturer's fleet in each year of the program. Tables III.B.1–1 and III.B.1–2 provide these estimates for each manufacturer.[123]

TABLE III.B.1–1—ESTIMATED FLEET CO_2-EQUIVALENT LEVELS CORRESPONDING TO THE PROPOSED STANDARDS FOR CARS

Manufacturer	Model year				
	2012	2013	2014	2015	2016
BMW	265	257	249	238	227
Chrysler	266	259	251	242	231
Daimler	270	263	257	245	234
Ford	266	259	251	239	228
General Motors	266	258	250	239	228
Honda	259	251	244	232	221
Hyundai	260	252	244	233	221
Kia	262	253	246	235	223
Mazda	258	250	243	231	220
Mitsubishi	255	247	240	228	217
Nissan	263	255	247	236	225
Porsche	242	234	227	215	204
Subaru	252	244	237	225	214
Suzuki	244	236	229	217	206
Tata	286	278	271	259	248
Toyota	257	250	242	231	220
Volkswagen	254	246	239	228	217

TABLE III.B.1–2—ESTIMATED FLEET CO_2-EQUIVALENT LEVELS CORRESPONDING TO THE PROPOSED STANDARDS FOR LIGHT TRUCKS

Manufacturer	Model year				
	2012	2013	2014	2015	2016
BMW	334	324	313	298	283
Chrysler	349	339	329	315	300
Daimler	346	334	323	308	293
Ford	363	352	343	329	314
General Motors	372	361	351	337	322
Honda	333	322	311	295	280
Hyundai	330	320	308	293	278
Kia	341	330	319	303	288
Mazda	321	311	300	286	271
Mitsubishi	320	310	299	284	269
Nissan	352	341	332	318	303
Porsche	338	327	316	301	286
Subaru	319	308	297	282	267
Suzuki	324	313	301	286	271
Tata	326	316	305	289	275
Toyota	342	332	320	305	291

[122] *See* CAA section 202(a)(2).

[123] These levels do not include the effect of flexible fuel credits, transfer of credits between cars and trucks, temporary lead time allowance, or any other credits.

TABLE III.B.1–2—ESTIMATED FLEET CO_2-EQUIVALENT LEVELS CORRESPONDING TO THE PROPOSED STANDARDS FOR LIGHT TRUCKS—Continued

Manufacturer	Model year				
	2012	2013	2014	2015	2016
Volkswagen	344	333	322	307	292

These estimates were aggregated based on projected production volumes into the fleet-wide averages for cars and trucks (Table III.B.1–3).[124]

TABLE III.B.1–3—ESTIMATED FLEET-WIDE CO_2-EQUIVALENT LEVELS CORRESPONDING TO THE PROPOSED STANDARDS

	Cars	Trucks
Model year	CO_2 (g/mi)	CO_2 (g/mi)
2012	261	352
2013	254	341
2014	245	331
2015	234	317
2016 and later	224	303

As shown in Table III.B.1–3, fleet-wide CO_2-equivalent emission levels for cars under the proposed approach are projected to decrease from 261 to 224 grams per mile between MY 2012 and MY 2016. Similarly, fleet-wide CO_2-equivalent emission levels for trucks are projected to decrease from 352 to 303 grams per mile. These numbers do not include the effects of other flexibilities and credits in the program. The estimated achieved values can be found in Chapter 5 of the Draft Regulatory Impact Analysis (DRIA).

EPA has also estimated the average fleet-wide levels for the combined car and truck fleets. These levels are provided in Table III.B.1–4. As shown, the overall fleet average CO_2 level is expected to be 250 g/mile in 2016.

TABLE III.B.1–4—ESTIMATED FLEET-WIDE COMBINED CO_2-EQUIVALENT LEVELS CORRESPONDING TO THE PROPOSED STANDARDS

Model year	Combined car and truck CO_2 (g/mi)
2012	295
2013	286
2014	276
2015	263
2016	250

[124] Due to rounding during calculations, the estimated fleet-wide CO_2-equivalent levels may vary by plus or minus 1 gram.

As noted above, EPA is proposing standards that would result in increasingly stringent levels of CO_2 control from MY 2012 though MY 2016—applying the CO_2 footprint curves applicable in each model year to the vehicles expected to be sold in each model year produces fleet-wide annual reductions in CO_2 emissions. As explained in Section III.D below and the relevant support documents, EPA believes that the proposed level of improvement achieves important CO_2 emissions reductions through the application of feasible control technology at reasonable cost, considering the needed lead time for this program. EPA further believes that the proposed averaging, banking and trading provisions, as well as other credit-generating mechanisms, allow manufacturers further flexibilities which reduce the cost of the proposed CO_2 standards and help to provide adequate lead time. EPA believes this approach is justified under section 202(a) of the Clean Air Act.

EPA has analyzed the feasibility under the CAA of achieving the proposed CO_2 standards, based on projections of what actions manufacturers are expected to take to reduce emissions. The results of the analysis are discussed in detail in Section III.D below and in the DRIA. EPA also presents the estimated costs and benefits of the proposed car and truck CO_2 standards in Section III.H. In developing the proposal, EPA has evaluated the kinds of technologies that could be utilized by the automobile industry, as well as the associated costs for the industry and fuel savings for the consumer, the magnitude of the GHG reductions that may be achieved, and other factors relevant under the CAA.

With respect to the lead time and cost of incorporating technology improvements that reduce GHG emissions, EPA and NHTSA place important weight on the fact that during MYs 2012–2016 manufacturers are expected to redesign and upgrade their light-duty vehicle products (and in some cases introduce entirely new vehicles not on the market today). Over these five model years there would be an opportunity for manufacturers to evaluate almost every one of their vehicle model platforms and add technology in a cost-effective way to control GHG emissions and improve fuel economy. This includes redesign of the air conditioner systems in ways that will further reduce GHG emissions. The time-frame and levels for the proposed 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 GHG reductions, and to do this as part of the normal vehicle redesign process. This is an important aspect of the proposal, as it would 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 would also provide manufacturers the opportunity to plan for compliance using a multi-year time frame, again in accord with their normal business practice.

Consistent with the requirement of CAA section 202(a)(1) that standards be applicable to vehicles ''for their useful life,'' EPA is proposing CO_2 vehicle standards that would apply for the useful life of the vehicle. Under section 202(i) of the Act, which authorized the Tier 2 standards, EPA established a useful life period of 10 years or 120,000 miles, whichever first occurs, for all Tier 2 light-duty vehicles and light-duty trucks.[125] Tier 2 refers to EPA's standards for criteria pollutants such as NO_X, HC, and CO. EPA is proposing new CO_2 standards for the same group of vehicles, and therefore the Tier 2 useful life would apply for CO_2 standards as well. The in-use emission standard will be 10% higher than the certification standard, to address issues of production variability and test-to-test variability. The in-use standard is discussed in Section III.E.

EPA is proposing to measure CO_2 for certification and compliance purposes using the same test procedures currently used by EPA for measuring fuel economy. These procedures are the Federal Test Procedure (FTP or ''city'' test) and the Highway Fuel Economy

[125] *See* 65 FR 6698 (February 10, 2000).

Test (HFET or ''highway'' test).[126] This corresponds with the data used to develop the footprint-based CO_2 standards, since the data on control technology efficiency was also developed in reference to these test procedures. Although EPA recently updated the test procedures used for fuel economy labeling, to better reflect the actual in-use fuel economy achieved by vehicles, EPA is not proposing to use these test procedures for the CO_2 standards proposed here, given the lack of data on control technology effectiveness under these procedures.[127] As stated in Section I, EPA and NHTSA invite comments on potential amendments to the CAFE and GHG test procedures, including but not limited to air conditioner-related emissions, that could be implemented beginning in MY 2017.

EPA proposes to include hydrocarbons (HC) and carbon monoxide (CO) in its CO_2 emissions calculations on a CO_2-equivalent basis. It is well accepted that HC and CO are typically oxidized to CO_2 in the atmosphere in a relatively short period of time and so are effectively part of the CO_2 emitted by a vehicle. In terms of standard stringency, accounting for the carbon content of tailpipe HC and CO emissions and expressing it as CO_2-equivalent emissions would add less than one percent to the overall CO_2-equivalent emissions level. This will also ensure consistency with CAFE calculations since HC and CO are included in the ''carbon balance'' methodology that EPA uses to determine fuel usage as part of calculating vehicle fuel economy levels.

2. What Are the CO_2 Attribute-Based Standards?

EPA proposes to use the same vehicle category definitions that are used in the CAFE program for the 2011 model year standards.[128] The CAFE vehicle category definitions differ slightly from the EPA definitions for cars and light trucks used for the Tier 2 program, as well as other EPA vehicle programs. Specifically, NHTSA's reconsideration of the CAFE program statutory language has resulted in many two-wheel drive SUVs under 6000 pounds gross vehicle weight being reclassified as cars under the CAFE program. The proposed approach of using CAFE definitions allows EPA's proposed CO_2 standards and the proposed CAFE standards to be harmonized across all vehicles. In other words, vehicles would be subject to either car standards or truck standards under both programs, and not car standards under one program and trucks standards under the other.

EPA is proposing separate car and truck standards, that is, vehicles defined as cars have one set of footprint-based curves for MY 2012–2016 and vehicles defined as trucks have a different set for MY 2012–2016. In general, for a given footprint the CO_2 g/mi target for trucks is less stringent then for a car with the same footprint.

EPA is not proposing a single fleet standard where all cars and trucks are measured against the same footprint curve for several reasons. First, some vehicles classified as trucks (such as pick-up trucks) have certain attributes not common on cars which attributes contribute to higher CO_2 emissions—notably high load carrying capability and/or high towing capability. Due to these differences, it is reasonable to separate the light-duty vehicle fleet into two groups. Second, EPA would like to harmonize key program design elements of the GHG standards with NHTSA's CAFE program where it is reasonable to do so. NHTSA is required by statute to set separate standards for passenger cars and for non-passenger cars.

Finally, most of the advantages of a single standard for all light duty vehicles are also present in the two-fleet standards proposed here. Because EPA is proposing to allow unlimited credit transfer between a manufacturer's car and truck fleets, the two fleets can essentially be viewed as a single fleet when manufacturers consider compliance strategies. Manufacturers can thus choose on which vehicles within their fleet to focus GHG reducing technology and then use credit transfers as needed to demonstrate compliance, just as they would if there was a single fleet standard. The one benefit of a single light-duty fleet not captured by a two-fleet approach is that a single fleet prevents potential ''gaming'' of the car and truck definitions to try and design vehicles which are more similar to passenger cars but which may meet the regulatory definition of trucks. Although this is of concern to EPA, we do not believe at this time that concern is sufficient to outweigh the other reasons for proposing separate car and truck fleet standards. EPA requests comment on this approach.

For model years 2012 and later, EPA is proposing a series of CO_2 standards that are described mathematically by a family of piecewise linear functions (with respect to vehicle footprint). The form of the function is as follows:

$CO_2 = a$, if $x \leq l$
$CO_2 = cx + d$, if $l < x \leq h$
$CO_2 = b$, if $x > h$

Where:
CO_2 = the CO_2 target value for a given footprint (in g/mi)
a = the minimum CO_2 target value (in g/mi)
b = the maximum CO_2 target value (in g/mi)
c = the slope of the linear function (in g/mi per sq ft)
d = is the zero-offset for the line (in g/mi CO_2)
x = footprint of the vehicle model (in square feet, rounded to the nearest tenth)
l & h are the lower and higher footprint limits, constraints, or the boundary (''kinks'') between the flat regions and the intermediate sloped line.

EPA's proposed parameter values that define the family of functions for the proposed CO_2 fleetwide average car and truck standards are as follows:

TABLE III.B.2–1—PARAMETER VALUES FOR CARS

[For CO_2 gram per mile targets]

Model year	a	b	c	d	Lower constraint	Upper constraint
2012	242	313	4.72	48.8	41	56
2013	234	305	4.72	40.8	41	56
2014	227	297	4.72	33.2	41	56
2015	215	286	4.72	22.0	41	56
2016 and later	204	275	4.72	10.9	41	56

[126] EPA established the FTP for emissions measurement in the early 1970s. In 1976, in response to the Energy Policy and Conservation Act (EPCA) statute, EPA extended the use of the FTP to fuel economy measurement and added the HFET.[126] The provisions in the 1976 regulation, effective with the 1977 model year, established procedures to calculate fuel economy values both for labeling and for CAFE purposes.

[127] *See* 71 FR 77872, December 27, 2006.

[128] *See* 49 CFR part 523.

TABLE III.B.2–2—PARAMETER VALUES FOR TRUCKS

[For CO_2 gram per mile targets]

Model year	a	b	c	d	Lower constraint	Upper constraint
2012	298	399	4.04	132.6	41	66
2013	287	388	4.04	121.6	41	66
2014	276	377	4.04	110.3	41	66
2015	261	362	4.04	95.2	41	66
2016 and later	246	347	4.04	80.4	41	66

The equations can be shown graphically for each vehicle category, as shown in Figures III.B.2–1 and III.B.2–2. These standards (or functions) decrease from 2012–2016 with a vertical shift. A more detailed description of the development of the attribute based standard can be found in Chapter 2 of the Draft Joint TSD. More background discussion on other alternative attributes and curves EPA explored can be found in the EPA DRIA. EPA recognizes that the CAA does not mandate that EPA use an attribute based standard, as compared to NHTSA's obligations under EPCA. The EPA believes that proposing a footprint-based program will harmonize EPA's proposed program and the proposed CAFE program as a single national program, resulting in reduced compliance complexity for manufacturers. EPA's reasons for proposing to use an attribute based standard are discussed in more detail in the Joint TSD. Comments are requested on this proposal to use the attribute-based approach for regulating tailpipe CO_2 emissions.

BILLING CODE 4910–59–P

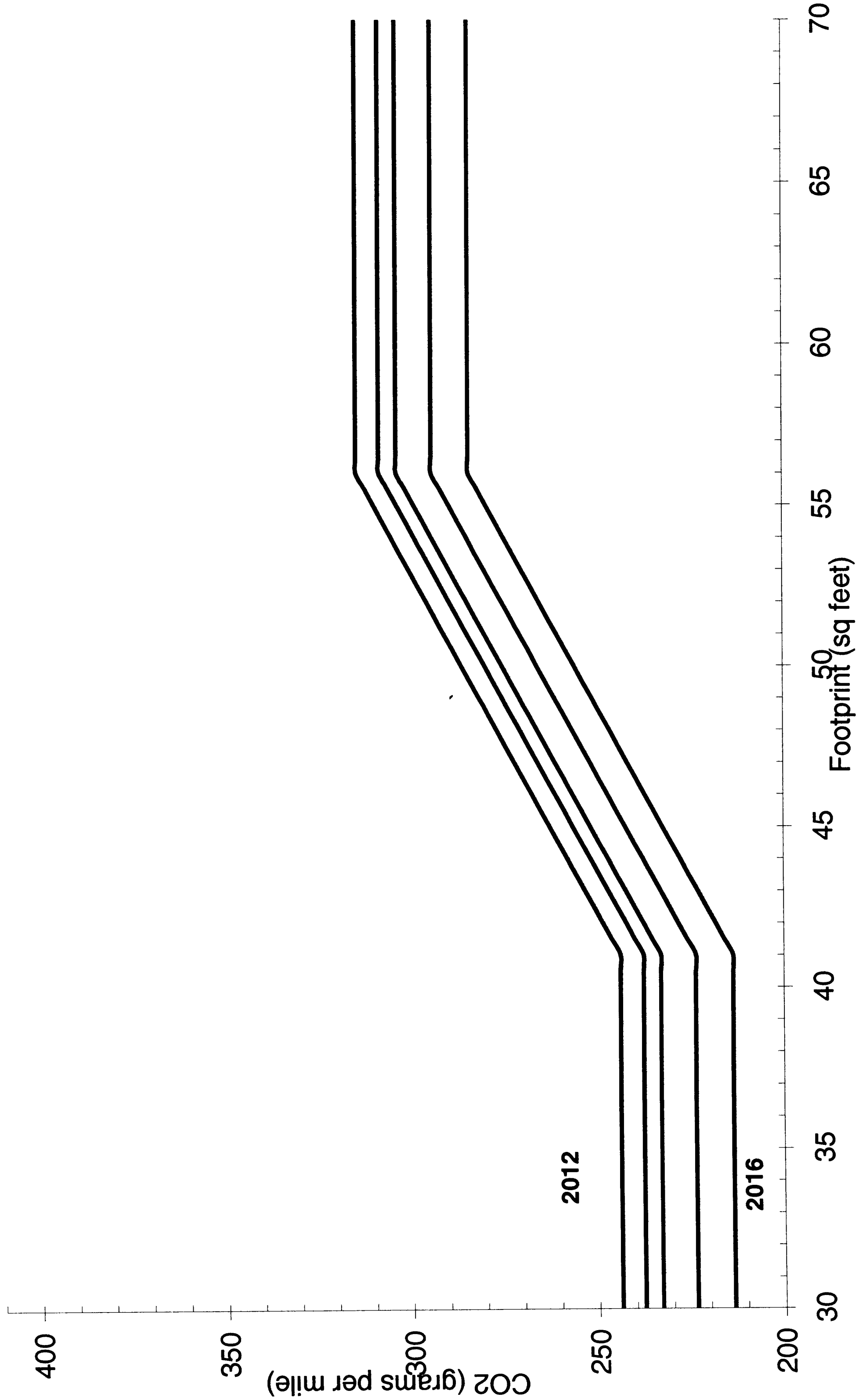


Figure III.B.2-1. CO2 (g/mi) Car standard curves.

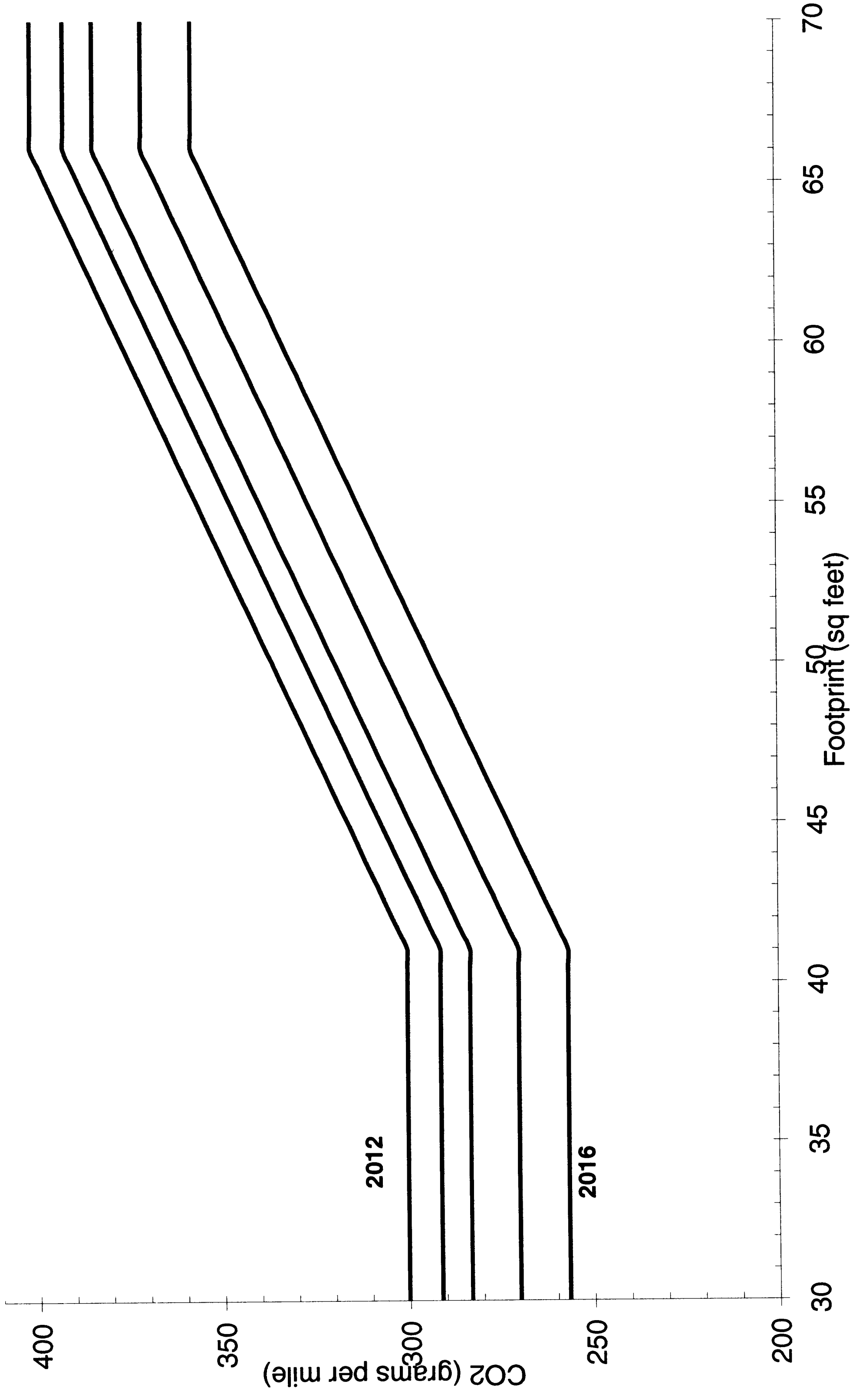


Figure III.B.2-2. CO2 (g/mi) Truck standard curves.

BILLING CODE 4910–59–C

3. Overview of How EPA's Proposed CO_2 Standards Would Be Implemented for Individual Manufacturers

This section provides a brief overview of how EPA proposes to implement the CO_2 standards. Section III.E explains EPA's proposed approach for certification and compliance in detail. EPA is proposing two kinds of standards—fleet average standards determined by a manufacturer's fleet profile of various models, and in-use standards that would apply to the various models that make up the manufacturer's fleet. Although this is similar in concept to the current light-duty vehicle Tier 2 program, there are important differences. In explaining EPA's proposal for the CO_2 standards, it is useful to summarize how the Tier 2 program works.

Under Tier 2, manufacturers select a test vehicle prior to certification and test the vehicle and/or its emissions hardware to determine both its emissions performance when new and the emissions performance expected at the end of its useful life. Based on this testing, the vehicle is assigned to one of several specified bins of emissions levels, identified in the Tier 2 rule, and this bin level becomes the emissions standard for the test group the test vehicle represents. All of the vehicles in the group must meet the emissions level for that bin throughout their useful life. The emissions level assigned to the bin is also used in calculating the manufacturer's fleet average emissions performance.

Since compliance with the Tier 2 fleet average depends on actual test group sales volumes and bin levels, it is not possible to determine compliance at the time the manufacturer applies for and receives a certificate of conformity for a test group. Instead, at certification, the manufacturer demonstrates that the vehicles in the test group are expected to comply throughout their useful life with the emissions bin assigned to that test group, and makes a good faith demonstration that its fleet is expected to comply with the Tier 2 average when the model year is over. EPA issues a certificate for the vehicles covered by 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 Tier 2.

EPA proposes to retain the Tier 2 approach of requiring manufacturers to demonstrate in good faith at the time of certification that models in a test group will meet applicable standards throughout useful life. EPA also proposes to retain the practice of conditioning certificates upon attainment of the fleet average standard. However, there are several important differences between a Tier 2 type of program and the CO_2 standards program EPA is proposing. These differences and resulting modifications to certification are summarized below and are described in detail in Section III.E.

EPA is proposing to certify test groups as it does for Tier 2, with the CO_2 emission results for the test vehicle as the initial or default standard for all of the models in the test group. However, manufacturers would later substitute test data for individual models in that test group, based on the model level fuel economy testing that typically occurs through the course of the model year. This model level data would then be used to assign a distinct certification level for that model, instead of the initial test group level. These model level results would then be used to calculate the fleet average after the end of production.[129] The option to substitute model level test data for the test group data is at the manufacturer's discretion, except they are required as under the CAFE test protocols to test, at a minimum, enough models to represent 90 percent of their production. The test group level would continue to apply for any model that is not covered by model level testing. A related difference is that the fleet average calculation for Tier 2 is based on test group bin levels and test group sales whereas under this proposal the CO_2 fleet level would be based on a combination of test group and model-level emissions and model-level production. For the new CO_2 standards, EPA is proposing to use production rather than sales in calculating the fleet average in order to more closely conform with CAFE, which is a production-based program. EPA does not expect any significant environmental effect because there is little difference between production and sales, and this will reduce the complexity of the program for manufacturers.

4. Averaging, Banking, and Trading Provisions for CO_2 Standards

As explained above, a fleet average CO_2 program for passenger cars and light trucks is proposed. EPA has implemented similar averaging programs for a range of motor vehicle types and pollutants, from the Tier 2 fleet average for NO_X to motorcycle hydrocarbon (HC) plus oxides of nitrogen (NO_X) emissions to NO_X and particulate matter (PM) emissions from heavy-duty engines.[130] The proposed program would operate much like EPA's existing averaging programs in that manufacturers would calculate production-weighted fleet average emissions at the end of the model year and compare their fleet average with a fleet average standard to determine compliance. As in other EPA averaging programs, the Agency is also proposing a comprehensive program for averaging, banking, and trading of credits which together will help manufacturers in planning and implementing the orderly phase-in of emissions control technology in their production, using their typical redesign schedules.

Averaging, Banking, and Trading (ABT) of emissions credits has been an important part of many mobile source programs under CAA Title II, both for fuels programs as well as for engine and vehicle programs. ABT is important because it can help to address many issues of technological feasibility and lead-time, as well as considerations of cost. ABT is an integral part of the standard setting itself, and is not just an add-on to help reduce costs. In many cases, ABT resolves issues of lead-time or technical feasibility, allowing EPA to set a standard that is either numerically more stringent or goes into effect earlier than could have been justified otherwise. This provides important environmental benefits at the same time it increases flexibility and reduces costs for the regulated industry.

This section discusses generation of credits by achieving a fleet average CO_2 level that is lower than the manufacturer's CO_2 fleet average standard. EPA is proposing a variety of additional ways credits may be generated by manufacturers. Section III.C describes these additional opportunities to generate credits in detail. EPA is proposing that credits could be earned through A/C system improvements beyond a specified baseline. Credits can also be generated by producing alternative fuel vehicles, by producing advanced technology vehicles including electric vehicles, plug-in hybrids, and fuel cell vehicles, and by using technologies that improve off-cycle emissions. In addition, EPA is proposing that early credits could be generated prior to the proposed program's MY 2012 start date. The credits would be used in calculating the fleet averages at the end of the model year, with the exception of early credits which would be tracked separately. These proposed credit generating opportunities are described below in Section III.C.

As explained earlier, manufacturers would determine the fleet average standard that would apply to their car fleet and the standard for their truck fleet from the applicable attribute-based curve. A manufacturer's credit or debit

[129] The final in-use vehicle standards for each model would also be based on the model-level fuel economy testing. As discussed in Section III.E.4, an in-use adjustment factor would be applied to the model level results to determine the in-use standard that would apply during the useful life of the vehicle.

[130] For example, see the Tier 2 light-duty vehicle emission standards program (65 FR 6698, February 10, 2000), the 2010 and later model year motorcycle emissions program (69 FR 2398, January 15, 2004), and the 2007 and later model year heavy-duty engine and vehicle standards program (66 FR 5001, January 18, 2001).

balance would be determined by comparing their fleet average with the manufacturer's CO_2 standard for that model year. The standard would be calculated from footprint values on the attribute curve and actual production levels of vehicles at each footprint. A manufacturer would generate credits if its car or truck fleet achieves a fleet average CO_2 level lower than its standard and would generate debits if its fleet average CO_2 level is above that standard. At the end of the model year, each manufacturer would calculate a production-weighted fleet average for each averaging set, cars and trucks. A manufacturer's car or truck fleet that achieves a fleet average CO_2 level lower than its standard would generate credits, and if its fleet average CO_2 level is above that standard its fleet would generate debits.

EPA is proposing to account for the difference in expected lifetime vehicle miles traveled (VMT) between cars and trucks in order to preserve CO_2 reductions when credits are transferred between cars and trucks. As directed by EISA, NHTSA accomplishes this in the CAFE program by using an adjustment factor that is applied to credits when they are transferred between car and truck compliance categories. The CAFE adjustment factor accounts for two different influences that can cause the transfer of car and truck credits (expressed in tenths of a mpg), if left unadjusted, to potentially negate fuel reductions. First, mpg is not linear with fuel consumption, *i.e.*, a 1 mpg improvement above a standard will imply a different amount of actual fuel consumed depending on the level of the standard. Second, NHTSA's conversion corrects for the fact that the typical lifetime miles for cars is less than that for trucks, meaning that credits earned for cars and trucks are not necessarily equal. NHTSA's adjustment factor essentially converts credits into vehicle lifetime gallons to ensure preservation of fuel savings and the transfer credits on an equal basis, and then converts back to the statutorily required credit units of tenths of a mile per gallon. To convert to gallons NHTSA's conversion must take into account the expected lifetime mileage for cars and trucks. Because EPA is proposing standards that are expressed on a CO_2 gram per mile basis, which is linear with fuel consumption, EPA's credit calculations do not need to account for the first issue noted above. However, EPA is proposing to account for the second issue by expressing credits when they are generated in total lifetime megagrams (metric tons), rather than through the use of conversion factors that would apply at certain times. In this way credits could be freely exchanged between car and truck compliance categories without adjustment. Additional detail regarding this approach, including a discussion of the vehicle lifetime mileage estimates for cars and trucks can be found in Section III.E.5. A discussion of the estimated vehicle lifetime miles traveled can be found in Chapter 4 of the draft Joint Technical Support Document. EPA requests comment on the proposed approach.

A manufacturer that generates credits in a given year and vehicle category could use those credits in essentially four ways, although with some limitations. These provisions are very similar to those of other EPA averaging, banking, and trading programs. These provisions have the potential to reduce costs and compliance burden, and support the feasibility of the standards being proposed in terms of lead time and orderly redesign by a manufacturer, thus promoting and not reducing the environmental benefits of the program.

First, the manufacturer would have to offset any deficit that had accrued in that averaging set in a prior model year and had been carried over to the current model year. In such a case, the manufacturer would be obligated to use any current model year credits to offset that deficit. This is referred to in the CAFE program as credit carry-back. EPA's proposed deficit carry-forward, or credit carry-back provisions are described further, below.

Second, after satisfying any needs to offset pre-existing deficits within a vehicle category, remaining credits could be banked, or saved for use in future years. EPA is proposing that credits generated in this program be available to the manufacturer for use in any of the five years after the year in which they were generated, consistent with the CAFE program under EISA. This is also referred to as a credit carry-forward provision. For other new emission control programs, EPA has sometimes initially restricted credit life to allow time for the Agency to assess whether the credit program is functioning as intended. When EPA first offered averaging and banking provisions in its light-duty emissions control program (the National Low Emission Vehicle Program), credit life was restricted to three years. The same is true of EPA's early averaging and banking program for heavy-duty engines. As these programs matured and were subsequently revised, EPA became confident that the programs were functioning as intended and that the standards were sufficiently stringent to remove the restrictions on credit life.

EPA is therefore acting consistently with our past practice in proposing to reasonably restrict credit life in this new program. The Agency believes, subject to consideration of public comment, that a credit life of five years represents an appropriate balance between promoting orderly redesign and upgrade of the emissions control technology in the manufacturer's fleet and the policy goal of preventing large numbers of credits accumulated early in the program from interfering with the incentive to develop and transition to other more advanced emissions control technologies. As discussed below in Section III.C, EPA is proposing that any early credits generated by a manufacturer, beginning as soon as MY 2009, would also be subject to the five-year credit carry-forward restriction based on the year in which they are generated. This would limit the effect of the early credits on the long-term emissions reductions anticipated to result from the proposed new standards.

Third, EPA is proposing to allow manufacturers to transfer credits between the two averaging sets, passenger cars and trucks, within a manufacturer. For example, credits accrued by over-compliance with a manufacturer's car fleet average standard could be used to offset debits accrued due to that manufacturer's not meeting the truck fleet average standard in a given year. EPA believes that such cross-category use of credits by a manufacturer would provide important additional flexibility in the transition to emissions control technology without affecting overall emission reductions.

Finally, accumulated credits could be traded to another vehicle manufacturer. As with intra-company credit use, such inter-company credit trading would provide flexibility in the transition to emissions control technology without affecting overall emission reductions. Trading credits to another vehicle manufacturer would be a straightforward process between the two manufacturers, but could also involve third parties that could serve as credit brokers. Brokers would not own the credits at any time. These sorts of exchanges are typically allowed under EPA's current emission credit programs, *e.g.*, the Tier 2 light-duty vehicle NO_X fleet average standard and the heavy-duty engine NO_X fleet average standards, although manufacturers have seldom made such exchanges. EPA seeks comment on enhanced reporting requirements or other methods that could help EPA assess validity of credits, especially those obtained from third-party credit brokers

If a manufacturer had a deficit at the end of a model year—that is, its fleet average level failed to meet the required fleet average standard—EPA proposes that the manufacturer could carry that deficit forward (also referred to credit carry-back) for a total of three model years after the model year in which that deficit was generated. As noted above, such a deficit carry-forward could only occur after the manufacturer applied any banked credits or credits from another averaging set. If a deficit still remained after the manufacturer had applied all available credits, and the manufacturer did not obtain credits elsewhere, the deficit could be carried over for up to three model years. No deficit could be carried into the fourth model year after the model year in which the deficit occurred. Any deficit from the first model year that remained after the third model year would thus constitute a violation of the condition on the certificate, which would constitute a violation of the Clean Air Act and would be subject to enforcement action.

In the Tier 2 rulemaking proposal, EPA proposed to allow deficits to be carried forward for one year. In their comments on that proposal, manufacturers argued persuasively that by the time they can tabulate their average emissions for a particular model year, the next model year is likely to be well underway and it is too late to make calibration, marketing, or production mix changes to adjust that year's credit generation. Based on those comments, in the Tier 2 final rule EPA finalized provisions that allowed the deficit to be carried forward for a total of three years. EPA continues to believe that three years is an appropriate amount of time that gives the manufacturers adequate time to respond to a deficit situation but does not create a lengthy period of prolonged non-compliance with the fleet average standards.[131] Subsequent EPA emission control programs that incorporate ABT provisions (*e.g.*, the Mobile Source Air Toxics rule) have provided this three-year deficit carry-forward provision for this reason.[132]

The proposed averaging, banking, and trading provisions are generally consistent with those included in the CAFE program, with a few notable exceptions. As with EPA's proposed approach, CAFE allows five year carry-forward of credits and three year carry-back. Transfers of credits across a manufacturer's car and truck averaging sets are also allowed, but with limits established by EISA on the use of transferred credits. The amount of transferred credits that can be used in a year is limited, and transferred credits may not be used to meet the CAFE minimum domestic passenger car standard. CAFE allows credit trading, but again, traded credits cannot be used to meet the minimum domestic passenger car standard. EPA is not proposing these constraints on the use of transferred credits.

Additional details regarding the averaging, banking, and trading provisions and how EPA proposes to implement these provisions can be found in Section III.E.

5. CO_2 Optional Temporary Lead-time Allowance Alternative Standards

EPA is proposing a limited and narrowly prescribed option, called the Temporary Lead-time Allowance Alternative Standards (TLAAS), to provide additional lead time for a certain subset of manufacturers. This option is designed to address two different situations where we project that more lead time is needed, based on the level of emissions control technology and emissions control performance currently exhibited by certain vehicles. One situation involves manufacturers who have traditionally paid CAFE fines instead of complying with the CAFE fleet average, and as a result at least part of their vehicle production currently has significantly higher CO_2 and lower fuel economy levels than the industry average. More lead time is needed in the program's initial years to upgrade these vehicles to meet the aggressive CO_2 emissions performance levels required by the proposal. The other situation involves manufacturers who have a limited line of vehicles and are unable to take advantage of averaging of emissions performance across a full line of production. For example, some smaller volume manufacturers focus on high performance vehicles with higher CO_2 emissions, above the CO_2 emissions target for that vehicle footprint, but do not have other types of vehicles in their production mix with which to average. Often, these manufacturers also pay fines under the CAFE program rather than meeting the applicable CAFE standard. Because voluntary non-compliance is impermissible for the GHG standards proposed under the CAA, both of these types of manufacturers need additional lead time to upgrade vehicles and meet the proposed standards. EPA is proposing an optional, temporary alternative standard, which is only slightly less stringent, and limited to the first four model years (2012—2015) of the National Program, so that these manufacturers can have sufficient lead time to meet the tougher MY 2016 GHG standards, while preserving consumer choice of vehicles during this time.

In MY 2016, the TLAAS option ends, and all manufacturers, regardless of size, and domestic sales volume, must comply with the same CO_2 standards, while under the CAFE program companies would continue to be allowed to pay civil penalties in lieu of complying with the CAFE standards. However, because companies must meet both the CAFE standards and the EPA CO_2 standards, the National Program will have the practical impact of providing a level playing field for all companies beginning in MY 2016—a situation which has never existed under the CAFE program. This option thereby results in more fuel savings and CO_2 reductions than would be the case under the CAFE program.

EPA projects that the environmental impact of the proposed TLAAS program will be very small. If all companies eligible to use the TLAAS use it to the maximum extent allowed, total GHG emissions from the proposal will increase by less than 0.4% over the lifetime of the MY 2012–2016 vehicles. EPA believes the impact will be even smaller, as we do not expect all of the eligible companies to use this option, and we do not expect all companies who do use the program will use it to the maximum extent allowed, as we have included provisions which discourage companies from using the TLAAS any longer than it is needed.

EPA has structured the TLAAS option to provide more lead time in these kinds of situations, but to limit the program so that it would only be used in situations where these kinds of lead time concerns arise. Based on historic data on sales, EPA is using a specific historic U.S. sales volume as the best way to identify the subset of production that falls into this situation. Under the TLAAS, these manufacturers would be allowed to produce up to but no more than 100,000 vehicles that would be subject to a somewhat less stringent CO_2 standard. This 100,000 volume is not an annual limit, but is an absolute limit for the total number of vehicles which can use the TLAAS program over the model years 2012–2015. Any additional production would be subject to the same standards as any other manufacturer. In addition, EPA is imposing a variety of restrictions on the use of the TLAAS program, discussed in more detail below, to ensure that only manufacturers who need more lead-time

[131] *See* 65 FR 6745 (February 10, 2000).

[132] *See* 71 FR 8427 (February 26, 2007).

for the kinds of reasons noted above are likely to use the program. Finally, the program is temporary and expires at the end of MY 2015. A more complete discussion of the program is provided below. EPA believes the proposed program reasonably addresses a real world lead time constraint, and does it in a way that balances the need for more lead time with the need to minimize any resulting loss in potential emissions reductions. EPA invites comment as to whether its proposal is the best way to balance these concerns.

EPA proposes to establish a TLAAS for a specified subset of manufacturers. There are two types of companies who would make use of TLAAS—those manufacturers who have paid CAFE fines in recent years, and who need additional lead-time to incorporate the needed technology; and those companies who are not full-line manufacturers, who have a smaller range of models and vehicle types, who may need additional lead-time as well. This alternative standard would apply to manufacturers with total U.S. sales of less than 400,000 vehicles per year, using 2009 model year final sales numbers to determine eligibility for these alternative standards. EPA reviewed the sales volumes of manufacturers over the last few years, and determined that manufacturers below this level typically fit the characteristics discussed above, and manufacturers above this level did not. Thus, EPA chose this level because it functionally identifies the group of manufacturers described above, recognizing that there is nothing intrinsic in the sales volume itself that warrants this allowance. EPA was not able to identify any other objective criteria that would more appropriately identify the manufacturers and vehicle fleets described above.

EPA is proposing that manufacturers qualifying for TLAAS would be allowed to meet slightly less stringent standards for a limited number of vehicles for model years 2012–2015. Specifically, an eligible manufacturer could have a total of up to 100,000 units of cars and trucks combined over model years 2012–2015, and during those model years those vehicles would be subject to a standard 1.25 times the standard that would otherwise apply to those vehicles under the primary program. In other words, the footprint curves upon which the individual manufacturer standards for the TLAAS fleets are based would be less stringent by a factor of 1.25 for up to 100,000 of an eligible manufacturer's vehicles for model years 2012–2015. As noted, this approach seeks to balance the need to provide additional lead-time without reducing the environmental benefits of the proposed program. EPA believes that 100,000 units over four model years achieves an appropriate balance as the emissions impact is quite small, but does provide companies with some flexibility during MY 2012–2015. For example, for a manufacturer producing 400,000 vehicles per year, this would be a total of up to 100,000 vehicles out of a total production of up to 1.6 million vehicles over the four year period, or about 6 percent of total production.

Manufacturers with no U.S. sales in model year 2009 would not qualify for the TLAAS program. Manufacturers meeting the cut-point of 400,000 for MY 2009 but with U.S. directed production above 400,000 in any subsequent model years would remain eligible for the TLAAS program. Also, the total sales number applies at the corporate level, so if a corporation owns several vehicle brands the aggregate sales for the corporation would be used. These provisions would help prevent gaming of the provisions through corporate restructuring. Corporate ownership or control relationships would be based on determinations made under CAFE for model year 2009. In other words, corporations grouped together for purposes of meeting CAFE standards, would be grouped together for determining whether or not they are eligible under the 400,000 vehicle cut point.

EPA derived the 100,000 maximum unit set aside number based on a gradual phase-out schedule shown in Table III.B.5–1, below. However, individual manufacturers' situations will vary significantly and so EPA believes a flexible approach that allows manufacturers to use the allowance as they see fit during these model years would be most appropriate. As another example, an eligible manufacturer could also choose to apply the TLAAS program to an average of 25,000 vehicles per year, over the four-year period. Therefore, EPA is proposing that a total of 100,000 vehicles of an eligible manufacturer, with any combination of cars or trucks, could be subject to the alternative standard over the four year period without restrictions.

TABLE III.B.5–1—TLAAS EXAMPLE VEHICLE PRODUCTION VOLUMES

Model year	2012	2013	2014	2015
Sales Volume	40,000	30,000	20,000	10,000

The TLAAS vehicles would be separate car and truck fleets for that model year and would be subject to the less stringent footprint-based standards of 1.25 times the primary fleet average that would otherwise apply. The manufacturer would determine what vehicles are assigned to these separate averaging sets for each model year. EPA is proposing that credits from the primary fleet average program can be transferred and used in the TLAAS program. Credits within the TLAAS program may also be transferred between the TLAAS car and truck averaging sets for use through 2015 when the TLAAS would end. However, credits generated under TLAAS would not be allowed to be transferred or traded to the primary program. Therefore, any unused credits under TLAAS would expire after model year 2015. EPA believes that this is necessary to limit the program to situations where it is needed and to prevent the allowance from being inappropriately transferred to the long-term primary program.

EPA is concerned that some manufacturers would be able to place relatively clean vehicles in the TLAAS to maximize TLAAS credits if credit use was unrestricted. However, any credits generated from the primary program that are not needed for compliance in the primary program, should be used to offset the TLAAS vehicles. EPA is thus proposing to restrict the use of banking and trading between companies of credits in the primary program in years in which the TLAAS is being used. For example, manufacturers using the TLAAS in MY 2012 could not bank credits in the primary program during MY 2012 for use in MY 2013 and later. No such restriction would be in place for years when the TLAAS is not being used. EPA also believes this provision is necessary to prevent credits from being earned simply by removing some high-emitting vehicles from the primary fleet. Absent this restriction, manufacturers would be able to choose to use the TLAAS for these vehicles and also be able to earn credits under the primary program that could be banked or traded under the primary program without restriction. EPA is proposing two additional restrictions regarding the use of the TLAAS by requiring that for any of the 2012–2015 model years for which an eligible manufacturer would like to use the TLAAS, the manufacturer must use two of the available flexibilities in the GHG program first in order to try and show compliance with the primary standard before accessing the TLAAS. Specifically, before using the TLAAS the manufacturer must: (1) use any banked emission credits from a previous model year; and, (2) use any available credits from the companies' car or truck fleet for the specific model year (*i.e.,* use credit transfer from cars to trucks or from trucks to cars, that is, before using the TLAAS for either the car fleet or the truck fleet, make use of any available credit transfers first). EPA is requesting comments on all aspects of the proposed TLAAS program including comments on other provisions that might be needed to ensure that the TLAAS program is being used as intended and to ensure no gaming occurs.

Finally, EPA recognizes that there will be a wide range of companies within the eligible manufacturers with sales less than 400,000 vehicles in model year 2009. Some of these companies, while having relatively small U.S. sales volumes, are large global automotive firms, including companies such as Mercedes and Volkswagen. Other companies are significantly smaller niche firms, with sales volumes closer to 10,000 vehicles per year worldwide; an example of this type of firm is Aston Martin. EPA anticipates that there are a small number of such smaller volume manufacturers, which have claimed that they may face greater challenges in meeting the proposed standards due to their limited product lines across which to average. EPA requests comment on whether the proposed TLAAS program, as described above, provides sufficient lead-time for these smaller firms to incorporate the technology needed to comply with the proposed GHG standards.

6. Proposed Nitrous Oxide and Methane Standards

In addition to fleet-average CO_2 standards, EPA is proposing separate per-vehicle standards for nitrous oxide (N_2O) and methane (CH_4) emissions. Standards are being proposed that would cap vehicle N_2O and CH_4 emissions at current levels. Our intention is to set emissions standards that act to cap emissions to ensure that future vehicles do not increase their N_2O and CH_4 emissions above levels that would be allowed under the proposal.

EPA considered an approach of expressing each of these standards in common terms of CO_2-equivalent emissions and combining them into a single standard along with CO_2 and HFC emissions. California's ''Pavley'' program adopted such a CO_2-equivalent emissions standards approach to GHG emissions in their program.[133] However, these pollutants are largely independent of one another in terms of how they are generated by the vehicle and how they are tested for during implementation. Potential control technologies and strategies for each pollutant also differ. Moreover, an approach that provided for averaging of these pollutants could undermine the stringency of the CO_2 standards, as at this time we are proposing standards which ''cap'' N_2O and CH_4 emissions, rather then proposing a level which is either at the industry fleet-wide average or which would result in reductions from these pollutants. It is possible that once EPA begins to receive more detailed information on the N_2O and CH_4 performance of the new vehicle fleet as a result of this proposed rule (if it were to be finalized as proposed) that for a future action for model years 2017 and later EPA could consider a CO_2-equivalent standard which would not result in any increases in GHG emissions due to the current lack of detailed data on N_2O and CH_4 emissions performance. In addition, EPA seeks comment on whether a CO_2-equivalent emissions standard should be considered for model years 2012 through 2016, and whether there are advantages or disadvantages to such an approach, including potential impacts on harmonization with CAFE standards.

Almost universally across current car and truck designs, both gasoline- and diesel-fueled, these emissions are relatively low, and our intent is to not require manufacturers to make technological improvements in order to reduce N_2O and CH_4 at this time. However, it is important that future vehicle technologies or fuels do not result in increases in these emissions, and this is the intent of the proposed ''cap'' standards.

EPA requests comments on our approach to regulating N_2O and CH_4 emissions including the appropriateness of ''cap'' standards as opposed to ''technology-forcing'' standards, the technical bases for the proposed N_2O and CH_4 standards, the proposed test procedures, and timing. Specifically, EPA seeks comment on the appropriateness of the proposed levels of the N_2O and CH_4 standards to accomplish our stated intent. In addition, EPA seeks comment on any additional emissions data on N_2O and CH_4 from current technology vehicles.

a. Nitrous Oxide (N_2O) Exhaust Emission Standard

N_2O is a global warming gas with a high global warming potential.[134] It accounts for about 2.7% of the current greenhouse gas emissions from cars and light trucks. EPA is proposing a per-vehicle N_2O emission standard of 0.010 g/mi, measured over the traditional FTP vehicle laboratory test cycles. The standard would become effective in model year 2012 for all light-duty cars and trucks. 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.

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 Tier 2 compatible 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 is a more significant concern with diesel vehicles, and potentially future gasoline lean-burn engines, equipped with advanced catalytic NO_X emissions control systems. 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. Excess oxygen present in the exhaust during lean-burn conditions in diesel or lean-burn gasoline engines equipped with these advanced systems can favor N_2O formation if catalyst temperatures are not carefully controlled. Without

[133] California Environmental Protection Agency Air Resources Board, Staff Report: Initial Statement of Reasons for Proposed Rulemaking Public Hearing To Consider Adoption Of Regulations To Control Greenhouse Gas Emissions From Motor Vehicles, August 6, 2004.

[134] N_2O has a GWP of 310 according to the IPCC Second Assessment Report (SAR).

specific attention to controlling N_2O emissions in the development of such new NO_X control systems, vehicles could have N_2O emissions many times greater than are emitted by current gasoline vehicles.

EPA is proposing an N_2O emission standard that EPA believes would be met by current-technology gasoline vehicles at essentially no cost. As noted, N_2O formation in current catalyst systems occurs, but the emission levels are 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, EPA believes that the proposed standard would ensure that the design of advanced NO_X control systems, especially for future diesel and lean-burn gasoline vehicles, would control N_2O emission levels. While current NO_X control approaches used on current Tier 2 diesel vehicles do not tend to form N_2O emissions, EPA believes that the proposed standards would discourage any new emission control designs 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 the Tier 2 vehicle emission standards for NO_X would not increase their emission levels, and that the cap would ensure that future vehicle designs would appropriately control their emissions of N_2O. The proposed N_2O level is approximately two times the average N_2O level of current gasoline passenger cars and light-duty trucks that meet the Tier 2 NO_X standards.[135] 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 is not proposing a more stringent standard for current gasoline and diesel vehicles because the stringent Tier 2 program and the associated NO_X fleet average requirement already result in significant N_2O control, and does not expect current N_2O levels to rise for these vehicles. EPA requests comment on this technical assessment of current and potential future N_2O formation in cars and trucks.

While EPA believes that manufacturers will likely be able to acquire and install N_2O analytical equipment, the agency also recognizes that some companies may face challenges. Given the short lead-time for this rule, EPA proposes that manufacturers be able to apply for a certificate of conformity with the N_2O standard for model year 2012 based on a compliance statement based on good engineering judgment. For 2013 and later model years, manufacturers would need to submit measurements of N_2O for compliance purposes.

Diesel cars and light trucks 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 consider different catalyst formulations. While some of these approaches may have modest 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 Tier 2 standards.

Vehicle emissions regulations do not currently require testing for N_2O, and most test facilities do not have equipment for its measurement. Manufacturers without this capability would need to acquire and install appropriate measurement equipment. However, EPA is proposing four N_2O measurement methods, all of which are commercially available today. EPA expects that most manufacturers would use photo-acoustic measurement equipment, which the Agency estimates would result in a one-time cost of about \$50,000–\$60,000 for each test cell that would need to be upgraded.

Overall, EPA believes that manufacturers of cars and light trucks, both gasoline and diesel, would meet the proposed standard without implementing any significantly new technologies, and there are not expected to be any significant costs associated with this proposed standard.

b. Methane (CH_4) Exhaust Emission Standard

CH_4 (or methane) is greenhouse gas with a high global warming potential.[136] It accounts for about 0.2% of the greenhouse gases from cars and light trucks.

EPA is proposing a CH_4 emission standard of 0.030 g/mi as measured on the FTP, to apply beginning with model year 2012 for both cars and trucks. EPA believes that this level for the standard would be met by current gasoline and diesel vehicles, and would prevent large increases in future CH_4 emissions in the event that alternative fueled vehicles with high methane emissions, like some past dedicated compressed natural gas (CNG) vehicles, become a significant part of the vehicle fleet. Currently EPA does not have separate CH_4 standards because unlike other hydrocarbons it does not contribute significantly to ozone formation,[137] However CH_4 emissions levels in the gasoline and diesel car and light truck fleet have nevertheless generally been controlled by the Tier 2 non-methane organic gases (NMOG) emission standards. However, 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.

The proposed standard would cap CH_4 emission levels, with the expectation that current gasoline vehicles meeting the Tier 2 emission standards would not increase their levels, and that 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. The level of the standard would generally be achievable through normal emission control methods already required to meet Tier 2 program emission standards for NMOG and EPA is therefore not attributing any cost to this part of this proposal. Since CH_4 is produced in gasoline and diesel engines similar to other hydrocarbon components, controls targeted at reducing overall NMOG levels generally also work at reducing CH_4 emissions. Therefore, for gasoline and diesel vehicles, the Tier 2 NMOG standards will generally prevent increases in CH_4 emissions levels from today. CH_4 from Tier 2 light-duty vehicles is relatively low compared to other GHGs largely due to the high effectiveness of previous National Low Emission Vehicle (NLEV) and current Tier 2 programs in controlling overall HC emissions.

The level of the proposed standard is approximately two times the average Tier 2 gasoline passenger cars and light-duty trucks level.[138] 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

135 Memo to docket ''Deriving the standard from EPA's MOVES model emission factors, '' December 2007.

136 CH_4 has a GWP of 21 according to the IPCC Second Assessment Report (SAR).

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

138 Memo to docket ''Deriving the standard from EPA's MOVES model emission factors, '' December 2007.

current gasoline vehicles. Similarly, since current diesel vehicles generally have even lower CH_4 emissions than gasoline vehicles, EPA believes that diesels would also meet the proposed standard. However, EPA also believes that to set a CH_4 emission standard more stringent than the proposed standard could effectively make the Tier 2 NMOG standard more stringent.

In recent model years, a small number of cars and light trucks were sold that were designed for dedicated use of compressed natural gas (CNG) that met Tier 2 emission standards. While emission control designs on these recent dedicated CNG-fueled vehicles demonstrate CH_4 control as effective as gasoline or diesel equivalent vehicles, CNG-fueled vehicles have historically produced significantly higher CH_4 emissions than gasoline or diesel vehicles. This is because their CNG fuel is essentially methane and any unburned fuel that escapes combustion and not oxidized by the catalyst is emitted as methane. However, even if these vehicles meet the Tier 2 NMOG standard and appear to have effective CH_4 control by nature of the NMOG controls, Tier 2 standards do not require CH_4 control. While the proposed CH_4 cap standard should not require any different emission control designs beyond what is already required to meet Tier 2 NMOG standards on a dedicated CNG vehicle, the cap will ensure that systems maintain the current level of CH_4 control. EPA is not proposing more stringent CH_4 standards because the same controls that are used to meet Tier 2 NMOG standards should result in effective CH_4 control. Increased CH_4 stringency beyond proposed levels could inadvertently result in increased Tier 2 NMOG stringency absent an emission control technology unique to CH_4. Since CH_4 is already measured under the current Tier 2 regulations (so that it may be subtracted to calculate non-methane hydrocarbons), 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 makers of CNG vehicles.

7. Small Entity Deferment

EPA is proposing to defer setting GHG emissions standards for small entities meeting the Small Business Administration (SBA) criteria of a small business as described in 13 CFR 121.201. EPA would instead consider appropriate GHG standards for these entities as part of a future regulatory action. This includes small entities in three distinct categories of businesses for light-duty vehicles: small volume manufacturers, independent commercial importers (ICIs), and alternative fuel vehicle converters. EPA has identified about 13 entities that fit the Small Business Administration (SBA) criterion of a small business. EPA estimates there are 2 small volume manufacturers, 8 ICIs, and 3 alternative fuel vehicle converters currently in the light-duty vehicle market. EPA estimates that these small entities comprise less than 0.1 percent of the total light-duty vehicle sales in the U.S., and therefore the proposed deferment will have a negligible impact on the GHG emissions reductions from the proposed standards. Further detail is provided in Section III.I.3, below.

To ensure that EPA is aware of which companies would be deferred, EPA is proposing that such entities submit a declaration to EPA containing a detailed written description of how that manufacturer qualifies as a small entity under the provisions of 13 CFR 121.201. Because such entities are not automatically exempted from other EPA regulations for light-duty vehicles and light-duty trucks, absent such a declaration, EPA would assume that the entity was subject to the greenhouse gas control requirements in this GHG proposal. The declaration would need to be submitted at time of vehicle emissions certification under the EPA Tier 2 program. Small 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. EPA expects that the additional paperwork burden associated with completing and submitting a small entity declaration to gain deferral from the proposed GHG standards would be negligible and easily done in the context of other routine submittals to EPA. However, EPA has 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 III.I.2.

C. Additional Credit Opportunities for CO_2 Fleet Average Program

The standards being proposed represent a significant multi-year challenge for manufacturers, especially in the early years of the program. Section III.B.4 described EPA proposals for how manufacturers could generate credits by achieving fleet average CO_2 emissions below the fleet average standard, and also how manufacturers could use credits to comply with standards. As described in Section III.B.4, credits could be carried forward five years, carried back three years, transferred between vehicle categories, and traded between manufacturers. The credits provisions proposed below would provide manufacturers with additional ways to earn credits starting in MY 2012. EPA is also proposing early credits provisions for the 2009–2011 model years, as described below in Section III.C.5.

The provisions proposed below would provide additional flexibility, especially in the early years of the program. This flexibility helps to address issues of lead-time or technical feasibility for various manufacturers and in several cases provides an incentive for promotion of technology pathways that warrant further development, whether or not they are an important or central technology on which critical features of this program are premised. EPA is proposing a variety of credit opportunities because manufacturers are not likely to be in a position to use every credit provision. EPA expects that manufacturers are likely to select the credit opportunities that best fit their future plans. EPA believes it is critical that manufacturers have options to ease the transition to the final MY 2016 standards. At the same time, EPA believes these credit programs must be designed in a way to ensure that they achieve emission reductions that achieve real-world reductions over the full useful life of the vehicle (or, in the case of FFV credits and Advanced Technology credits, to incentivize the introduction of those vehicle technologies) and are verifiable. In addition, EPA wants to ensure these credit programs do not provide an opportunity for manufacturers to earn ''windfall'' credits. EPA seeks comments on how to best ensure these objectives are achieved in the design of the credit programs. EPA requests comment on all aspects of these proposed credits provisions.

1. Air Conditioning Related Credits

EPA proposes that manufacturers be able to generate and use credits for improved air conditioner (A/C) systems in complying with the CO_2 fleetwide average standards described above. EPA expects that most manufacturers will choose to utilize the A/C provisions as part of its compliance demonstration (and for this reason cost of compliance with A/C related emission reductions are assumed in the cost analysis). The A/C provisions are structured as credits, unlike the CO_2 standards for which manufacturers will demonstrate compliance using 2-cycle tests (see Sections III.B and III.E.). Those tests do not measure either A/C leakage or tailpipe CO_2 emissions attributable to A/C load (see Section III.C.1.b below describing proposed alternative test procedures for assessing tailpipe CO_2 emission attributable to A/C engine load). Thus, it is a manufacturer's option to include A/C GHG emission reductions as an aspect of its compliance demonstration. Since this is an elective alternative, EPA is referring to the A/C part of the proposal as a credit.

EPA estimates that direct A/C GHG emissions—emissions due to the leakage of the hydrofluorocarbon refrigerant in common use today—account for 4.3% of CO_2-equivalent GHGs from light-duty cars and trucks. This includes the direct leakage of refrigerant as well as the subsequent leakage associated with maintenance and servicing, and with disposal at the end of the vehicle's life. The emissions that are impacted by leakage reductions are the direct leakage and the maintenance and servicing. Together these are equivalent to CO_2 emissions of approximately 13.6 g/mi per vehicle (this is 14.9 g/mi if end of life emissions are also included). EPA also estimates that indirect GHG emissions (additional CO_2 emitted due to the load of the A/C system on the engine) account for another 3.9% of light-duty GHGs.[139] This is equivalent to CO_2 emissions of approximately 14.2 g/mi per vehicle. The derivation of these figures can be found in the EPA DRIA.

EPA believes that it is important to address A/C direct and indirect emissions because the technologies that manufacturers will employ to reduce vehicle exhaust CO_2 will have little or no impact on A/C related emissions. Without addressing A/C-related emissions, as vehicles become more efficient, the A/C related contribution will become a much larger portion of the overall vehicle GHG emissions.

Over 95% of the new cars and light trucks in the United States are equipped with A/C systems and, as noted, there are two mechanisms by which A/C systems contribute to the emissions of greenhouse gases: through leakage of refrigerant into the atmosphere and through the consumption of fuel to provide power to the A/C system. With leakage, it is the high global warming potential (GWP) of the current automotive refrigerant—R134a, with a GWP of 1430—that results in the CO_2-equivalent impact of 13.6 g/mi.[140] Due to the high GWP of this HFC, 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. Manufacturers can choose to reduce A/C leakage emissions by using leak-tight components. Also, manufacturers can largely eliminate the global warming impact of leakage emissions by adopting systems that use an alternative, low-GWP refrigerant.[141] The A/C system also contributes to increased CO_2 emissions through the additional work required to operate the compressor, fans, and blowers. This additional work typically is provided through the engine's crankshaft, and delivered via belt drive to the alternator (which provides electric energy for powering the fans and blowers) and A/C compressor (which pressurizes the refrigerant during A/C operation). The additional fuel used to supply the power through the crankshaft necessary to operate the A/C system is converted into CO_2 by the engine during combustion. This incremental CO_2 produced from A/C operation can thus be reduced by increasing the overall efficiency of the vehicle's A/C system, which in turn will reduce the additional load on the engine from A/C operation.[142]

Manufacturers can make very feasible improvements to their A/C systems to address A/C system leakage and efficiency. EPA proposes two separate credit approaches to address leakage reductions and efficiency improvements independently. A proposed leakage reduction credit would take into account the various technologies that could be used to reduce the GHG impact of refrigerant leakage, including the use of an alternative refrigerant with a lower GWP. A proposed efficiency improvement credit would account for the various types of hardware and control of that hardware available to increase the A/C system efficiency. Manufacturers would be required to attest the durability of the leakage reduction and the efficiency improvement technologies over the full useful life of the vehicle.

EPA believes that both reducing A/C system leakage and increasing efficiency are highly cost-effective and technologically feasible. EPA expects most manufacturers will choose to use these A/C credit provisions, although some may not find it necessary to do so.

a. A/C Leakage Credits

The refrigerant used in vehicle A/C systems can get into the atmosphere by many different means. These refrigerant emissions occur from the slow leakage over time that all closed high pressure systems will experience. Refrigerant loss occurs from permeation through hoses and leakage at connectors and other parts where the containment of the system is compromised. The rate of leakage can increase due to deterioration of parts and connections as well. In addition, there are emissions that occur during accidents and maintenance and servicing events. Finally, there are end-of-life emissions if, at the time of vehicle scrappage, refrigerant is not fully recovered.

Because the process of refrigerant leakage has similar root causes as those that cause fuel evaporative emissions from the fuel system, some of the control technologies are similar (including hose materials and connections). There are however, some fundamental differences between the systems that require a different approach. The most notable difference is that A/C systems are completely closed systems, whereas the fuel system is not. Fuel systems are meant to be refilled as liquid fuel is consumed by the engine, while the A/C system ideally should never require ''recharging'' of the contained refrigerant. Thus it is critical that the A/C system leakages be kept to an absolute minimum. These emissions are typically too low to accurately measure in most current SHED chambers designed for fuel evaporative emissions measurement, especially for systems that are new or early in life. Therefore, if leakage emissions were to be measured directly, new measurement facilities would need to be built by the OEM manufacturers and very accurate new test procedures would need to be developed. Especially because there are indications that much of the industry is moving toward alternative refrigerants (post-2016 for most manufacturers), EPA is not proposing such a direct measurement approach to addressing refrigerant leakage.

[139] See Chapter 2, section 2.2.1.2 of the DRIA.

[140] The global warming potentials (GWP) used in the NPRM analysis are consistent with Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). At this time, the IPCC Second Assessment Report (SAR) global warming potential values have been agreed upon as the official U.S. framework for addressing climate change. The IPCC SAR GWP values 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 GWP used may lead to adjustments.

[141] Refrigerant emissions during maintenance and at the end of the vehicle's life (as well as emissions during the initial charging of the system with refrigerant) are also addressed by the CAA Title VI stratospheric ozone program, as described below.

[142] We will not be addressing changes to the weight of the A/C system, since the issue of CO_2 emissions from the fuel consumption of normal (non-A/C) operation, including basic vehicle weight, is inherently addressed with the primary CO_2 standards (*See* III.B above).

Instead, EPA proposes that manufacturers demonstrate improvements in their A/C system designs and components through a design-based method. Manufacturers implementing systems expected to result in reduced refrigerant leakage would be eligible for credits that could then be used to meet their CO_2 emission compliance requirements. The proposed ''A/C Leakage Credit'' provisions would generally assign larger credits to system designs that are expected to result in greater leakage reduction. In addition, EPA proposes that proportionately larger A/C Leakage Credits be available to manufacturers that substitute a lower-GWP refrigerant for the current R134a refrigerant.

Our proposed method for calculating A/C Leakage Credits 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. The leakage score can be compared to expected fleetwide leakage rates in order to quantify improvements for a given A/C system. Credits would be generated from leakage reduction improvements that exceeded average fleetwide leakage rates.

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.

The cooperative industry and government Improved Mobile Air Conditioning (IMAC) program [143] has demonstrated that new-vehicle leakage emissions can be reduced by 50%. This program has shown that this level of improvement can be accomplished by reducing the number and improving the quality of the components, fittings, seals, and hoses of the A/C system. All of these technologies are already in commercial use and exist on some of today's systems.

EPA is proposing that a manufacturer wishing to earn A/C Leakage Credits 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 IMAC and the Society of Automotive Engineers (as SAE Surface Vehicle Standard J2727, August 2008 version). The J2727 approach is 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 IMAC approach, our proposed credit approach would associate each component with a specific leakage rate in grams per year identical to the values in J2727. A manufacturer choosing to claim Leakage Credits would sum the leakage values for an A/C system for a total A/C leakage score. EPA is proposing a formula for converting the grams-per-year leakage score to a grams-per-mile CO_2eq value, taking vehicle miles traveled (VMT) and the GWP of the refrigerant into account. This formula is:

Credit = (MaxCredit) * [1 − (LeakScore/AvgImpact) * (GWPRefrigerant/1430)]

Where:

MaxCredit is 12.6 and 15.7 g/mi CO_2eq for cars and trucks respectively. These become 13.8 and 17.2 for cars and trucks if alternative refrigerants are used since they get additional credits for end-of-life emissions reductions.

LeakScore is the leakage score of the A/C system as measured according to methods similar to the J2727 procedure in units of g/yr. The minimum score which is deemed feasible is fixed at 8.3 and 10.4 g/yr for cars and trucks respectively.

AvgImpact is the average impact of A/C leakage, which is 16.6 and 20.7 g/yr for cars and trucks respectively.

GWPRefrigerant is the global warming potential for direct radiative forcing of the refrigerant as defined by EPA (or IPCC).

All of the parameters and limits of the equation are derived in the EPA DRIA.

For systems using the current refrigerant, EPA proposes that these emission rates could at most be feasibly reduced by half, based on the conclusions of the IMAC study, and consideration of emission over the full life of the vehicle. (This latter point is discussed further in the DRIA.)

As discussed above, EPA recognizes that substituting an alternative refrigerant (one with a significantly lower global warming potential, GWP), would potentially be a very effective way to reduce the impact of all forms of refrigerant emissions, including maintenance, accidents, and vehicle scrappage. To address future GHG regulations in Europe and California, systems using alternative refrigerants—including HFO1234yf, with a GWP of 4—are under serious development and have been demonstrated in prototypes by A/C component suppliers. These alternative refrigerants have remaining cost, safety and feasibility hurdles for commercial applications.[144] However, the European Union has enacted regulations phasing in alternative refrigerants with GWP less than 150 starting in 2010, and the State of California proposed providing credits for alternative refrigerant use in its GHG rule.

Within the timeframe of 2012–2016, EPA is not expecting the use of low-GWP refrigerants to be widespread. However, EPA believes that these developments are promising, and have included in our proposed A/C Leakage Credit system provisions to account for the effective refrigerant reductions that could be expected from refrigerant substitution. The quantity of A/C Leakage Credits that would be available would be a function of the GWP of the alternative refrigerant, with the largest credits being available for refrigerants approaching a GWP of zero.[145] For a hypothetical alternative refrigerant with a GWP of 1, effectively eliminating leakage as a GHG concern, our proposed credit calculation method could result in maximum credits equal total average emissions, or credits of 13.4 and 17.8 g/mi CO_2eq for cars and trucks, respectively. This option is also captured in the equation above.

It is possible that alternative refrigerants could, without compensating action by the manufacturer, reduce the efficiency of the A/C system (see discussion of the A/C Efficiency Credit below.) However, EPA believes that manufacturers will have substantial incentives to design their systems to maintain the efficiency of the A/C system, therefore EPA is not accounting for any potential efficiency degradation.

EPA requests comment on all aspects of our proposed A/C Leakage Credit system.

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

[144] Although *see* 71 FR 55140 (Sept. 21, 2006) (proposal pursuant to section 612 of the CAA finding CO_2 and HFC 152a as acceptable refrigerant substitutes as replacements for CFC–12 in motor vehicle air conditioning systems, and stating (at 55142) that ''data … indicate that use of CO_2 and HFC 152a with risk mitigation technologies does not pose greater risks compared to other substitutes'').

[145] For example, the GWP for R152a is 120, the GWP of HFO–1234yf is 4, and the GWP of CO_2 as a refrigerant is 1.

b. A/C Efficiency Credits

EPA is proposing that manufacturers that make improvements in their A/C systems to increase efficiency and thus reduce CO_2 emissions due to A/C system operation be eligible for A/C Efficiency Credits. As with A/C Leakage Credits, manufacturers could apply A/C Efficiency Credits toward compliance with their overall CO_2 standards.

As mentioned above, EPA estimates that the CO_2 emissions due to A/C related loads on the engine account for approximately 3.9% of total greenhouse gas emissions from passenger vehicles in the United States. Usage of A/C systems is inherently higher in hotter and more humid months and climates; however, vehicle owners may use their A/C systems all year round in all parts of the nation. For example, people commonly use A/C systems to cool and dehumidify the cabin air for passenger comfort on hot humid days, but they also use the systems to de-humidify cabin air to assist in defogging/de-icing the front windshield and side glass in cooler weather conditions for improved visibility. A more detailed discussion of seasonal and geographical A/C usage rates can be found in the DRIA.

Most of the additional load on the engine from A/C system operation comes from the compressor, which pumps the refrigerant around the system loop. Significant additional load on the engine may also come from electric or hydraulic fans, which are used to move air across the condenser, and from the electric blower, which is used to move air across the evaporator and into the cabin. Manufacturers have several currently-existing technology options for improving efficiency, including more efficient compressors, fans, and motors, and systems controls that avoid over-chilling the air (and subsequently re-heating it to provide the desired air temperature with an associated loss of efficiency). For vehicles equipped with automatic climate-control systems, real-time adjustment of several aspects of the overall system (such as engaging the full capacity of the cooling system only when it is needed, and maximizing the use of recirculated air) can result in improved efficiency. Table III.C.1–1 below lists some of these technologies and their respective efficiency improvements.

As with the A/C Leakage Credit program, EPA is interested in performance-based standards (or credits) based on measurement procedures whenever possible. While design-based assessments of expected emissions can be a reasonably robust way of quantifying emission improvements, these approaches have inherent shortcomings, as discussed for the case of A/C leakage above. Design-based approaches depend on the quality of the data from which they are calibrated, and it is possible that apparently proper equipment may function less effectively than expected. Therefore, while the proposal uses a design-based menu approach to quantify improvements in A/C efficiency, it is also proposed to begin requiring manufacturers to confirm that technologies applying for Efficiency Credits are measurably improving system efficiency.

EPA believes that there is a more critical need for a test procedure to quantify A/C Efficiency Credits than for Leakage Credits, for two reasons. First, the efficiency gains for various technologies are more difficult to quantify using a design-based program (like the SAEJ2727-based procedure used to generate Leakage Credits). Second, while leakage may disappear as a significant source of GHG emissions if a shift toward alternate refrigerants develops, no parallel factor exists in the case of efficiency improvements. EPA is thus proposing to phase-in a performance-based test procedure over time beginning in 2014, as discussed below. In the interim, EPA proposes a design-based ''menu'' approach for estimating efficiency improvements and, thus, quantifying A/C Efficiency Credits.

For model years 2012 and 2013, EPA proposes that a manufacturer wishing to generate A/C Efficiency Credits for a group of its vehicles with similar A/C systems would compare several of its vehicle A/C-related components and systems with a ''menu'' of efficiency-related technology improvements (*see* Table III.C.1–1 below). Based on the technologies the manufacturer chooses, an A/C Efficiency Credit value would be established. This design-based approach would recognize the relationships and synergies among efficiency-related technologies. Manufacturers could receive credit based on the technologies they chose to incorporate in their A/C systems and the associated credit value for each technology. The total A/C Efficiency Credit would be the total of these values, up to a maximum feasible credit of 5.7 g/mi CO_2eq. This would be the maximum improvement from current average efficiencies for A/C systems (see the DRIA for a full discussion of our derivation of the proposed reductions and credit values for individual technologies and for the maximum total credit available). Although the total of the individual technology credit values may exceed 5.7 g/mi CO_2eq, synergies among the technologies mean that the values are not additive, and thus A/C Efficiency credit could not exceed 5.7 g/mi CO_2eq.

The EPA requests comment on adjusting the A/C efficiency credit to account for potential decreases (or increases) in efficiency when using an alternative refrigerant by using the change in the coefficient of performance. The effects may include the impact of a secondary loop system (including the incremental effect on tailpipe CO_2 emissions that the added weight of such a system would incur).

TABLE III.C.1–1 EFFICIENCY-IMPROVING A/C TECHNOLOGIES AND CREDITS

Technology description	Estimated reduction in A/C CO_2 emissions (percent)	A/C Efficiency credit (g/mi CO_2)
Reduced reheat, with externally-controlled, variable-displacement compressor	30	1.7
Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable-displacement compressor	20	1.1
Default to recirculated air whenever ambient temperature is greater than 75 °F	30	1.7
Blower motor and cooling fan controls which limit waste energy (*e.g.* pulse width modulated power controller)	15	0.9
Electronic expansion valve	20	1.1
Improved evaporators and condensers (with system analysis on each component indicating a COP improvement greater than 10%, when compared to previous design)	20	1.1
Oil Separator	10	0.6

For model years 2014 and later, EPA proposes that manufacturers seeking to generate A/C Efficiency Credits would need to use a specific performance test to confirm that the design changes were also improving A/C efficiency. Manufacturers would need to perform an A/C CO_2 Idle Test for each A/C system (family) for which it desired to generate Efficiency Credits. Manufacturers would need to demonstrate at least a 30% improvement over current average efficiency levels to qualify for credits. Upon qualifying on the Idle Test, the manufacturer would be eligible to use the menu approach above to quantify the credits it would earn.

The proposed A/C CO_2 Idle Test procedure, which EPA has designed specifically to measure A/C CO_2 emissions, would be performed while the vehicle engine is at idle. This proposed laboratory idle test would be similar to the idle carbon monoxide (CO) test that was once a part of EPA vehicle certification. The test would determine the additional CO_2 generated at idle when the A/C system is operated. The A/C CO_2 Idle Test would be run with and without the A/C system cooling the interior cabin while the vehicle's engine is operating at idle and with the system under complete control of the engine and climate control system

The proposed A/C CO_2 Idle Test is similar to that proposed in April 2009 for the Mandatory GHG Reporting Rule, with several improvements. These improvements include tighter restrictions on test cell temperatures and humidity levels in order to more closely control the loads from operation of the A/C system. EPA also made additional refinements to the required in-vehicle blower fan settings for manually controlled systems to more closely represent ''real world'' usage patterns. These details can be found in the DRIA and the regulations.

The design of the A/C CO_2 Idle Test represents a balancing of the need for performance tests whenever possible to ensure the most accurate quantification of efficiency improvements, with practical concerns for testing burden and facility requirements. EPA believes that the proposed Idle Test adds to the robust quantification of A/C credits that will result in real-world efficiency improvements and reductions in A/C-related CO_2 emissions. EPA is proposing that the Idle Test be required in order to qualify for A/C Efficiency Credits beginning in 2014 to allow sufficient time for manufacturers to make the necessary facilities improvements and to establish a comfort level with the test.

EPA also considered a more comprehensive testing approach to quantifying A/C CO_2 emissions that could be somewhat more technically robust, but would require more test time and test facility improvements for many manufacturers. This approach would be to adapt an existing test procedure, the Supplemental Federal Test Procedure (SFTP) for A/C operation, called the SC03, in specific ways for it to function as a tool to evaluate A/C CO_2 emissions. The potential test method is described in some detail here, and EPA encourages comment on how this type of test might or might not accomplish the goals of robust performance-based testing and reasonable test burdens.

EPA designed the SC03 test to measure criteria pollutants under severe air conditioning conditions not represented in the FTP and Highway Fuel Economy Tests. EPA did not specifically design the SC03 to measure incremental reductions in CO_2 emissions from more efficient A/C technologies. For example, due to the severity of the SC03 test environmental conditions and the relatively short duration of the SC03 cycle, it is difficult for the A/C system to achieve a stabilized interior cabin condition that reflects incremental improvements. Many potential efficiency improvements in the A/C components and controls (*i.e.*, automatic recirculation and heat exchanger fan control) are specifically measured only during stabilized conditions, and therefore become difficult or impossible to measure and quantify during this test. In addition, SC03 testing is also somewhat constrained and costly due to limited number of test facilities currently capable of performing testing under the required environmental conditions.

One value of using the SC03 as the basis for a new test to quantify A/C-related efficiency improvements would be the significant degree of control of test cell ambient conditions. The load placed on an A/C system, and thus the incremental CO_2 emissions, are highly dependent on the ambient conditions in the test cell, especially temperature and humidity, as well as simulated solar load. Thus, as with the proposed Idle Test, a new SC03-based test would need to accurately and reliably control these conditions. (This contrasts with FTP testing for criteria pollutants, which does not require precise control of cell conditions because test results are generally much less sensitive to changes in cell temperature or humidity).

However, for the purpose of quantifying A/C system efficiency improvements, EPA believes a test cell temperature less severe than the 95°F required by the SC03 would be appropriate. A cell temperature of 85°F would better align the initial cooling phase (''pull-down'') as well as the stabilized phase of A/C operation with real-world driving conditions.

Another value of an SC03-based test would be the opportunity to create operating conditions for vehicle A/C systems that in some ways would better simulate ''real world'' operation than either the proposed Idle Test or the current SC03. The SC03 test cycle, roughly 10 minutes in length, has a similar average speed, maximum speed, and percentage of time at idle as the FTP. However, since the SC03 test cycle was designed principally to measure criteria pollutants under maximum A/C load conditions, it is not long enough to allow temperatures in the passenger cabin to consistently stabilize. EPA believes that once the pull-down phase has occurred and cabin temperatures have dropped dramatically to a suitable interior comfort level, additional test cycle time would be needed to measure how efficiently the A/C system operates under stabilized conditions.

To capture the A/C operation during stabilized operation, EPA would consider adding two phases to the SC03 test of roughly 10 minutes each. Each additional phase would simply be repeats of the SC03 drive cycle, with two exceptions. During the second phase, the A/C system would now be operating at cabin temperature at or approaching a stabilized condition. During the third phase, the A/C system would be turned off. The purpose of the third phase would be to establish the base CO_2 emissions with no A/C loads on the engine, which would provide a baseline for the incremental CO_2 due to A/C use. EPA would likely weight the CO_2 g/mi results for the first and second phases of the test as follows: 50% for phase 1, and 50% for phase 2. From this average CO_2 the methodology would subtract the CO_2 result from phase 3, yielding an incremental CO_2 (in g/mi) due to A/C use.

EPA expects to continue working with industry, the California Air Resources Board, and other stakeholders to move toward increasingly robust performance tests for A/C and may include such changes in this final rule. EPA requests comment on all aspects of our proposed A/C Efficiency Credits program.

c. Interaction With Title VI Refrigerant Regulations

Title VI of the Clean Air Act deals with the protection of stratospheric ozone. Section 608 establishes a comprehensive program to limit emissions of certain ozone-depleting substances (ODS). The rules promulgated under section 608 regulate the use and disposal of such substances during the service, repair or disposal of appliances and industrial process refrigeration. In addition, section 608 and the regulations promulgated under it, prohibit knowingly venting or releasing ODS during the course of maintaining, servicing, repairing or disposing of an appliance or industrial process refrigeration equipment. Section 609 governs the servicing of motor vehicle air conditioners (MVACs). The regulations promulgated under section 609 (40 CFR part 82, subpart B) establish standards and requirements regarding the servicing of MVACs. These regulations include establishing standards for equipment that recovers and recycles or only recovers refrigerant (CFC–12, HFC 134a, and for blends only recovers) from MVACs; requiring technician training and certification by an EPA-approved organization; establishing recordkeeping requirements; imposing sales restrictions; and prohibiting the venting of refrigerants. Section 612 requires EPA to review substitutes for class I and class II ozone depleting substances and to consider whether such substitutes will cause an adverse effect to human health or the environment as compared with other substitutes that are currently or potentially available. EPA promulgated regulations for this program in 1992 and those regulations are located at 40 CFR part 82, subpart G. When reviewing substitutes, in addition to finding them acceptable or unacceptable, EPA may also find them acceptable so long as the user meets certain use conditions. For example, all motor vehicle air conditioning system must have unique fittings and a uniquely colored label for the refrigerant being used in the system.

EPA views this proposed rule as complementing these Title VI programs, and not conflicting with them. To the extent that manufacturers choose to reduce refrigerant leakage in order to earn A/C Leakage Credits, this would dovetail with the Title VI section 609 standards which apply to maintenance events, and to end-of-vehicle life disposal. In fact, as noted, a benefit of the proposed A/C credit provisions is that there should be fewer and less impactive maintenance events for MVACs, since there will be less leakage. In addition, the credit provisions would not conflict (or overlap) with the Title VI section 609 standards. EPA also believes the menu of leak control technologies proposed today would complement the section 612 requirements, because these control technologies would help ensure that R134a (or other refrigerants) would be used in a manner that further minimizes potential adverse effects on human health and the environment.

2. Flex Fuel and Alternative Fuel Vehicle Credits

As described in this section, EPA is proposing credits for flexible-fuel vehicles (FFVs) and alternative fuel vehicles starting in the 2012 model year. FFVs are vehicles that can run both on an alternative fuel and conventional fuel. Most FFVs are E–85 vehicles, which can run on a mixture of up to 85 percent ethanol and gasoline. Dedicated alternative fuel vehicles are vehicles that run exclusively on an alternative fuel (*e.g.*, compressed natural gas). EPCA includes an incentive under the CAFE program for production of dual-fueled vehicles or FFVs, and dedicated alternative fuel vehicles.[146] EPCA's provisions were amended by the EISA to extend the period of availability of the FFV credits, but to begin phasing them out by annually reducing the amount of FFV credits that can be used in demonstrating compliance with the CAFE standards.[147] EPCA does not premise the availability of the FFV credits on actual use of alternative fuel. Under EPCA, after MY 2019 no FFV credits will be available for CAFE compliance.[148] Under EPCA, for dedicated alternative fuel vehicles, there are no limits or phase-out. EPA is proposing that FFV and Alternative Fuel Vehicle Credits be calculated as a part of the calculation of a manufacturer's overall fleet average fuel economy and fleet average carbon-related exhaust emissions (§ 600.510–12).

EPA is not proposing to include electric vehicles (EVs) or plug-in hybrid electric vehicles (PHEVs) in these flex fuel and alternative fuel provisions. These vehicles would be covered by the proposed advanced technology vehicle credits provisions described in Section III.C.3, so including them here would lead to a double counting of credits.

a. Model Year 2012—2015 Credits

i. FFVs

For the GHG program, EPA is proposing to allow FFV credits corresponding to the amounts allowed by the amended EPCA only during the period from MYs 2012 to 2015. (As discussed below in Section III.E., EPA is proposing that CAFE-based FFV credits would not be permitted as part of the early credits program.) Several manufacturers have already taken the availability of FFV credits into account in their near-term future planning for CAFE and this reliance indicates that these credits need to be considered in considering adequacy of lead time for the CO_2 standards. EPA thus believes that allowing these credits, in the near term, would help provide adequate lead time for manufacturers to implement the new multi-year standards, but that for the longer term there is adequate lead time without the use of such credits. This will also tend to harmonize the GHG and the CAFE program during these interim years. As discussed below, EPA is proposing for MY 2016 and later that manufacturers would not receive FFV credits unless they reliably estimate the extent the alternative fuel is actually being used by vehicles in order to count the alternative fuel use in the vehicle's CO_2 emissions level determination.

As with the CAFE program, EPA proposes to base credits on the assumption that the vehicles would operate 50% of the time on the alternative fuel and 50% of the time on conventional fuel, resulting in CO_2 emissions that are based on an arithmetic average of alternative fuel and conventional fuel CO_2 emissions.[149] The measured CO_2 emissions on the alternative fuel would be multiplied by a 0.15 volumetric conversion factor which is included in the CAFE calculation as provided by EPCA. Through this mechanism a gallon of alternative fuel is deemed to contain 0.15 gallons of fuel. EPA is proposing to take the same approach for 2012–2015 model years. For example, for a flexible-fuel vehicle that emitted 330 g/mi CO_2 operating on E–85 and 350 g/mi CO_2 operating on gasoline, the resulting CO_2 level to be used in the manufacturer's fleet average calculation would be:

$$CO_2 = \frac{\left[(330 \times 0.15) + 350\right]}{2} = 199.8\ g/mi$$

EPA understands that by using the CAFE approach—including the 0.15 factor—the CO_2 emissions value for the vehicle is calculated to be significantly lower than it actually would be otherwise, even if the vehicle were assumed to operate on the alternative fuel at all times. This represents a ''credit'' being provided to FFVs.

[146] 49 U.S.C 32905.

[147] *See* 49 U.S.C 32906. The mechanism by which EPCA provides an incentive for production of FFVs is by specifying that their fuel economy is determined using a special calculation procedure that results in those vehicles being assigned a higher fuel economy level than would otherwise occur. 49 U.S.C. section 32905(b). This is typically referred to as an FFV credit.

[148] 49 U.S.C 32906.

[149] 49 U.S.C 32905 (b).

EPA notes also that the above equation and example are based on an FFV that is an E–85 vehicle. EPCA, as amended by EISA, also establishes the use of this approach, including the 0.15 factor, for all alternative fuels, not just E–85.[150] The 0.15 factor is used for B–20 (20 percent biofuel and 80 percent diesel) FFVs. EPCA also establishes this approach, including the 0.15 factor, for gaseous-fueled FFVs such as a vehicle able to operate on gasoline and CNG.[151] (For natural gas FFVs, EPCA establishes a factor of 0.823 gallons of fuel for every 100 cubic feet a natural gas used to calculate a gallons equivalent.)[152] The EISA statute's use of the 0.15 factor in this way provides a similar regulatory treatment across the various types of alternative fuel vehicles. EPA also proposes to use the 0.15 factor for all FFVs in keeping with the goal of not disrupting manufacturers' near-term compliance planning. EPA, in any case, expects the vast majority of FFVs to be E–85 vehicles, as is the case today.

The FFV credit limits for CAFE are 1.2 mpg for model years 2012–2014 and 1.0 mpg for model year 2015.[153] In CO_2 terms, these CAFE limits translate to declining CO_2 credit limits over the four model years, as the CAFE standards increase in stringency (as the CAFE standard increases numerically, the limit becomes a smaller fraction of the standard). EPA proposes credit limits shown in Table III.C.2–1 based on the proposed average CO_2 standards for cars and trucks. These have been calculated by comparing the average proposed CAFE standards with and without the FFV credits, converted to CO_2. EPA requests comments on this proposed approach.

TABLE III.C.2–1—FFV CO_2 STANDARD CREDIT LIMITS (G/MILE)

Model year	Cars	Trucks
2012	9.8	17.9
2013	9.3	17.1
2014	8.9	16.3
2015	6.9	12.6

EPA also requests comments on basing the calculated CO_2 credit limit on the individual manufacturer standards calculated from the footprint curves. For example, if a manufacturer's 2012 car standard was 260 g/mile, the credit limit in CO_2 terms would be 9.5 g/mile and if it were 270 g/mile the limit would be 10.2 g/mile. This approach would be somewhat more complex and would mean that the FFV CO_2 credit limits would vary by manufacturer as their footprint based standards vary. However, it would more closely track CAFE FFV credit limits.

ii. Dedicated Alternative Fuel Vehicles

EPA proposes to calculate CO_2 emissions from dedicated alternative fuel vehicles for MY 2012—2015 by measuring the CO_2 emissions over the test procedure and multiplying the results by the 0.15 conversion factor described above. For example, for a dedicated alternative fuel vehicle that would achieve 330 g/mi CO_2 while operating on alcohol (ethanol or methanol), the effective CO_2 emissions of the vehicle for use in determining the vehicle's CO_2) emissions would be calculated as follows:

$$CO_2 = 330 \times 0.15 = 49.5 \text{ g/mi}$$

b. Model Years 2016 and Later

i. FFVs

For 2016 and later model years, EPA proposes to treat FFVs similarly to conventional fueled vehicles in that FFV emissions would be based on actual CO_2 results from emission testing on the alternative fuel. The manufacturer would also be required to demonstrate that the alternative fuel is actually being used in the vehicles. The manufacturer would need to establish the ratio of operation that is on the alternative fuel compared to the conventional fuel. The ratio would be used to weight the CO_2 emissions performance over the 2-cycle test on the two fuels. The 0.15 conversion factor would no longer be included in the CO_2 emissions calculation. For example, for a flexible-fuel vehicle that emitted 300 g/mi CO_2 operating on E–85 ten percent of the time and 350 g/mi CO_2 operating on gasoline ninety percent of the time, the CO_2 emissions for the vehicles to be used in the manufacturer's fleet average would be calculated as follows:

$$CO_2 = (300 \times 0.10) + (350 \times 0.90) = 345 \text{ g/mi}$$

The most complex part of this approach is to establish what data are needed for a manufacturer to accurately demonstrate use of the alternative fuel. One option EPA is considering is establishing a rebuttable presumption using a ''top-down'' approach based on national E–85 fuel use to assign credits to FFVs sold by manufacturers under this program. For example, national E–85 volumes and national FFV sales could be used to prorate E–85 use by manufacturer sales volumes and FFVs already in-use. EPA would conduct an analysis of vehicle miles travelled (VMT) by year for all FFVs using its emissions inventory MOVES model. Using the VMT ratios and the overall E–85 sales, E–85 usage could be assigned to each vehicle. This method would account for the VMT of new FFVs and FFVs already in the existing fleet using VMT data in the model. The model could then be used to determine the ratio of E–85 and gasoline for new vehicles being sold. Fluctuations in E–85 sales and FFV sales would be taken into account to adjust the credits annually. EPA believes this is a reasonable way to apportion E–85 use across the fleet.

If manufacturers decided not to use EPA's assigned credits based on the top-down analysis, they would have a second option of presenting their own data for consideration as the basis for credits. Manufacturers have suggested demonstrations using vehicle on-board data gathering through the use of on-board sensors and computers. California's program allows FFV credits based on FFV use and envisioned manufacturers collecting fuel use data from vehicles in fleets with on-site refueling. Any approach must reasonably ensure that no CO_2 emissions reductions anticipated under the program are lost.

EPA proposes that manufacturers would need to present a statistical analysis of alternative fuel usage data collected on actual vehicle operation. EPA is not attempting to specify how the data is collected or the amount of data needed. However, the analysis must be based on sound statistical methodology. Uncertainty in the analysis must be accounted for in a way that provides reasonable certainty that the program does not result in loss of emissions reductions. EPA requests comment on how this demonstration could reasonably be made.

EPA recognizes that under EPCA FFV credits are entirely phased-out of the CAFE program by MY 2020, and apply in the prior years with certain limitations, but without a requirement that the manufacturers demonstrate actual use of the alternative fuel. Under this proposal EPA would treat FFV credits the same as under EPCA for model years 2012–2015, but would apply a different approach starting with model year 2016. Unlike EPCA, CAA section 202(a) does not mandate that EPA treat FFVs in a specific way. Instead EPA is required to exercise its own judgment and determine an appropriate approach that best promotes the goals of this CAA section. Under these circumstances, EPA proposes to treat FFVs for model years 2012–2015 the same as under EPCA, for the lead time reasons described above. Starting

[150] 49 U.S.C 32905 (c).

[151] 49 U.S.C 32905 (d).

[152] 49 U.S.C section 32905 (c).

[153] 49 U.S.C section 32906 (a).

with model year 2016, EPA believes the appropriate approach is to ensure that emissions reduction credits are based upon a demonstration that emissions reductions have been achieved, to ensure the credits are for real reductions instead of reductions that have not likely occurred. This will promote the environmental goals of this proposal. At the same time, the ability to generate credits upon a demonstration of usage of the alternative fuel will provide an actual incentive to see that such fuels are used. Under the EPCA credit provision, there is an incentive to produce FFVs but no actual incentive to ensure that the alternative fuels are used. GHG and energy security benefits are only achieved if the alternative fuel is actually used, and EPA's approach will now provide such an incentive. This approach will promote greater use of renewable fuels, as compared to a situation where there is a credit but no usage requirement. This is also consistent with the agency's overall commitment to the expanded use of renewable fuels. Therefore EPA is not proposing to phase-out the FFV program for MYs 2016 and later but instead to base the program on real-world reductions (*i.e.*, actual vehicle CO_2 emissions levels based on actual use of the two fuels, without the 0.15 conversion factor specified under EISA). Based on existing certification data, E–85 FFV CO_2 emissions are typically about 5 percent lower on E–85 than CO_2 emissions on 100 percent gasoline. However, currently there is little incentive to optimize CO_2 performance for vehicles when running on E–85. EPA believes the above approach would provide such an incentive to manufacturers and that E–85 vehicles could be optimized through engine redesign and calibration to provide additional CO_2 reductions. EPA requests comments on the above.

ii. Dedicated Alternative Fuel Vehicles

EPA proposes that for model years 2016 and later dedicated alternative fuel vehicles, CO_2 would be measured over the 2-cycle test in order to be included in a manufacturer's fleet average CO_2 calculations. As noted above, this is different than CAFE methodology which provides a methodology for calculating a petroleum-based mpg equivalent for alternative fuel vehicles so they can be included in CAFE. However, because CO_2 can be measured directly from alternative fuel vehicles over the test procedure, EPA believes this is the simplest and best approach since it is consistent with all other vehicle testing under the proposed CO_2 program.

3. Advanced Technology Vehicle Credits for Electric Vehicles, Plug-in Hybrids, and Fuel Cells

EPA is proposing additional credit opportunities to encourage the early commercialization of advanced vehicle powertrains, including electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles. These technologies have the potential for more significant reductions of GHG emissions than any technology currently in commercial use, and EPA believes that encouraging early introduction of such technologies will help to enable their wider use in the future, promoting the technology-based emission reduction goals of section 202(a)(1) of the Clean Air Act.

EPA proposes that these advanced technology credits would take the form of a multiplier that would be applied to the number of vehicles sold such that they would count as more than one vehicle in the manufacturer's fleet average. These advanced technology vehicles would then count more heavily when calculating fleet average CO_2 levels. The multiplier would not be applied when calculating the manufacturer's foot-print-based standard, only when calculating the manufacturer's fleet average levels. EPA proposes to use a multiplier in the range of 1.2 to 2.0 for all EVs, PHEVs, and fuel cell vehicles produced from MY 2012 through MY 2016. EPA proposes that starting in MY 2017, the multiplier would no longer be used. As described in Section III.C.5, EPA is also proposing to allow early advanced technology vehicle credits to be generated for model years 2009–2011. EPA requests comment on the level of the multiplier and whether it should be the same value for each of these three technologies. Further, if EPA determines that a multiplier of 2.0, or another level near the higher end of this range, is appropriate for the final rule, EPA requests comment on whether the multiplier should be phased down over time, such as: 2.0 for MY 2009 through MY 2012, 1.8 in MY 2013, 1.6 in MY 2014, 1.4 in MY 2015, and 1.2 in MY 2016 (*i.e.*, the multiplier could phase-down by 0.2 per year). In addition, EPA requests comment on whether or not it would be appropriate to differentiate between EVs and PHEVs for advanced technology credits. Under such an approach, PHEVs could be provided a lesser multiplier compare to EVs. Also, the PHEV multiplier could be prorated based on the equivalent electric range (*i.e.*, the extent to which the PHEV operates on average as an EV) of the vehicle in order to incentivize battery technology development. This approach would give more credits to ''stronger'' PHEV technology.

EPA has provided this type of credit previously, in the Tier 2 program. This approach provides an incentive for manufacturers to prove out ultra-clean technology during the early years of the program. In Tier 2, early credits for Tier 2 vehicles certified to the very cleanest bins (equivalent to California's standards for super ultra low emissions vehicles (SULEVs) and zero emissions vehicles (ZEVs)) had a multiplier of 1.5 or 2.0.[154] The multiplier range of 1.2 to 2.0 being proposed for GHGs is consistent with the Tier 2 approach. EPA believes it is appropriate to provide incentives to manufacturers to produce vehicles with very low emissions levels and that these incentives may help pave the way for greater and/or more cost effective emission reductions from future vehicles. EPA would like to finalize an approach which appropriately balances the benefits of encouraging advanced technologies with the overall environmental reductions of the proposed standards as a whole.

As with other vehicles, CO_2 for these vehicles would be determined as part of vehicle certification, based on emissions over the 2-cycle test procedures, to be included in the fleet average CO_2 levels.

For electric vehicles, EPA proposes that manufacturers would include them in the average with CO_2 emissions of zero grams/mile both for early credits, and for the MY 2012–2016 time frame. Similarly, EPA proposes to include as zero grams/mile of CO_2 the electric portion of PHEVs (*i.e.,* when PHEVs are operating as electric vehicles) and fuel cell vehicles. EPA recognizes that for each EV that is sold, in reality the total emissions off-set relative to the typical gasoline or diesel powered vehicle is not zero, as there is a corresponding increase in upstream CO_2 emissions due to an increase in the requirements for electric utility generation. However, for the time frame of this proposed rule, EPA is also interested in promoting very advanced technologies such as EVs which offer the future promise of significant reductions in GHG emissions, in particular when coupled with a broader context which would include reductions from the electricity generation. For the California Paley 1 program, California assigned EVs a CO_2 performance value of 130 g/mile, which was intended to represent the average CO_2 emissions required to charge an EV using representative CO_2 values for the California electric utility grid. For this

[154] *See* 65 FR 6746, February 10, 2000.

proposal, EPA is assigning an EV a value of zero g/mile, which should be viewed as an interim solution for how to account for the emission reduction potential of this type of vehicle, and may not be the appropriate long-term approach. EPA requests comment on this proposal and whether alternative approaches to address EV emissions should be considered, including approaches for considering the lifecycle emissions from such advanced vehicle technologies.

The criteria and definitions for what vehicles qualify for the multiplier are provided in Section III.E. As described in Section III.E, EPA is proposing definitions for EVs, PHEVs, and fuel cell vehicles to ensure that only credible advanced technology vehicles are provided credits.

EPA requests comments on the proposed approach for advanced technology vehicle credits.

4. Off-Cycle Technology Credits

EPA is proposing an optional credit opportunity intended to apply to new and innovative technologies that reduce vehicle CO_2 emissions, but for which the CO_2 reduction benefits are not captured over the 2-cycle test procedure used to determine compliance with the fleet average standards (*i.e.,* ''off-cycle''). Eligible innovative technologies would be those that are relatively newly introduced in one or more vehicle models, but that are not yet implemented in widespread use in the light-duty fleet. EPA will not approve credits for technologies that are not innovative or novel approaches to reducing greenhouse gas emissions. Further, any credits for these off-cycle technologies must be based on real-world GHG reductions not captured on the current 2-cycle tests and verifiable test methods, and represent average U.S. driving conditions.

Similar to the technologies used to reduce A/C system indirect CO_2 emissions such as compressor efficiency improvements, eligible technologies would not be active during the 2-cycle test and therefore the associated improvements in CO_2 emissions would not be captured. EPA will not consider technologies to be eligible for these credits if the technology has a significant impact on CO_2 emissions over the FTP and HFET tests. Because these technologies are not nearly so well developed and understood, EPA is not prepared to require their utilization to meet the CO_2 standards. However, EPA is aware of some emerging and innovative technologies and concepts in various stages of development with CO_2 reduction potential that might not be adequately captured on the FTP or HFET, and that some of these technologies might merit some additional CO_2 credit for the manufacturer. Examples include solar panels on hybrids or electric vehicles, adaptive cruise control, and active aerodynamics. EPA believes 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 this. This optional credit opportunity would be available through the 2016 model year.

EPA is proposing that manufacturers quantify CO_2 reductions associated with the use of the off-cycle technologies such that the credits could be applied on a g/mile equivalent basis, as is proposed for A/C system improvements. Credits would have to be based on real additional reductions of CO_2 emissions and would need to be quantifiable and verifiable with a repeatable methodology. Such submissions of data should be submitted to EPA subject to public scrutiny. EPA proposes 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.

As discussed below, EPA is proposing a two-tiered process for demonstrating the CO_2 reductions of an innovative and novel technology with benefits not captured by the FTP and HFET test procedures. First, a manufacturer would determine whether the benefit of the technology could be captured using the 5-cycle methodology currently used to determine fuel economy label values. 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. If this determination is affirmative, the manufacturer would follow the protocol laid out below and in the proposed regulations. If the manufacturer finds that the technology is such that the benefit is not adequately captured using the 5-cycle approach, then the manufacturer would have to develop a robust methodology, subject to EPA approval, to demonstrate the benefit and determine the appropriate CO_2 gram per mile credit.

a. Technology Demonstration Using EPA 5-Cycle Methodology

As noted above, the CO_2 reduction benefit of some innovative technologies could be demonstrated using the 5-cycle approach currently used for EPA's fuel economy labeling program. The 5-cycle methodology was finalized in EPA's 2006 fuel economy labeling rule,[155] which provides a more accurate fuel economy label estimate to consumers starting with 2008 model year vehicles. In addition to the FTP and HFET test procedures, the 5-cycle approach folds in the test results from three additional test procedures to determine fuel economy. The additional test cycles include cold temperature operation, high temperature, high humidity and solar loading, and aggressive and high-speed driving; thus these tests could be used to demonstrate the benefit of a technology that reduces CO_2 over these types of driving and environmental conditions. Using the test results from these additional test cycles collectively with the 2-cycle data provides a more precise estimate of the average fuel economy and CO_2 emissions of a vehicle for both the city and highway independently. A significant benefit of using the 5-cycle methodology to measure and quantify the CO_2 reductions is that the test cycles are properly weighted for the expected average U.S. operation, meaning that the test results could be used without further adjustments.

The use of these supplemental cycles may provide a method by which technologies not demonstrated on the baseline 2-cycles can be quantified. The cold temperature FTP can capture new technologies that improve the CO_2 performance of vehicles during colder weather operation. These improvements may be related to warm-up of the engine or other operation during the colder temperature. An example of such a new, innovative technology is a waste heat capture device that provides heat to the cabin interior, enabling additional engine-off operation during colder weather not previously enabled due to heating and defrosting requirements. The additional engine-off time would result in additional CO_2 reductions that otherwise would not have been realized without the heat capture technology.

While A/C credits for efficiency improvements will largely be captured in the A/C credits proposal through the credit menu of known efficiency improving components and controls,

[155] Fuel Economy Labeling of Motor Vehicles: Revisions to Improve Calculation of Fuel Economy Estimates; Final Rule (71 FR 77872, December 27, 2006).

certain new technologies may be able to use the high temperatures, humidity, and solar load of the SC03 test cycle to accurately measure their impact. An example of a new technology may be a refrigerant storage device that accumulates pressurized refrigerant during driving operation or uses recovered vehicle kinetic energy during deceleration to pressurize the refrigerant. Much like the waste heat capture device used in cold weather, this device would also allow additional engine-off operation while maintaining appropriate vehicle interior occupant comfort levels. SC03 test data measuring the relative impact of innovative A/C-related technologies could be applied to the 5-cycle equation to quantify the CO_2 reductions of the technology. Another example is glazed windows. This reflects sunlight away from the cabin so that the energy required to stabilize the cabin air to a comfortable level is decreased. The impact of these windows may be measureable on an SC03 test (with and without the window option).

The US06 cycle may be used to capture innovative technologies designed to reduce CO_2 emissions during higher speed and more aggressive acceleration conditions, but not reflected on the 2-cycle tests. An example of this is an active aerodynamic technology. This technology recognizes the benefits of reduced aerodynamic drag at higher speeds and makes changes to the vehicle at those speeds. The changes may include active front or grill air deflection devices designed to redirect frontal airflow. Certain active suspension devices designed primarily to reduce aerodynamic drag by lowering the vehicle at higher speeds may also be measured on the US06 cycle. To properly measure these technologies on the US06, the vehicle would require unique load coefficients with and without the technologies. The different load coefficient (properly weighted for the US06 cycle) could effectively result in reduced vehicle loads at the higher speeds when the technologies are active. Similar to the previously discussed cycles, the results from the US06 test with and without the technology could then use the 5-cycle methodology to quantify CO_2 reductions.

If the 5-cycle procedures can be used to demonstrate the innovative technology, then the process would be relatively simple. The manufacturer would simply test vehicles with and without the technology installed or operating and compare results. All 5-cycles would be tested with the technology enabled and disabled, and the test results would be used to calculate a combined city/highway CO_2 value with the technology and without the technology. These values would be compared to determine the amount of the credit; the combined city/highway CO_2 value with the technology operating would be subtracted from the combined city/highway CO_2 value without the technology operating to determine the gram per mile CO_2 credit. It is likely that multiple tests of each of the five test procedures would need to be performed in order to achieve the necessary strong degree of statistical significance of the credit determination results. This would have to be done for each model type for which a credit was being sought, unless the manufacturer could demonstrate that the impact of the technology was independent of the vehicle configuration on which it was installed. In this case, EPA may consider allowing the test to be performed on an engine family basis or other grouping. At the end of the model year, the manufacturer would determine the number of vehicles produced subject to each credit amount and report that to EPA in the final model year report. The gram per mile credit value determined with the 5-cycle comparison testing would be multiplied by the total production of vehicles subject to that value to determine the total number of credits.

b. Alternative Off-Cycle Credit Methodologies

In cases where the benefit of a technological approach to reducing CO_2 emissions can not be adequately represented using existing test cycles, EPA will work with and advise manufacturers in developing test procedures and analytical approaches to estimate the effectiveness of the technology for the purpose of generating credits. Clearly the first step should be a thorough assessment of whether the 5-cycle approach can be used, but if the manufacturer finds that the 5-cycle process is fundamentally inadequate for the specific technology being considered by the manufacturer, then an alternative approach may be developed and submitted to EPA for approval. The demonstration program should be robust, verifiable, and capable of demonstrating the real-world emissions benefit of the technology with strong statistical significance.

The CO_2 benefit of some technologies may be able to be demonstrated with a modeling approach, using engineering principles. An example would be where a roof solar panel is used to charge the on-board vehicle battery. The amount of potential electrical power that the panel could supply could be modeled for average U.S. conditions and the units of electrical power translated to equivalent fuel energy or annualized CO_2 emission rate reduction from the captured solar energy. The CO_2 reductions from other technologies may be more challenging to quantify, especially if they are interactive with the driver, geographic location, environmental condition, or other aspect related to operation on actual roads. In these cases, manufacturers might have to design extensive on-road test programs. Any such on-road testing programs would need to be statistically robust and based on average U.S. driving conditions, factoring in differences in geography, climate, and driving behavior across the U.S.

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. EPA 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 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 review and approval. EPA believes that 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 credits.

EPA requests comments on the proposed approach for off-cycle emissions credits, including comments on how best to structure the program. EPA particularly requests 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 manufacturer's proposed test methods.

5. Early Credit Options

EPA is proposing to allow manufacturers to generate early credits in model years 2009–2011. As described below, credits could be generated through early additional fleet average CO_2 reductions, early A/C system improvements, early advanced technology vehicle credits, and early off-cycle credits. As with other credits, early credits would be subject to a five year carry-forward limit based on the model year in which they are generated. Early credits could also be transferred between vehicle categories (*e.g.,* between the car and truck fleet) or traded among manufacturers without limits. The agencies note that CAFE credits earned in MYs prior to MY 2011 will still be available to manufacturers for use in the CAFE program in accordance with applicable regulations.

EPA is not proposing certification, compliance, or in-use requirements for vehicles generating early credits. MY 2009 would be complete and MY 2010 would be well underway by the time the rule is promulgated. This would make certification, compliance, and in-use requirements unworkable. As discussed below, manufacturers would be required to submit an early credits report to EPA for approval no later than the time they submit their final CAFE report for MY 2011. This report would need to include details on all early credits the manufacturer generates, why the credits are bona fide, how they are quantified, and how they can be verified.

As a general principle, EPA believes these early credit programs must be designed in a way to ensure that they are capturing real-world reductions. In addition, EPA wants to ensure these credit programs do not provide an opportunity for manufacturers to earn ''windfall'' credits that do not result in actual, surplus CO_2 emission reductions. EPA seeks comments on how to best ensure these objectives are achieved in the design of the early credit program options.

a. Credits Based on Early Fleet Average CO_2 Reductions

EPA is proposing opportunities for early credit generation in MYs 2009–2011 through over-compliance with a fleet average CO_2 baseline established by EPA. EPA is proposing four pathways for doing so. Manufacturers would select one of the four paths for credit generation for the entire three year period and could not switch between pathways for different model years. For two pathways, the baseline would be set by EPA to be equivalent to the California standards for the relevant model year. Generally, manufacturers that over-comply with those CARB standards would earn credits. Two additional pathways, described below, would include credits based on over-compliance with CAFE standards in States that have not adopted the California standards.

Pathway 1 would be to earn credits by over-complying with the California equivalent baseline over the manufacturer's fleet of vehicles sold nationwide. Pathway 2 would be for manufacturers to generate credits against the baseline only for the fleet of vehicles sold in California and the CAA section 177 States.[156] This approach would include any CAA 177 States as of the date of promulgation of the Final Rule in this proceeding. Manufacturers would be required to include both cars and trucks in the program. Under Pathways 1 and 2, EPA proposes that manufacturers would be required to cover any deficits incurred against the baseline levels established by EPA during the three year period 2009–2011 before credits could be carried forward into the 2012 model year. For example, a deficit in 2011 would have to be subtracted from the sum of credits earned in 2009 and 2010 before any credits could be applied to 2012 (or later) model year fleets. EPA is proposing this provision to help ensure the early credits generated under this program are consistent with the credits available under the California program during these model years.

Table III.C.5–1 provides the California equivalent baselines EPA proposes to use as the basis for CO_2 credit generation under the California-based pathways. These are the California GHG standards for the model years shown, with a 2.0 g/mile adjustment to account for the exclusion of N_2O and CH_4, which are included in the California GHG standards, but not included in the credits program. Manufacturers would generate CO_2 credits by achieving fleet average CO_2 levels below these baselines. As shown in the table, the California-based early credit pathways are based on the California vehicle categories. Also, the California-based baseline levels are not footprint-based, but universal levels that all manufacturers would use. Manufacturers would need to achieve fleet levels below those shown in the table in order to earn credits.

TABLE III.C.5–1—CALIFORNIA EQUIVALENT BASELINES CO_2 EMISSIONS LEVELS FOR EARLY CREDIT GENERATION

Model year	Passenger cars and light trucks with an LVW of 0–3,750 lbs	Light trucks with a LVW of 3,751 or more and a GVWR of up to 8,500 lbs plus medium-duty passenger vehicles
2009	321	437
2010	299	418
2011	265	388

EPA proposes that manufacturers using Pathways 1 or 2 above would use year end car and truck sales in each category. Although production data is used for the program starting in 2012, EPA is proposing to use sales data for the early credits program in order to apportion vehicles by State. This is described further below. Manufacturers would calculate actual fleet average emissions over the appropriate vehicle fleet, either for vehicles sold nationwide for Pathway 1, or California plus 177 States sales for Pathway 2. Early CO_2 credits would be based on the difference between the baseline shown in the table above and the actual fleet average emissions level achieved. Any early A/C credits generated by the manufacturer, described below in Section III.C.5.b, would be included in the fleet average level determination. In model year 2009, the California CO_2 standards for cars (321 g/mi CO_2) are only slightly more stringent than the 2009 CAFE car standard of 27.5 mpg, which is approximately equivalent to 323 g/mi CO_2, and the California light-truck standard (437 g/mi CO_2) is less stringent than the equivalent CAFE standard, recognizing that there are some differences between the way the California program and the CAFE

[156] CAA 177 States refers to States that have adopted the California GHG standards. At present, there are thirteen CAA 177 States including New York, Massachusetts, Maryland, Vermont, Maine, Connecticut, Arizona, New Jersey, New Mexico, Oregon, Pennsylvania, Rhode Island, Washington, and Washington, DC.

program categorize vehicles. Under the proposed option, manufacturers would have to show that they over comply over the entire three model year time period, not just the 2009 model year, to generate early credits under either Pathways 1, 2 or 3. A manufacturer cannot use credits generated in model year 2009 unless they offset any debits from model years 2010 and 2011. EPA expects that the requirement to over comply over the entire time period covering these three model years should mean that the credits that are generated are real and are in excess of what would have otherwise occurred. However, because of the circumstances involving the 2009 model year, in particular for companies with significant truck sales, there is some concern that under Pathways 1, 2, and 3, there is a potential for a large number of credits generated in 2009 against the California standard, in particular for a number of companies who have significantly over-achieved on CAFE in recent model years. EPA wants to avoid a situation where, contrary to expectation, some part of the early credits generated by a manufacturer are in fact not excess, where companies could trade such credits to other manufacturers, risking a delay in the addition of new technology across the industry from the 2012 and later EPA CO_2 standards. For this reason, EPA requests comment on the merits of prohibiting the trading of model year 2009 generated early credits between firms.

In addition, for Pathways 1 and 2, EPA proposes that manufacturers may also include alternative compliance credits earned per the California alternative compliance program.[157] These alternative compliance credits are based on the demonstrated use of alternative fuels in flex fuel vehicles. As with the California program, the credits would be available beginning in MY 2010. Therefore, these early alternative compliance credits would be available under EPA's program for the 2010 and 2011 model years. FFVs would otherwise be included in the early credit fleet average based on their emissions on the conventional fuel. This would not apply to EVs and PHEVs. The emissions of EVs and PHEVs would be determined as described in Section III.E. Manufacturers could choose to either include their EVs and PHEVs in one of the four pathways described in this section or under the early advanced technology emissions credits described below, but not both due to issues of credit double counting.

EPA is also proposing two additional early credit pathways manufacturers could select. Pathways 3 and 4 incorporate credits based on over-compliance with CAFE standards for vehicles sold outside of California and CAA 177 States in MY 2009–2011. Pathway 3 would allow manufacturers to earn credits as under Pathway 2, plus earn CAFE-based credits in other States. Credits would not be generated for cars sold in California and CAA 177 States unless vehicle fleets in those States are performing better than the standards which otherwise would apply in those States, *i.e.* the baselines shown in Table III.C.5–1 above.

Pathway 4 would be for manufacturers choosing to forego California-based early credits entirely and earn only CAFE-based credits outside of California and CAA 177 States. EPA proposes that manufacturers would not be able to include FFV credits under the CAFE-based early credit pathways since those credits do not automatically reflect actual reductions in CO_2 emissions.

The proposed baselines for CAFE-based early pathways are provided in Table III.C.5–2 below. They are based on the CAFE standards for the 2009–2011 model years. For CAFE standards in 2009–2011 model years that are footprint-based, the baseline would vary by manufacturer. Footprint-based standards are in effect for the 2011 model year CAFE standards.[158] Additionally, for Reform CAFE truck standards, footprint standards are optional for the 2009–2010 model years. Where CAFE footprint-based standards are in effect, manufacturers would calculate a baseline using the footprints and sales of vehicles outside of California and CAA 177 States. The actual fleet CO_2 performance calculation would also only include the vehicles sold outside of California and CAA 177 States, and as mentioned above, may not include FFV credits.

TABLE III.C.5–2—CAFE EQUIVALENT BASELINES CO_2 EMISSIONS LEVELS FOR EARLY CREDIT GENERATION

Model year	Cars	Trucks
2009	323	381.*
2010	323	376.*
2011	Footprint-based standard	Footprint-based standard.

* Would be footprint-based standard for manufacturers selecting footprint option under CAFE.

For the CAFE-based pathways, EPA proposes to use the NHTSA car and truck definitions that are in place for the model year in which credits are being generated. EPA understands that the NHTSA definitions change starting in the 2011 model year, and would therefore change part way through the early credits program. EPA further recognizes that MDPVs are not part of the CAFE program until the 2011 model year, and therefore would not be part of the early credits calculations for 2009–2010 under the CAFE-based pathways.

Pathways 2 through 4 involve splitting the vehicle fleet into two groups, vehicles sold in California and CAA 177 States and vehicles sold outside of these States. This approach would require a clear accounting of location of vehicle sales by the manufacturer. EPA believes it will be reasonable for manufacturers to accurately track sales by State, based on its experience with the National Low Emissions Vehicle (NLEV) Program. NLEV required manufacturers to meet separate fleet average standards for vehicles sold in two different regions of the country.[159] As with NLEV, the determination would be based on where the completed vehicles are delivered as a point of first sale, which in most cases would be the dealer.[160]

As noted above, EPA proposes that manufacturers choosing to generate early credits would select one of the four pathways for the entire early credits program and would not be able to switch among them. EPA proposes that manufacturers would submit their early credits report when they submit their final CAFE report for MY 2011 (which is required to be submitted no

[157] *See* Section 6.6.E, California Environmental Protection Agency Air Resources Board, Staff Report: Initial Statement of Reasons For Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions From Motor Vehicles, August 6, 2004.

[158] 74 FR 14196, March 30, 2009.

[159] 62 FR 31211, June 6, 1997.

[160] 62 FR 31212, June 6, 1997.

later than 90 days after the end of the model year). Manufacturers would have until then to decide which pathway to select. This would give manufacturers enough time to determine which pathway works best for them. This timing may be necessary in cases where manufacturers earn credits in MY 2011 and need time to assess data and prepare an early credits submittal for final EPA approval.

The table below provides a summary of the four fleet average-based CO_2 early credit pathways EPA is proposing. As noted above, EPA is concerned with potential ''windfall'' credits and is seeking comments on how to best ensure the objective of achieving surplus, real-world reductions is achieved in the design of the credit programs. In addition, EPA requests comments on the merits of each of these pathways. Specifically, EPA requests comment on whether or not any of the pathways could be eliminated to simplify the program without diminishing its overall flexibility. For example, Pathway 2 may not be particularly useful to manufacturers if the California/177 State and overall national fleets are projected to be similar during these model years. EPA also requests comment on proposed program implementation structure and provisions.

TABLE III.C.5–3—SUMMARY OF PROPOSED EARLY FLEET AVERAGE CO_2 CREDIT PATHWAYS

Common Elements	—Manufacturers would select a pathway. Once selected, may not switch among pathways. —All credits subject to 5 year carry-forward restrictions. —For Pathways 2–4, vehicles apportioned by State based on point of first sale.
Pathway 1: California-based Credits for National Fleet.	—Manufacturers earn credits based on fleet average emissions compared with California equivalent baseline set by EPA. —Based on nationwide CO_2 sales-weighted fleet average. —Based on use of California vehicle categories. —FFV alternative compliance credits per California program may be included. —Once in the program, manufacturers must make up any deficits that are incurred prior to 2012 in order to carry credits forward to 2012 and later.
Pathway 2: California-based Credits for vehicles sold in California plus CAA 177 States.	—Same as Pathway 1, but manufacturers only includes vehicles sold in California and CAA 177 States in the fleet average calculation.
Pathway 3: Pathway 2 plus CAFE-based Credits outside of California plus CAA 177 States.	—Manufacturer earns credits as provided by Pathway 2: California-based credits for vehicles sold in California plus CAA 177 States, plus: —CAFE-based credits allowed for vehicles sold outside of California and CAA 177 States. —For CAFE-based credits, manufacturers earn credits based on fleet average emissions compared with baseline set by EPA. —CAFE-based credits based on NHTSA car and truck definitions. —FFV credits not allowed to be included for CAFE-based credits.
Pathway 4: Only CAFE-based Credits outside of California plus CAA 177 States.	—Manufacturer elects to only earn CAFE-based credits for vehicles sold outside of California and CAA 177 States. Earns no California and 177 State credits. —For CAFE-based credits, manufacturers earn credits based on fleet average emissions compared with baseline set by EPA. —CAFE-based credits based on NHTSA car and truck definitions. —FFV credits not allowed to be included for CAFE-based credits.

b. Early A/C Credits

EPA proposes that manufacturers could earn early A/C credits in MYs 2009–2011 using the same A/C system design-based EPA provisions being proposed for MYs commencing in 2012, as described in Section III.C.1, above. Manufacturers would be able to earn early A/C CO_2-equivalent credits by demonstrating improved A/C system performance, for both direct and indirect emissions. To earn credits for vehicles sold in California and CAA 177 States, the vehicles would need to be included in one of the California-based early credit pathways described above in III.C.5.a. EPA is proposing this constraint in order to avoid credit double counting with the California program in place in those States, which also allows A/C system credits in this time frame. Manufacturers would fold the A/C credits into the fleet average CO_2 calculations under the California-based pathway. For example, the MY 2009 California-based program car baseline would be 321 g/mile (see Table III.C.5–1). If a manufacturer under Pathway 1 had a MY 2009 car fleet average CO_2 level of 320 g/mile and then earned an additional 9 g/mile CO_2-equivalent A/C credit, the manufacturers would earn a total of 10 g/mile of credit. Vehicles sold outside of California and 177 States would be eligible for the early A/C credits whether or not the manufacturers participate in other aspects of the early credits program.

c. Early Advanced Technology Vehicle Credits

EPA is proposing to allow early advanced technology vehicle credits for sales of EVs, PHEVs, and fuel cell vehicles. To avoid double-counting, manufacturers would not be allowed to generate advanced technology credits for vehicles they choose to include in Pathways 1 through 4 described in III.C.5.a, above. EPA proposes to use a similar methodology to that proposed for MYs 2012 and later, as described in Section III.C.3, above. EPA proposes to use a multiplier in the range of 1.2 to 2.0 for all eligible vehicles (*i.e.,* EVs, PHEVs, and fuel cells). Manufacturers, however, would track the number of these vehicles sold in the model years 2009—2011, and the emissions level of the vehicles, rather than a CO_2 credit. When a manufacturer chooses to use the vehicle credits to comply with 2012 or later standards, the vehicle counts including the multiplier would be folded into the CO_2 fleet average. For example, if a manufacturer sells 1,000 EVs in MY 2011, and if the final multiplier level were 2.0, the manufacturer would apply the multiplier of 2.0 and then be able to include 2,000 vehicles at 0 g/mile in their MY 2012 fleet to decrease the fleet average for that model year. As with other early credits, these early advanced technology vehicle credits would be tracked by model year (2009, 2010, or 2011) and would be subject to 5 year carry-forward restrictions. Again, manufacturers would not be allowed to include the EVs, PHEVs, or fuel cell vehicles in the early credit pathways discussed above in Section III.C.5.a, otherwise the vehicles would be double counted. As discussed in Section III.C.3, EPA is requesting comment on a multiplier in the range of 1.2 to 2.0, including a potential phase-down in the multiplier by model year 2016, if a multiplier near the higher end of this range is determined for the final rule. This request for comment also extends to the potential for early advance technology vehicle credits. EPA is also requesting comment on the appropriate gram/mile metric for EVs and fuel cellvehicles, as well as for the EV-only contribution for a PHEV.

d. Early Off-Cycle Credits

EPA's proposed off-cycle innovative technology credit provisions are provided in Section III.C.4. EPA requests comment on beginning these credits in the 2009–2011 time frame, provided manufacturers are able to make the necessary demonstrations outlined in Section III.C.4, above.

D. Feasibility of the Proposed CO_2 Standards

This proposal is based on the need to obtain significant GHG emissions reductions from the transportation sector, and the recognition that there are cost-effective technologies to achieve such reductions in the 2012–2016 time frame. As in many prior mobile source rulemakings, the decision on what standard to set is largely based on 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 standards derived from assessing these issues are also evaluated in terms of the need for reductions of greenhouse gases, the degree of reductions achieved by the standards, and the impacts of the standards in terms of costs, quantified benefits, and other impacts of the standards. The availability of technology to achieve reductions and the cost and other aspects of this technology are therefore a central focus of this rulemaking.

EPA is taking the same basic approach in this rulemaking, although the technological problems and solutions involved in this rulemaking differ in some ways from prior mobile source rulemakings. Here, the focus of the emissions control technology is on reducing CO_2 and other greenhouse gases. Vehicles combust fuel to perform two basic functions: (1) Transport the vehicle, its passengers and its contents, and (2) operate various accessories during the operation of the vehicle such as the air conditioner. Technology can reduce CO_2 emissions by either making more efficient use of the energy that is produced through combustion of the fuel or reducing the energy needed to perform either of these functions.

This focus on efficiency calls for looking at the vehicle as an entire system. In addition to fuel delivery, combustion, and aftertreatment technology, any aspect of the vehicle that affects the need to produce energy must also be considered. For example, the efficiency of the transmission system, which takes the energy produced by the engine and transmits it to the wheels, and the resistance of the tires to rolling both have major impacts on the amount of fuel that is combusted while operating the vehicle. The braking system, the aerodynamics of the vehicle, and the efficiency of accessories, such as the air conditioner, all affect how much fuel is combusted.

In evaluating vehicle efficiency, we have excluded fundamental changes in vehicles' size and utility. For example, we did not evaluate converting minivans and SUVs to station wagons, converting vehicles with four wheel drive to two wheel drive, or reducing headroom in order to lower the roofline and reduce aerodynamic drag. We have limited our assessment of technical feasibility and resultant vehicle cost to technologies which maintain vehicle utility as much as possible. Manufacturers may decide to alter the utility of the vehicles which they sell in response to this rule. Assessing the societal cost of such changes is very difficult as it involves assessing consumer preference for a wide range of vehicle features.

This need to focus on the efficient use of energy by the vehicle as a system leads to a broad focus on a wide variety of technologies that affect almost all the systems in the design of a vehicle. As discussed below, there are many technologies that are currently available which can reduce vehicle energy consumption. These technologies are already being commercially utilized to a limited degree in the current light-duty fleet. These technologies include hybrid technologies that use higher efficiency electric motors as the power source in combination with or instead of internal combustion engines. While already commercialized, hybrid technology continues to be developed and offers the potential for even greater efficiency improvements. Finally, there are other advanced technologies under development, such as lean burn gasoline engines, which offer the potential of improved energy generation through improvements in the basic combustion process. In addition, the available technologies are not limited to powertrain improvements but also include mass reduction, electrical system efficiencies, and aerodynamic improvements.

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. Vehicle manufacturers typically develop many different models by basing them on a limited number of vehicle platforms. The platform typically consists of a common vehicle architecture and structural components. This allows for efficient use of design and manufacturing resources. Given the very large investment put into designing and producing each vehicle model, manufacturers typically plan on a major redesign for the models approximately every 5 years. 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 economy, and safety regulations.

This redesign 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 generally does not allow for major technology changes although more minor ones can be done (*e.g.*, small aerodynamic improvements, valve timing 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 reducing technologies involving several different systems in the vehicle that are available for consideration. Many can involve major changes to the vehicle, such as changes to the engine block and cylinder heads, redesign of the transmission and its packaging in the vehicle, changes in vehicle shape to improve aerodynamic efficiency and the application of aluminum in body panels to reduce mass. Logically, the incorporation of emissions control technologies would be during the periodic redesign process. This approach 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. It also allows the manufacturer to fit the process of upgrading emissions control technology into its multi-year planning process, and it avoids the large increase in resources and costs that would occur if technology had to be added outside of the redesign process.

This proposed rule affects five years of vehicle production, model years 2012–2016. Given the now-typical five year redesign cycle, nearly all of a manufacturer's vehicles will be redesigned over this period. However, this assumes that a manufacturer has sufficient lead time to redesign the first model year affected by this proposed rule with the requirements of this proposed rule in mind. In fact, the lead time available for model year 2012 is relatively short. The time between a likely final rule and the start of 2013 model year production is likely to be just over two years. At the same time, manufacturer product plans indicate that they are planning on introducing many of the technologies EPA projects could be used to show compliance with the proposed CO_2 standards in both 2012 and 2013. In order to account for the relatively short lead time available prior to the 2012 and 2013 model years, albeit mitigated by their existing plans, EPA has factored this reality into how the availability is modeled for much of the technology being considered for model years 2012–2016 as a whole. If the technology to control greenhouse gas emissions is efficiently folded into this redesign process, then EPA projects that 85 percent of each manufacturer's sales will be able to be redesigned with many of the CO_2 emission reducing technologies by the 2016 model year, and as discussed below, to reduce emissions of HFCs from the air conditioner.

In determining the level of this first ever GHG emissions standard under the CAA for light-duty vehicles, EPA proposes to use an approach that accounts for and builds on this redesign process. This provides the opportunity for several control technologies to be incorporated into the vehicle during redesign, achieving significant emissions reductions from the model at one time. This is in contrast to what would be a much more costly approach of trying to achieve small increments of reductions over multiple years by adding technology to the vehicle piece by piece outside of the redesign process.

As described below, the vast majority of technology required by this proposal is commercially available and already being employed to a limited extent across the fleet. The vast majority of the emission reductions which would result from this proposed rule would result from the increased use of these technologies. EPA also believes that this proposed rule would encourage the development and limited use of more advanced technologies, such as PHEVs and EVs.

In developing the proposed standard, EPA built on the technical work performed by the State of California during its development of its statewide GHG program. EPA began by evaluating a nationwide CAA standard for MY 2016 that would require the levels of technology upgrade, across the country, which California standards would require for the subset of vehicles sold in California under Pavley 1. In essence, EPA evaluated the stringency of the California Pavley 1 program but for a national standard. As mentioned above, and as described in detail in Section II.C of this preamble and Chapter 3 of the Joint TSD, one of the important technical documents included in EPA and NHTSA's assessment of vehicle technology effectiveness and costs was the 2004 NESCCAF report which was the technical foundation for California's Pavley 1 standard. However, in order to evaluate the impact of standards with similar stringency on a national basis to the California program EPA chose not to evaluate the specific California standards for several reasons. First, California's standards are universal standards (one for cars and one for trucks), while EPA is proposing attribute-based standards using vehicle footprint. Second, California's definitions of what vehicles are classified as cars and which are classified as trucks are different from those used by NHTSA for CAFE purposes and different from EPA's proposed classifications in this notice (which harmonizes with the CAFE definitions). In addition, there has been progress in the refinement of the estimation of the effectiveness and cost estimation for technologies which can be applied to cars and trucks since the California analysis in 2004 which could lead to different relative stringencies between cars and trucks than what California determined for its Pavley 1 program. There have also been improvements in the fuel economy and CO_2 performance of the actual new vehicle fleet since California's 2004 analysis which EPA wanted to reflect in our current assessment. For these reasons, EPA developed an assessment of an equivalent national new vehicle fleet-wide CO_2 performance standards for model year 2016 which would result in the new vehicle fleet in the State of California having CO_2 performance equal to the performance from the California Pavley 1 standards. This assessment is documented in Chapter 3.1 of the DRIA. The results of this assessment predicts that a national light-duty vehicle fleet which adopts technology that achieves performance of 250 g/mile CO_2 for model year 2016 would result in vehicles sold in California that would achieve the CO_2 performance equivalent to the Pavley 1 standards.

EPA then analyzed a level of 250 g/mi CO_2 in 2016 using the OMEGA model, and the car and truck footprint curves relative stringency discussed in Section II to determine what technology would be needed to achieve a fleet wide average of 250 g/mi CO_2. As discussed later in this section we believe this level of technology application to the light-duty vehicle fleet can be achieved in this time frame, that such standards will produce significant reductions in GHG emissions, and that the costs for both the industry and the costs to the consumer are reasonable. EPA also developed standards for the model years 2012 through 2015 that lead up to the 2016 level.

EPA's independent technical assessment of the technical feasibility of the proposed MY2012–2016 standards is described below. EPA has also evaluated a set of alternative standards for these model years, one that is more stringent than the proposed standards and one that is less stringent. The technical feasibility of these alternative standards is discussed at the end of this section.

Evaluating the feasibility of these standards primarily includes identifying available technologies and assessing their effectiveness, cost, and impact on relevant aspects of vehicle performance and utility. The wide number of technologies which are available and likely to be used in combination requires a more sophisticated assessment of their combined cost and effectiveness. An important factor is also the degree that these technologies are already being used in the current vehicle fleet and thus, unavailable for use to improve energy efficiency beyond current levels. Finally, the challenge for manufacturers to design the technology into their products, and the appropriate lead time needed to employ the technology over the product line of the industry must be considered.

Applying these technologies efficiently to the wide range of vehicles produced by various manufacturers is a challenging task. In order to assist in this task, EPA has developed a computerized model called the Optimization Model for reducing Emissions of Greenhouse gases from Automobiles (OMEGA) model. Broadly, the model starts with a description of the future vehicle fleet, including manufacturer, sales, base CO_2 emissions, footprint and the extent to which emission control technologies are already employed. For the purpose of this analysis, over 200 vehicle platforms were used to capture the important differences in vehicle and engine design and utility of future vehicle sales of roughly 16 million units in the 2016 timeframe. The model is then provided with a list of technologies which are applicable to various types of vehicles, along with their cost and effectiveness and the percentage of vehicle sales which can receive each technology during the redesign cycle of interest. The model combines this information with economic parameters, such as fuel prices and a discount rate, to project how various manufacturers would apply the available technology in order to meet various levels of emission control. The result is a description of which technologies are added to each vehicle platform, along with the resulting cost. While OMEGA can apply technologies which reduce CO_2 emissions and HFC refrigerant emissions associated with air conditioner use, this task is currently handled outside of the OMEGA model. The model can be set to account for various types of compliance flexibilities, such as FFV credits.

EPA invites comment on all aspects of this feasibility assessment. Both the OMEGA model and its inputs have been placed in the docket to this proposed rule and available for review.

The remainder of this section describes the technical feasibility analysis in greater detail. Section III.D.1 describes the development of our projection of the MY 2012–2016 fleet in the absence of this proposed rule. Section III.D.2 describes our estimates of the effectiveness and cost of the control technologies available for application in the 2012–2016 timeframe. Section III.D.3 combines these technologies into packages likely to be applied at the same time by a manufacturer. In this section, the overall effectiveness of the technology packages vis-à-vis their effectiveness when combined individually is described. Section III.D.4 describes the process which manufacturers typically use to apply new technology to their vehicles. Section III.D.5 describes EPA's OMEGA model and its approach to estimating how manufacturers would add technology to their vehicles in order to comply with CO_2 emission standards. Section III.D.6 presents the results of the OMEGA modeling, namely the level of technology added to manufacturers' vehicles and its cost. Section III.D.7 discusses the feasibility of the alternative 4-percent-per-year and 6-percent-per-year standards. Further detail on all of these issues can be found in EPA and NHTSA's draft Joint Technical Support Document as well as EPA's draft Regulatory Impact Analysis.

1. How Did EPA Develop a Reference Vehicle Fleet for Evaluating Further CO_2 Reductions?

In order to calculate the impacts of this proposed regulation, it is necessary to project the GHG emissions characteristics of the future vehicle fleet absent this proposed regulation. This is called the ''reference'' fleet. EPA developed this reference fleet by determining the characteristics of a specific model year (in this case, 2008) of vehicles, called the baseline fleet, and then projecting what changes if any would be made to these vehicles to comply with the MY2011 CAFE standards. Thus, the MY 2008 fleet is our ''baseline fleet,'' and the projection of the baseline to MY 2011–2016 is called the ''reference fleet.''

EPA used 2008 model year vehicles as the basis for its baseline fleet. 2008 model year is the most recent model year for which data is publicly available. Sources of data for the baseline include the EPA vehicle certification data, Ward's Automotive Group data, Motortrend.com, Edmunds.com, manufacturer product plans, and other sources to a lesser extent (such as articles about specific vehicles) revealed from Internet search engine research. EPA then projects this fleet out to the 2016 MY, taking into account factors such as changes in overall sales volume. Section II.B describes the development of the EPA reference fleet, and further details can be found in Section II.B of this preamble and Chapter 1 of the Draft Joint TSD.

The light-duty vehicle market is currently in a state of flux due to the volatility in fuel prices over the past several years and the current economic downturn. These factors have changed the relative sales of the various types of light-duty vehicles marketed, as well as total sales volumes. EPA and NHTSA desire to account for these changes to the degree possible in our forecast of the make-up of the future vehicle fleet. EPA wants to include improvements in fuel economy associated with the existing CAFE program. It is possible that manufacturers could increase fuel economy beyond the level of the 2011 MY CAFE standards for marketing purposes. However, it is difficult to separate fuel economy improvements in those years for marketing purposes from those designed to facilitate compliance with anticipated CAFE or CO_2 emission standards. Thus, EPA limits fuel economy improvements in the reference fleet to those projected to result from the existing CAFE standards. The addition of technology to the baseline fleet so that it complies with the MY 2011 CAFE standards is described later in Section III.D.4, as this uses the same methodology used to project compliance with the proposed CO_2 emission standards. In summary, the reference fleet represents vehicle characteristics and sales in the 2012 and later model years absent this proposed rule. Technology is then added to these vehicles in order to reduce CO_2 emissions to achieve compliance with the proposed CO_2 standards. EPA did not factor in any changes to vehicle characteristics or sales in projecting manufacturers' compliance with this proposal.

After the reference fleet is created, the next step aggregates vehicle sales by a combination of manufacturer, vehicle platform, and engine design. As discussed in Section III.D.4 below, manufacturers implement major design changes at vehicle redesign and tend to implement these changes across a vehicle platform. Because the cost of modifying the engine depends on the valve train design (such as SOHC, DOHC, etc.), the number of cylinders and in some cases head design, the vehicle sales are broken down beyond the platform level to reflect relevant engine differences. The vehicle groupings are shown in Table III.D.1–1.

TABLE III.D.1–1—VEHICLE GROUPINGS [a]

Vehicle description	Vehicle type	Vehicle description	Vehicle type
Large SUV (Car) V8+ OHV	13	Subcompact Auto I4	1
Large SUV (Car) V6 4v	16	Large Pickup V8+ DOHC	19
Large SUV (Car) V6 OHV	12	Large Pickup V8+ SOHC 3v	14
Large SUV (Car) V6 2v SOHC	9	Large Pickup V8+ OHV	13
Large SUV (Car) I4 and I5	7	Large Pickup V8+ SOHC	10
Midsize SUV (Car) V6 2v SOHC	8	Large Pickup V6 DOHC	18
Midsize SUV (Car) V6 S/DOHC 4v	5	Large Pickup V6 OHV	12
Midsize SUV (Car) I4	7	Large Pickup V6 SOHC 2v	11
Small SUV (Car) V6 OHV	12	Large Pickup I4 S/DOHC	7
Small SUV (Car) V6 S/DOHC	4	Small Pickup V6 OHV	12
Small SUV (Car) I4	3	Small Pickup V6 2v SOHC	8
Large Auto V8+ OHV	13	Small Pickup I4	7
Large Auto V8+ SOHC	10	Large SUV V8+ DOHC	17
Large Auto V8+ DOHC, 4v SOHC	6	Large SUV V8+ SOHC 3v	14
Large Auto V6 OHV	12	Large SUV V8+ OHV	13
Large Auto V6 SOHC 2/3v	5	Large SUV V8+ SOHC	10
Midsize Auto V8+ OHV	13	Large SUV V6 S/DOHC 4v	16
Midsize Auto V8+ SOHC	10	Large SUV V6 OHV	12
Midsize Auto V7+ DOHC, 4v SOHC	6	Large SUV V6 SOHC 2v	9
Midsize Auto V6 OHV	12	Large SUV I4/	7
Midsize Auto V6 2v SOHC	8	Midsize SUV V6 OHV	12
Midsize Auto V6 S/DOHC 4v	5	Midsize SUV V6 2v SOHC	8
Midsize Auto I4	3	Midsize SUV V6 S/DOHC 4v	5
Compact Auto V7+ S/DOHC	6	Midsize SUV I4 S/DOHC	7
Compact Auto V6 OHV	12	Small SUV V6 OHV	12
Compact Auto V6 S/DOHC 4v	4	Minivan V6 S/DOHC	16
Compact Auto I5	7	Minivan V6 OHV	12
Compact Auto I4	2	Minivan I4	7
Subcompact Auto V8+ OHV	13	Cargo Van V8+ OHV	13
Subcompact Auto V8+ S/DOHC	6	Cargo Van V8+ SOHC	10
Subcompact Auto V6 2v SOHC	8	Cargo Van V6 OHV	12
Subcompact Auto I5/V6 S/DOHC 4v	4		

[a] I4 = 4 cylinder engine, I5 = 5 cylinder engine, V6, V7, and V8 = 6, 7, and 8 cylinder engines, respectively, DOHC = Double overhead cam, SOHC = Single overhead cam, OHV = Overhead valve, v = number of valves per cylinder, "/" = and, "+" = or larger.

As mentioned above, the second factor which needs to be considered in developing a reference fleet against which to evaluate the impacts of this proposed rule is the impact of the 2011 MY CAFE standards, which were published earlier this year. Since the vehicles which comprise the above reference fleet are those sold in the 2008 MY, when coupled with our sales projections, they do not necessarily meet the 2011 MY CAFE standards.

The levels of the 2011 MY CAFE standards are straightforward to apply to future sales fleets, as is the potential fine-paying flexibility afforded by the CAFE program (*i.e.,* $55 per mpg of shortfall). However, projecting some of the compliance flexibilities afforded by EISA and the CAFE program are less clear. Two of these compliance flexibilities are relevant to EPA's analysis: (1) The credit for FFVs, and (2) the limit on the transferring of credits between car and truck fleets. The FFV credit is limited to 1.2 mpg in 2011 and EISA gradually reduces this credit, to 1.0 mpg in 2015 and eventually to zero in 2020. In contrast, the limit on car truck transfer is limited to 1.0 mpg in 2011, and EISA increases this to 1.5 mpg beginning in 2015 and then to 2.0 mpg beginning in 2020. The question here is whether to hold the 2011 MY CAFE provisions constant in the future or incorporate the changes in the FFV credit and car-truck credit trading limits contained in EISA.

EPA decided to hold the 2011 MY limits on FFV credit and car-truck credit trading constant in projecting the fuel economy and CO_2 emission levels of vehicles in our reference case. This approach treats the changes in the FFV credit and car-truck credit trading provisions consistently with the other EISA-mandated changes in the CAFE standards themselves. All EISA provisions relevant to 2011 MY vehicles are reflected in our reference case fleet, while all post-2011 MY provisions are not. Practically, relative to the alternative, this increases both the cost and benefit of the proposed standards. In our analysis of this proposed rule, any quantified benefits from the presence of FFVs in the fleet are not considered. Thus, the only impact of the FFV credit is to reduce onroad fuel economy. By assuming that the FFV credit stays at 1.2 mpg in the future absent this rule, the assumed level of onroad fuel economy that would occur absent this proposal is reduced. As this proposal eliminates the FFV credit starting in 2016, the net result is to increase the projected level of fuel savings from our proposed standards. Similarly, the higher level of FFV credit reduces projected compliance cost for manufacturers to meet the 2011 MY standards in our reference case. This increases the projected cost of meeting the proposed 2012 and later standards.

As just implied, EPA needs to project the technology (and resultant costs) required for the 2008 MY vehicles to comply with the 2011 MY CAFE standards in those cases where they do not automatically do so. The technology and costs are projected using the same methodology that projects compliance with the proposed 2012 and later CO_2 standards. The description of this process is described in the following four sections.

A more detailed description of the methodology used to develop these sales projections can be found in the Draft Joint TSD. Detailed sales projections by model year and manufacturer can also be found in the TSD. EPA requests comments on both the methodology used to develop the reference fleet, as well as the characteristics of the reference fleet.

2. What Are the Effectiveness and Costs of CO_2-Reducing Technologies?

EPA and NHTSA worked together to jointly develop information on the effectiveness and cost of the CO_2-reducing technologies, and fuel economy-improving technologies, other than A/C related control technologies. This joint work is reflected in Chapter 3 of the Draft Joint TSD and in Section II of this preamble. A summary of the effectiveness and cost of A/C related technology is contained here. For more detailed information on the effectiveness and cost of A/C related technology, please refer to Section III.C of this preamble and Chapter 2 of EPA's DRIA.

A/C improvements are an integral part of EPA's technology analysis and have been included in this section along with the other technology options. While discussed in Section III.C as a credit opportunity, air conditioning-related improvements are included in Table III.D.2–1.because A/C improvements are a very cost-effective technology at reducing CO_2 (or CO_2-equivalent) emissions. EPA expects most manufacturers will choose to use AC improvement credit opportunities as a strategy for meeting compliance with the CO_2 standards. Note that the costs shown in Table III.D.2–1 do not include maintenance savings that would be expected from the new AC systems. Further, EPA does not include AC-related maintenance savings in our cost and benefit analysis presented in Section III.H. EPA discusses the likely maintenance savings in Chapter 2 of the DRIA and requests comment on that discussion because we may include maintenance savings in the final rule and would like to have the best information available in order to do so. The EPA approximates that the level of the credits earned will increase from 2012 to 2016 as more vehicles in the fleet are redesigned. The penetrations and average levels of credit are summarized in Table III.D.2–2, though the derivation of these numbers (and the breakdown of car vs. truck credits) is described in the DRIA. As demonstrated in the IMAC study (and described in Section III.C as well as the DRIA), these levels are feasible and achievable with technologies that are available and cost-effective today.

These improvements are categorized as either leakage reduction, including use of alternative refrigerants, or system efficiency improvements. Unlike the majority of the technologies described in this section, A/C improvements will not be demonstrated in the test cycles used to quantify CO_2 reductions in this proposal. As described earlier, for this analysis A/C-related CO_2 reductions are handled outside of OMEGA model and therefore their CO_2 reduction potential is expressed in grams per mile rather than a percentage used by the OMEGA model. *See* Section III.C for the method by which potential reductions are calculated or measured. Further discussion of the technological basis for these improvements is included in Chapter 2 of the DRIA.

TABLE III.D.2–1—TOTAL CO_2 REDUCTION POTENTIAL AND 2016 COST FOR A/C RELATED TECHNOLOGIES FOR ALL VEHICLE CLASSES

[Costs in 2007 dollars]

	CO_2 reduction potential	Incremental compliance costs
A/C refrigerant leakage reduction	7.5 g/mi [161]	$17
A/C efficiency improvements	5.7 g/mi	53

TABLE III.D.2–2 A/C RELATED TECHNOLOGY PENETRATION AND CREDIT LEVELS EXPECTED TO BE EARNED

	Technology penetration (Percent)	Average credit over entire fleet
2012	25	3.1
2013	40	5.0
2014	60	7.5
2015	80	10.0
2016	85	10.6

3. How Can Technologies Be Combined into ''Packages'' and What Is the Cost and Effectiveness of Packages?

Individual technologies can be used by manufacturers to achieve incremental CO_2 reductions. However, as mentioned in Section III.D.1, EPA believes that manufacturers are more likely to bundle technologies into ''packages'' to capture synergistic aspects and reflect progressively larger CO_2 reductions with additions or changes to any given package. In addition, manufacturers would typically apply new technologies in packages during model redesigns—which occur once roughly every five years—rather than adding new technologies one at a time on an annual or biennial basis. This way, manufacturers can more efficiently make use of their redesign resources and more effectively plan for changes necessary to meet future standards.

Therefore, the approach taken here is to group technologies into packages of increasing cost and effectiveness. EPA determined that 19 different vehicle types provided adequate representation to accurately model the entire fleet. This was the result of analyzing the existing light duty fleet with respect to vehicle size and powertrain configurations. All vehicles, including cars and trucks, were first distributed based on their relative size, starting from compact cars and working upward to large trucks. Next, each vehicle was evaluated for powertrain, specifically the engine size, I4, V6, and V8, and finally by the number of valves per cylinder. Note that each of these 19 vehicle types was mapped into one of the five classes of vehicles mentioned in Section III.D.2. While the five classes provide adequate representation for the cost basis associated with most technology application, they do not adequately account for all existing vehicle attributes such as base vehicle powertrain configuration and mass reduction. As an example, costs and effectiveness estimates for engine friction reduction for the small car class were used to represent cost and effectiveness for three vehicle types: Subcompact cars, compact cars, and small multi-purpose vehicles (MPV) equipped with a 4-cylinder engine, however the mass reduction associated for each of these vehicle types was based on the vehicle type sales-weighted average. In another example, a vehicle type for V8 single overhead cam 3-valve engines was created to properly account for the incremental cost in moving to a dual overhead cam 4-valve

[161] This represents 50% improvement in leakage and thus 50% of the A/C leakage impact potential compared to a maximum of 15 g/mi credit that can be achieved through the incorporation of a low very GWP refrigerant.

configuration. Note also that these 19 vehicle types span the range of vehicle footprints—smaller footprints for smaller vehicles and larger footprints for larger vehicles—which serve as the basis for the standards proposed in this rule. A complete list of vehicles and their associated vehicle types is shown above in Table III.D.1–1.

Within each of the 19 vehicle types multiple technology packages were created in increasing technology content and, hence, increasing effectiveness. Important to note is that the effort in creating the packages attempted to maintain a constant utility for each package as compared to the baseline package. As such, each package is meant to provide equivalent driver-perceived performance to the baseline package. The initial packages represent what a manufacturer will most likely implement on all vehicles, including low rolling resistance tires, low friction lubricants, engine friction reduction, aggressive shift logic, early torque converter lock-up, improved electrical accessories, and low drag brakes.[162] Subsequent packages include advanced gasoline engine and transmission technologies such as turbo/downsizing, GDI, and dual-clutch transmission. The most technologically advanced packages within a segment included HEV, PHEV and EV designs. The end result being a list of several packages for each of 19 different vehicle types from which a manufacturer could choose in order to modify its fleet such that compliance could be achieved.

Before using these technology packages as inputs to the OMEGA model, the cost and effectiveness for the package was calculated. The first step—mentioned briefly above—was to apply the scaling class for each technology package and vehicle type combination. The scaling class establishes the cost and effectiveness for each technology with respect to the vehicle size or type. The Large Car class was provided as an example in Section III.D.2. Additional classes include Small Car, Minivan, Small Truck, and Large Truck and each of the 19 vehicle types was mapped into one of those five classes. In the next step, the cost for a particular technology package, was determined as the sum of the costs of the applied technologies. The final step, determination of effectiveness, requires greater care due to the synergistic effects mentioned in Section III.D.2. This step is described immediately below.

Usually, the benefits of the engine and transmission technologies can be combined multiplicatively. For example, if an engine technology reduces CO_2 emissions by five percent and a transmission technology reduces CO_2 emissions by four percent, the benefit of applying both technologies is 8.8 percent $(100\% - (100\% - 4\%) * (100\% - 5\%))$. In some cases, however, the benefit of the transmission-related technologies overlaps with many of the engine technologies. This occurs because the primary goal of most of the transmission technologies is to shift operation of the engine to more efficient locations on the engine map. Some of the engine technologies have the same goal, such as cylinder deactivation. In order to account for this overlap and avoid over-estimating emissions reduction effectiveness, EPA has developed a set of adjustment factors associated with specific pairs of engine and transmission technologies.

The various transmission technologies are generally mutually exclusive. As such, the effectiveness of each transmission technology generally supersedes each other. For example, the 9.5–14.5 percent reduction in CO_2 emissions associated with the automated manual transmission includes the 4.5–6.5 percent benefit of a 6-speed automatic transmission. Exceptions are aggressive shift logic and early torque converter lock-up. The former can be applied to any vehicle and the latter can be applied to any vehicle with an automatic transmission.

EPA has chosen to use an engineering approach known as the lumped-parameter technique to determine these adjustment factors. The results from this approach were then applied directly to the vehicle packages. The lumped-parameter technique is well documented in the literature, and the specific approach developed by EPA is detailed in Chapter 3 of the Draft Joint TSD.

Table III.D.3–1 presents several examples of the reduction in the effectiveness of technology pairs. A complete list and detailed discussion of these synergies is presented in Chapter 3 of the Draft Joint TSD.

TABLE III.D.3–1—REDUCTION IN EFFECTIVENESS FOR SELECTED TECHNOLOGY PAIRS

Engine technology	Transmission technology	Reduction in combined effectiveness (percent)
Intake cam phasing	5 speed automatic	0.5
Coupled cam phasing	5 speed automatic	0.5
Coupled cam phasing	Aggressive shift logic	0.5
Cylinder deactivation	5 speed automatic	1.0
Cylinder deactivation	Aggressive shift logic	0.5

Table III.D.3–2 presents several examples of the CO_2-reducing technology vehicle packages used in the OMEGA model for the large car class. Similar packages were generated for each of the 19 vehicle types and the costs and effectiveness estimates for each of those packages are discussed in detail in Chapter 3 of the Draft Joint TSD.

[162] When making reference to low friction lubricants, the technology being referred to is the engine changes and possible durability testing that would be done to accommodate the low friction lubricants, not the lubricants themselves.

TABLE III.D.3–2—CO_2 REDUCING TECHNOLOGY VEHICLE PACKAGES FOR A LARGE CAR EFFECTIVENESS AND COSTS IN 2016

[Costs in 2007 dollars]

Engine technology	Transmission technology	Additional technology	CO_2 reduction	Package cost
3.3L V6	4 speed automatic	None	Baseline	
3.0L V6 + GDI + CCP	6 speed automatic	3% Mass Reduction	17.9%	$1,022
3.0L V6 + GDI + CCP + Deac	6 speed automatic	5% Mass Reduction	20.6	1,280
3.0L V6 + GDI + CCP + Deac	6 speed DCT	10% Mass Reduction Start-Stop	34.2	2,108
2.2L I4 + GDI + Turbo + DCP	6 speed DCT	10% Mass Reduction Start-Stop	34.3	2,245

4. Manufacturers' Application of Technology

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 vehicle will need to remain competitive over its intended life, meet future regulatory requirements, and contribute to a manufacturer's CAFE requirements. Furthermore, automotive manufacturers are largely focused on creating vehicle platforms to limit the development of entirely new vehicles and to realize economies of scale with regard to variable cost. In very limited cases, manufacturers may implement an individual technology outside of a vehicle's redesign cycle. In following with these industry practices, EPA has created a set of vehicle technology packages that represent the entire light duty fleet.

EPA has historically allowed manufacturers of new vehicles or nonroad equipment to phase in available emission control technology over a number of years. Examples of this are EPA's Tier 2 program for cars and light trucks and its 2007 and later PM and NO_X emission standards for heavy-duty vehicles. In both of these rules, the major modifications expected from the rules were the addition of exhaust aftertreatment control technologies. Some changes to the engine were expected as well, but these were not expected to affect engine size, packaging or performance. The CO_2 reduction technologies described above potentially involve much more significant changes to car and light truck designs. Many of the engine technologies involve changes to the engine block and heads. The transmission technologies could change the size and shape of the transmission and thus, packaging. Improvements to aerodynamic drag could involve body design and therefore, the dies used to produce body panels. Changes of this sort potentially involve new capital investment and the obsolescence of existing investment.

At the same time, vehicle designs are not static, but change in major ways periodically. The manufacturers' product plans indicate that vehicles are usually redesigned every 5 years on average. Vehicles also tend to receive a more modest ''refresh'' between major redesigns, as discussed above. Because manufacturers are already changing their tooling, equipment and designs at these times, further changes to vehicle design at these times involve a minimum of stranded capital equipment. Thus, the timing of any major technological changes is projected to coincide with changes that manufacturers would already tend to be making to their vehicles. This approach effectively avoids the need to quantify any costs associated with discarding equipment, tooling, emission and safety certification, etc. when CO_2-reducing equipment is incorporated into a vehicle.

This proposed rule affects five years of vehicle production, model years 2012–2016. Given the now-typical five-year redesign cycle, nearly all of a manufacturer's vehicles will be redesigned over this period. However, this assumes that a manufacturer has sufficient lead time to redesign the first model year affected by this proposed rule with the requirements of this proposed rule in mind. In fact, the lead time available for model year 2012 is relatively short. The time between a likely final rule and the start of 2013 model year production is likely to be just over two years. At the same time, the manufacturer product plans indicate that they are planning on introducing many of the technologies projected to be required by this proposed rule in both 2012 and 2013. In order to account for the relatively short lead time available prior to the 2012 and 2013 model years, albeit mitigated by their existing plans, EPA projects that only 85 percent of each manufacturer's sales will be able to be redesigned with major CO_2 emission-reducing technologies by the 2016 model year. Less intrusive technologies can be introduced into essentially all a manufacturer's sales. This resulted in three levels of technology penetration caps, by manufacturer. Common technologies (*e.g.,* low friction lubes, aerodynamic improvements) had a penetration cap of 100%. More advanced powertrain technologies (*e.g.,* stoichiometric GDI, turbocharging) had a penetration cap of 85%. The most advanced technologies considered in this analysis (*e.g.,* diesel engines, as well as IMA, powersplit and 2-mode hybrids) had a 15% penetration cap.

5. How Is EPA Projecting That a Manufacturer Would Decide Between Options To Improve CO_2 Performance To Meet a Fleet Average Standard?

There are many ways for a manufacturer to reduce CO_2-emissions from its vehicles. A manufacturer can choose from a myriad of CO_2 reducing technologies and can apply one or more of these technologies to some or all of its vehicles. Thus, for a variety of levels of CO_2 emission control, there are an almost infinite number of technology combinations which produce the desired CO_2 reduction. EPA has created a new vehicle model, the Optimization Model for Emissions of Greenhouse gases from Automobiles (OMEGA) in order to make a reasonable estimate of how manufacturers will add technologies to vehicles in order to meet a fleet-wide CO_2 emissions level. EPA has described OMEGA's specific methodologies and algorithms in a memo to the docket for this rulemaking (Docket EPA–HQ–OAR–2009–0472).

The OMEGA model utilizes four basic sets of input data. The first is a description of the vehicle fleet. The key pieces of data required for each vehicle are its manufacturer, CO_2 emission level, fuel type, projected sales and footprint. The model also requires that each vehicle be assigned to one of the 19 vehicle types, which tells the model which set of technologies can be applied to that vehicle. (For a description of how the 19 vehicle types were created, reference Section III.D.3.) In addition, the degree to which each vehicle already reflects the effectiveness and cost of each available technology must also be input. This avoids the situation, for example, where the model might try to add a basic engine improvement to a current hybrid vehicle. Except for this type of information, the development of the required data regarding the reference fleet was described in Section III.D.1 above and in Chapter 1 of the Draft Joint TSD.

The second type of input data used by the model is a description of the technologies available to manufacturers, primarily their cost and effectiveness. Note that the five vehicle classes are not explicitly used by the model, rather the costs and effectiveness associated with each vehicle package is based on the associated class. This information was described in Sections III.D.2 and III.D.3 above as well as Chapter 3 of the Draft Joint TSD. In all cases, the order of the technologies or technology packages for a particular vehicle type is determined by the model user prior to running the model. Several criteria can be used to develop a reasonable ordering of technologies or packages. These are described in the Draft Joint TSD.

The third type of input data describes vehicle operational data, such as annual scrap rates and mileage accumulation rates, and economic data, such as fuel prices and discount rates. These estimates are described in Section II.F above, Section III.H below and Chapter 4 of the Draft Joint TSD.

The fourth type of data describes the CO_2 emission standards being modeled. These include the CO_2 emission equivalents of the 2011 MY CAFE standards and the proposed CO_2 standards for 2016. As described in more detail below, the application of A/C technology is evaluated in a separate analysis from those technologies which impact CO_2 emissions over the 2-cycle test procedure. Thus, for the percent of vehicles that are projected to achieve A/C related reductions, the CO_2 credit associated with the projected use of improved A/C systems is used to adjust the proposed CO_2 standard which would be applicable to each manufacturer to develop a target for CO_2 emissions over the 2-cycle test which is assessed in our OMEGA modeling.

As mentioned above for the market data input file utilized by OMEGA, which characterizes the vehicle fleet, our modeling must and does account for the fact that many 2008 MY vehicles are already equipped with one or more of the technologies discussed in Section III.D.2 above. Because of the choice to apply technologies in packages, and 2008 vehicles are equipped with individual technologies in a wide variety of combinations, accounting for the presence of specific technologies in terms of their proportion of package cost and CO_2 effectiveness requires careful, detailed analysis. The first step in this analysis is to develop a list of individual technologies which are either contained in each technology package, or would supplant the addition of the relevant portion of each technology package. An example would be a 2008 MY vehicle equipped with variable valve timing and a 6-speed automatic transmission. The cost and effectiveness of variable valve timing would be considered to be already present for any technology packages which included the addition of variable valve timing or technologies which went beyond this technology in terms of engine related CO_2 control efficiency. An example of a technology which supplants several technologies would be a 2008 MY vehicle which was equipped with a diesel engine. The effectiveness of this technology would be considered to be present for technology packages which included improvements to a gasoline engine, since the resultant gasoline engines have a lower CO_2 control efficiency than the diesel engine. However, if these packages which included improvements also included improvements unrelated to the engine, like transmission improvements, only the engine related portion of the package already present on the vehicle would be considered. The transmission related portion of the package's cost and effectiveness would be allowed to be applied in order to comply with future CO_2 emission standards.

The second step in this process is to determine the total cost and CO_2 effectiveness of the technologies already present and relevant to each available package. Determining the total cost usually simply involves adding up the costs of the individual technologies present. In order to determine the total effectiveness of the technologies already present on each vehicle, the lumped parameter model described above is used. Because the specific technologies present on each 2008 vehicle are known, the applicable synergies and dis-synergies can be fully accounted for.

The third step in this process is to divide the total cost and CO_2 effectiveness values determined in step 2 by the total cost and CO_2 effectiveness of the relevant technology packages. These fractions are capped at a value of 1.0 or less, since a value of 1.0 causes the OMEGA model to not change either the cost or CO_2 emissions of a vehicle when that technology package is added.

As described in Section III.D.3 above, technology packages are applied to groups of vehicles which generally represent a single vehicle platform and which are equipped with a single engine size (*e.g.,* compact cars with four cylinder engine produced by Ford). These groupings are described in Table III.D.1–1. Thus, the fourth step is to combine the fractions of the cost and effectiveness of each technology package already present on the individual 2008 vehicles models for each vehicle grouping. For cost, percentages of each package already present are combined using a simple sales-weighting procedure, since the cost of each package is the same for each vehicle in a grouping. For effectiveness, the individual percentages are combined by weighting them by both sales and base CO_2 emission level. This appropriately weights vehicle models with either higher sales or CO_2 emissions within a grouping. Once again, this process prevents the model from adding technology which is already present on vehicles, and thus ensures that the model does not double count technology effectiveness and cost associated with complying with the 2011 MY CAFE standards and the proposed CO_2 standards.

Conceptually, the OMEGA model begins by determining the specific CO_2 emission standard applicable for each manufacturer and its vehicle class (*i.e.,* car or truck). Since the proposed rule allows for averaging across a manufacturer's cars and trucks, the model determines the CO_2 emission standard applicable to each manufacturer's car and truck sales from the two sets of coefficients describing the piecewise linear standard functions for cars and trucks in the inputs, and creates a combined car-truck standard. This combined standard considers the difference in lifetime VMT of cars and trucks, as indicated in the proposed regulations which would govern credit trading between these two vehicle classes. For both the 2011 CAFE and 2016 CO_2 standards, these standards are a function of each manufacturer's sales of cars and trucks and their footprint values. When evaluating the 2011 MY CAFE standards, the car-truck trading was limited to 1.2 mpg. When evaluating the proposed CO_2 standards, the OMEGA model was run only for MY 2016. OMEGA is designed to evaluate technology addition over a complete redesign cycle and 2016 represents the final year of a redesign cycle starting with the first year of the proposed CO_2 standards, 2012. Estimates of the technology and cost for the interim model years are developed from the model projections made for 2016. This process is discussed in Chapter 6 of EPA's DRIA to this proposed rule. When evaluating the 2016 standards using the OMEGA model, the proposed CO_2 standard which manufacturers would otherwise have to meet to account for the anticipated level of A/C credits generated was adjusted. On an industry wide basis, the projection shows that manufacturers would generate 11 g/mi of A/C credit in 2016. Thus, the 2016 CO_2 target for the fleet evaluated using OMEGA was 261 g/mi instead of 250 g/mi.

The cost of the improved A/C systems required to generate the 11 g/mi credit was estimated separately. This is consistent with our proposed A/C credit procedures, which would grant manufacturers A/C credits based on their total use of improved A/C systems, and not on the increased use of such systems relative to some base model year fleet. Some manufacturers may already be using improved A/C technology. However, this represents a small fraction of current vehicle sales. To the degree that such systems are already being used, EPA is over-estimating both the cost and benefit of the addition of improved A/C technology relative to the true reference fleet to a small degree.

The model then works with one manufacturer at a time to add technologies until that manufacturer meets its applicable standard. The OMEGA model can utilize several approaches to determining the order in which vehicles receive technologies. For this analysis, EPA used a ''manufacturer-based net cost-effectiveness factor'' to rank the technology packages in the order in which a manufacturer would likely apply them. Conceptually, this approach estimates the cost of adding the technology from the manufacturer's perspective and divides it by the mass of CO_2 the technology will reduce. One component of the cost of adding a technology is its production cost, as discussed above. However, it is expected that new vehicle purchasers value improved fuel economy since it reduces the cost of operating the vehicle. Typical vehicle purchasers are assumed to value the fuel savings accrued over the period of time which they will own the vehicle, which is estimated to be roughly five years. It is also assumed that consumers discount these savings at the same rate as that used in the rest of the analysis (3 or 7 percent). Any residual value of the additional technology which might remain when the vehicle is sold is not considered. The CO_2 emission reduction is the change in CO_2 emissions multiplied by the percentage of vehicles surviving after each year of use multiplied by the annual miles travelled by age, again discounted to the year of vehicle purchase.

Given this definition, the higher priority technologies are those with the lowest manufacturer-based net cost-effectiveness value (relatively low technology cost or high fuel savings leads to lower values). Because the order of technology application is set for each vehicle, the model uses the manufacturer-based net cost-effectiveness primarily to decide which vehicle receives the next technology addition. Initially, technology package #1 is the only one available to any particular vehicle. However, as soon as a vehicle receives technology package #1, the model considers the manufacturer-based net cost-effectiveness of technology package #2 for that vehicle and so on. In general terms, the equation describing the calculation of manufacturer-based cost effectiveness is as follows:

$$ManufCostEff = \frac{TechCost - \sum_{i=1}^{PP}\left[dFS_i \times VMT_i\right] \times \frac{1}{(1-Gap)}}{\sum_{i}^{i+35}\left[\left[dCO2\right] \times VMT_i\right] \times \frac{1}{(1-Gap)}}$$

Where:

ManufCostEff = Manufacturer-Based Cost Effectiveness (in dollars per kilogram CO_2),
TechCost = Marked up cost of the technology (dollars),
PP = Payback period, or the number of years of vehicle use over which consumers value fuel savings when evaluating the value of a new vehicle at time of purchase,
dFS_i = Difference in fuel consumption due to the addition of technology times fuel price in year i,
dCO_2 = Difference in CO_2 emissions due to the addition of technology
VMTi = product of annual VMT for a vehicle of age i and the percentage of vehicles of age i still on the road,
1- Gap = Ratio of onroad fuel economy to two-cycle (FTP/HFET) fuel economy

EPA describes the technology ranking methodology and manufacturer-based cost effectiveness metric in greater detail in a technical memo to the Docket for this proposed rule (Docket EPA–HQ–OAR–2009–0472).

When calculating the fuel savings, the full retail price of fuel, including taxes is used. While taxes are not generally included when calculating the cost or benefits of a regulation, the net cost component of the manufacturer-based net cost-effectiveness equation is not a measure of the social cost of this proposal, but a measure of the private cost, (*i.e.,* a measure of the vehicle purchaser's willingness to pay more for a vehicle with higher fuel efficiency). Since vehicle operators pay the full price of fuel, including taxes, they value fuel costs or savings at this level, and the manufacturers will consider this when choosing among the technology options.

This definition of manufacturer-based net cost-effectiveness ignores any change in the residual value of the vehicle due to the additional technology when the vehicle is five years old. As discussed in Chapter 1of the DRIA, based on historic used car pricing, applicable sales taxes, and insurance, vehicles are worth roughly 23% of their original cost after five years, discounted to year of vehicle purchase at 7% per annum. It is reasonable to estimate that the added technology to improve CO_2 level and fuel economy would retain this same percentage of value when the vehicle is five years old. However, it is less clear whether first purchasers, and thus, manufacturers would consider this residual value when ranking technologies and making vehicle purchases, respectively. For this proposal, this factor was not included in our determination of manufacturer-based net cost-effectiveness in the analyses performed in support of this proposed rule. Comments are requested on the benefit of including an increase in the vehicle's residual value after five years in the calculation of effective cost.

The values of manufacturer-based net cost-effectiveness for specific technologies will vary from vehicle to vehicle, often substantially. This occurs for three reasons. First, both the cost and fuel-saving component cost, ownership fuel-savings, and lifetime CO_2 effectiveness of a specific technology all vary by the type of vehicle or engine to which it is being applied (*e.g.,* small car versus large truck, or 4-cylinder versus 8-cylinder engine). Second, the effectiveness of a specific technology often depends on the presence of other technologies already being used on the vehicle (*i.e.,* the dis-synergies. Third, the absolute fuel savings and CO_2 reduction of a percentage an incremental reduction in fuel consumption depends on the CO_2 level of the vehicle prior to adding the technology. Chapter 1 of the DRIA of this proposed rule contains further detail on the values of manufacturer-based net cost-effectiveness for the various technology packages.

EPA requests comment on the use of manufacturer-based net cost-effectiveness to rank CO_2 emission reduction technologies in the context of evaluating alternative fleet average standards for this rule. EPA believes this manufacturer-based net cost-effectiveness metric is appropriate for ranking technology in this proposed program because it considers effectiveness values that may vary widely among technology packages when determining the order of technology addition. Comments are requested on this option and on any others thought to be appropriate.

6. Why Are the Proposed CO_2 Standards Feasible?

The finding that the proposed standards would be technically feasible is based primarily on two factors. One is the level of technology needed to meet the proposed standards. The other is the cost of this technology. The focus is on the proposed standards for 2016, as this is the most stringent standard and requires the most extensive use of technology.

With respect to the level of technology required to meet the standards, EPA established technology penetration caps. As described in Section III.D.4, EPA used two constraints to limit the model's application of technology by manufacturer. The first was the application of common fuel economy enablers such as low rolling resistance tires and transmission logic changes. These were allowed to be used on all vehicles and hence had no penetration cap. The second constraint was applied to most other technologies and limited their application to 85% with the exception of the most advanced technologies (*e.g.,* powersplit and 2-mode hybrids) whose application was limited to 15%.

EPA used the OMEGA model to project the technology (and resultant cost) required for manufacturers to meet the current 2011 MY CAFE standards and the proposed 2016 MY CO_2 emission standards. Both sets of standards were evaluated using the OMEGA model. The 2011 MY CAFE standards were applied to cars and trucks separately with the transfer of credits from one category to the other allowed up to an increase in fuel economy of 1.0 mpg. Chrysler, Ford and General Motors are assumed to utilize FFV credits up to the maximum of 1.2 mpg for both their car and truck sales. Nissan is assumed to utilize FFV credits up to the maximum of 1.2 mpg for only their truck sales. The use of any banked credits from previous model years was not considered. The modification of the reference fleet to comply with the 2011 CAFE standards through the application of technology by the OMEGA model is the final step in creating the final reference fleet. This final reference fleet forms the basis for comparison for the model year 2016 standards.

Table III.D.6–1 shows the usage level of selected technologies in the 2008 vehicles coupled with 2016 sales prior to projecting their compliance with the 2011 MY CAFE standards. These technologies include converting port fuel-injected gasoline engines to direct injection (GDI), adding the ability to deactivate certain engine cylinders during low load operation (Deac), adding a turbocharger and downsizing the engine (Turbo), increasing the number of transmission speeds to 6 or, converting automatic transmissions to dual-clutch automated manual transmissions (Dual-Clutch Trans), adding 42 volt start-stop capability (Start-Stop), and converting a vehicle to a intermediate or strong hybrid design. This last category includes three current hybrid designs: integrated motor assist (IMA), power-split (PS) and 2-mode hybrids.

TABLE III.D.6–1—PENETRATION OF TECHNOLOGY IN 2008 VEHICLES WITH 2016 SALES: CARS AND TRUCKS

[Percent of sales]

	GDI	GDI+ deac	GDI+ turbo	Diesel	6 Speed or CV trans	Dual clutch trans	Start-stop	Hybrid
BMW	6.7	0.0	0.0	0.0	98.8	0.8	0.0	0.1
Chrysler	0.0	0.0	0.0	0.0	27.9	0.0	0.0	0.0
Daimler	6.2	0.0	0.0	6.2	74.7	11.4	0.0	0.0
Ford	0.6	0.0	0.0	0.0	28.1	0.0	0.0	0.0
General Motors	3.3	0.0	0.0	0.0	13.7	0.0	0.1	0.1
Honda	1.2	0.0	0.0	0.0	4.2	0.0	0.0	2.1
Hyundai	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.0
Kia	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0
Mazda	11.8	0.0	0.0	0.0	37.1	0.0	0.0	0.0
Mitsubishi	0.0	0.0	0.0	0.0	76.1	0.0	0.0	0.1
Nissan	17.7	0.0	0.0	0.0	33.3	0.0	0.0	0.0
Porsche	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0
Subaru	0.0	0.0	0.0	0.0	29.0	0.0	0.0	0.0
Suzuki	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Tata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toyota	7.5	0.0	0.0	0.0	30.6	0.0	0.0	12.8
Volkswagen	52.2	0.0	0.0	0.1	82.8	10.9	0.0	0.0
Overall	6.4	0.0	0.0	0.1	27.1	0.6	0.0	2.8

As can be seen, all of these technologies except for the direct injection gasoline engines with either cylinder deactivation or turbocharging and downsizing, were already being used on some 2008 MY vehicles. High speed transmissions were the most prevalent, with some manufacturers (*e.g.,* BMW, Suzuki) using them on essentially all of their vehicles. Both Daimler and VW equip many of their vehicles with automated manual transmissions, while VW makes extensive use of direct injection gasoline engine technology. Toyota has converted a significant percentage of its 2008 vehicles to strong hybrid design.

Table III.D.6–2 shows the usage level of the same technologies in the reference case fleet after projecting their compliance with the 2011 MY CAFE standards. Except for mass reduction, the figures shown represent the percentages of each manufacturer's sales which are projected to be equipped with the indicated technology. For mass reduction, the overall mass reduction projected for that manufacturer's sales is shown. The last row in Table III.D.6–2 shows the increase in projected technology penetration due to compliance with the 2011 MY CAFE standards. The results of DOT's Volpe Modeling were used to project that all manufacturers would comply with the 2011 MY standards in 2016 without the need to pay fines, with one exception. This exception was Porsche in the case of their car fleet. When projecting Porsche's compliance with the 2011 MY CAFE standard for cars, the car fleet was assumed to achieve a CO_2 emission level of 293.2 g/mi instead of the required 285.2 g/mi level (30.3 mpg instead of 31.2 mpg).

TABLE III.D.6–2—PENETRATION OF TECHNOLOGY UNDER 2011 MY CAFE STANDARDS IN 2016 SALES: CARS AND TRUCKS

[Percent of sales]

	GDI	GDI+ deac	GDI+ turbo	6 Speed or CV trans	Dual clutch trans	Start-stop	Hybrid	Mass reduction (percent)
BMW	7.3	11.1	0.0	86.3	11.1	11.1	0.1	0.5
Chrysler	0.0	0.0	0.0	27.9	0.0	0.0	0.0	0.0
Daimler	16.4	10.3	14.3	45.8	36.0	24.6	0.0	0.9
Ford	0.6	0.0	0.0	28.1	0.0	0.0	0.0	0.0
General Motors	3.3	0.0	0.0	13.7	0.0	0.1	0.1	0.0
Honda	1.2	0.0	0.0	4.2	0.0	0.0	2.1	0.0
Hyundai	0.0	0.0	0.0	4.9	0.0	0.0	0.0	0.0
Kia	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0
Mazda	11.8	0.0	0.0	37.1	0.0	0.0	0.0	0.0
Mitsubishi	0.0	2.2	0.0	76.0	2.2	2.2	0.1	0.0
Nissan	17.7	0.0	0.0	33.3	0.0	0.0	0.0	0.0
Porsche	0.0	25.0	23.2	0.0	48.2	37.1	0.0	1.2
Subaru	0.0	0.0	0.0	29.0	0.0	0.0	0.0	0.0
Suzuki	4.5	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Tata	14.5	60.9	0.0	14.5	60.9	60.9	0.0	2.6
Toyota	7.5	0.0	0.0	30.6	0.0	0.0	12.8	0.0
Volkswagen	51.2	6.9	11.8	60.8	29.6	18.7	0.0	0.3
Overall	6.7	1.2	0.8	25.4	2.6	2.0	2.8	0.1
Increase over 2008 MY	0.3	1.2	0.8	−1.7	2.0	2.0	0.0	0.0

As can be seen, the 2011 MY CAFE standards, when evaluated on an industry wide basis, require only a modest increase in the use of these technologies. Higher speed automatic transmission use actually decreases due to conversion of these units to more efficient designs such as automated manual transmissions and hybrids. However, the impact of the 2011 MY CAFE standards is much greater on selected manufacturers, particularly BMW, Daimler, Porsche, Tata (Jaguar/Land Rover) and VW. All of these manufacturers are projected to increase their use of advanced direct injection gasoline engine technology, advanced transmission technology, and start-stop technology. It should be noted that these manufacturers have traditionally paid fines under the CAFE program. However, with higher fuel prices and the lead-time available by 2016, these manufacturers would likely find it in their best interest to improve their fuel economy levels instead of continuing to pay fines (again with the exception of Porsche cars). While not shown, no gasoline engines were projected to be converted to diesel technology.

This 2008 baseline fleet, modified to meet 2011 standards, becomes our ''reference'' case. This is the fleet by which the control program (or 2016 rule) will be compared. Thus, it is also the fleet that would be assumed to exist in the absence of this rule. No air conditioning improvements are assumed for model year 2011 vehicles. The average CO_2 emission levels of this reference fleet vary slightly from 2012–2016 due to small changes in the vehicle sales by market segments and manufacturer. CO_2 emissions from cars range from 282–284 g/mi, while those from trucks range from 382–384 g/mi. CO_2 emissions from the combined fleet range from 316–320. These estimates are described in greater detail in Section 5.3.2.2 of the DRIA.

Conceptually, both EPA and NHTSA perform the same projection in order to develop their respective reference fleets. However, because the two agencies use two different models to modify the baseline fleet to meet the 2011 CAFE standards, the technology added will be slightly different. The differences, however, are small since most manufacturers do not require a lot of additional technology to meet the 2011 standards.

EPA then used the OMEGA model once again to project the level of technology needed to meet the proposed 2016 CO_2 emission standards. Using the results of the OMEGA model, every manufacturer was projected to be able to meet the proposed 2016 standards with the technology described above except for four: BMW, VW, Porsche and Tata due to the OMEGA cap on technology penetration by manufacturer. For these manufacturers, the results presented below are those with the fully allowable application of technology and not for the technology projected to enable compliance with the proposed standards. Described below are a number of potential feasible solutions for how these companies can achieve compliance. The overall level of technology needed to meet the proposed 2016 standards is shown in Table III.D.6–3. As discussed above, all manufacturers are projected to improve the air conditioning systems on 85% of their 2016 sales.

TABLE III.D.6–3—PENETRATION OF TECHNOLOGY FOR PROPOSED 2016 CO_2 STANDARDS: CARS AND TRUCKS

[Percent of sales]

	GDI	GDI+ deac	GDI+ turbo	6 Speed auto trans	Dual clutch trans	Start-stop	Hybrid	Mass reduction
BMW	4	35	47	15	71	71	14	5
Chrysler	51	28	3	37	51	51	0	6
Daimler	3	44	39	11	73	72	13	5
Ford	29	39	13	19	67	67	0	6
General Motors	34	26	7	13	55	55	0	5
Honda	24	1	2	10	22	22	2	2
Hyundai	28	3	14	3	43	43	0	3
Kia	37	0	5	7	35	35	0	3
Mazda	54	2	16	31	43	43	0	4
Mitsubishi	65	2	7	22	66	66	0	6
Nissan	29	26	5	34	57	56	1	5
Porsche	7	36	49	10	70	70	15	4
Subaru	46	4	14	0	64	51	0	4
Suzuki	66	5	8	9	69	69	0	4
Tata	4	81	0	14	70	70	15	6
Toyota	37	2	0	30	33	16	13	2
Volkswagen	9	26	58	12	72	70	15	4
Overall	30	18	10	19	49	45	4	4
Increase over 2011 CAFE	24	17	9	−7	46	43	1	4

As can be seen, the overall average reduction in vehicle weight is projected to be 4%. This reduction varies across the two vehicle classes and vehicle base weight. For cars below 2,950 pounds curb weight, the average reduction is 2.3% (62 pounds), while the average was 4.4% (154 pounds) for cars above 2,950 curb weight. For trucks below 3,850 pounds curb weight, the average reduction is 3.5% (119 pounds), while it was 4.5% (215 pounds) for trucks above 3,850 curb weight. Splitting trucks at a higher weight, for trucks below 5,000 pounds curb weight, the average reduction is 3.3% (140 pounds), while it was 6.7% (352 pounds) for trucks above 5,000 curb weight.

The levels of requisite technologies differ significantly across the various manufacturers. Therefore, several analyses were performed to ascertain the cause. Because the baseline case fleet consists of 2008 MY vehicle designs, these analyses were focused on these vehicles, their technology and their CO_2 emission levels.

Comparing CO_2 emissions across manufacturers is not a simple task. In addition to widely varying vehicle styles, designs, and sizes, manufacturers have implemented fuel efficient technologies to varying degrees, as indicated in Table III.D.6–1. The projected levels of requisite technology to enable compliance with the proposed 2016 standards shown in Table III.D.6–3 account for two of the major factors which can affect CO_2 emissions: (1) Level of technology already being utilized and (2) vehicle size, as represented by footprint.

For example, the fuel economy of a manufacturer's 2008 vehicles may be relatively high because of the use of advanced technology. This is the case with Toyota's high sales of their Prius hybrid. However, the presence of this technology in a 2008 vehicle eliminates the ability to significantly reduce CO_2 further through the use of this technology. In the extreme, if a manufacturer were to hybridize a high level of its sales in 2016, it doesn't matter whether this technology was present in 2008 or whether it would be added in order to comply with the standards. The final level of hybrid technology would be the same. Thus, the level at which technology is present in 2008 vehicles does not explain the difference in requisite technology levels shown in Table III.D.6–3.

Similarly, the proposed CO_2 emission standards adjust the required CO_2 level according to a vehicle's footprint, requiring lower absolute emission levels from smaller vehicles. Thus, just because a manufacturer produces larger vehicles than another manufacturer does not explain the differences seen in Table III.D.6–3.

In order to remove these two factors from our comparison, the EPA lumped parameter model described above was used to estimate the degree to which technology present on each 2008 MY vehicle in our reference fleet was improving fuel efficiency. The effect of this technology was removed and each vehicle's CO_2 emissions were estimated as if it utilized no additional fuel efficiency technology beyond the baseline. The differences in vehicle size were accounted for by determining the difference between the sales-weighted average of each manufacturer's ''no technology'' CO_2 levels to their required CO_2 emission level under the proposed 2016 standards. The industry-wide difference was subtracted from each manufacturer's value to highlight which manufacturers had lower and higher than average ''no technology'' emissions. The results are shown in Figure III.D.6–1.

BILLING CODE 4910–59–P

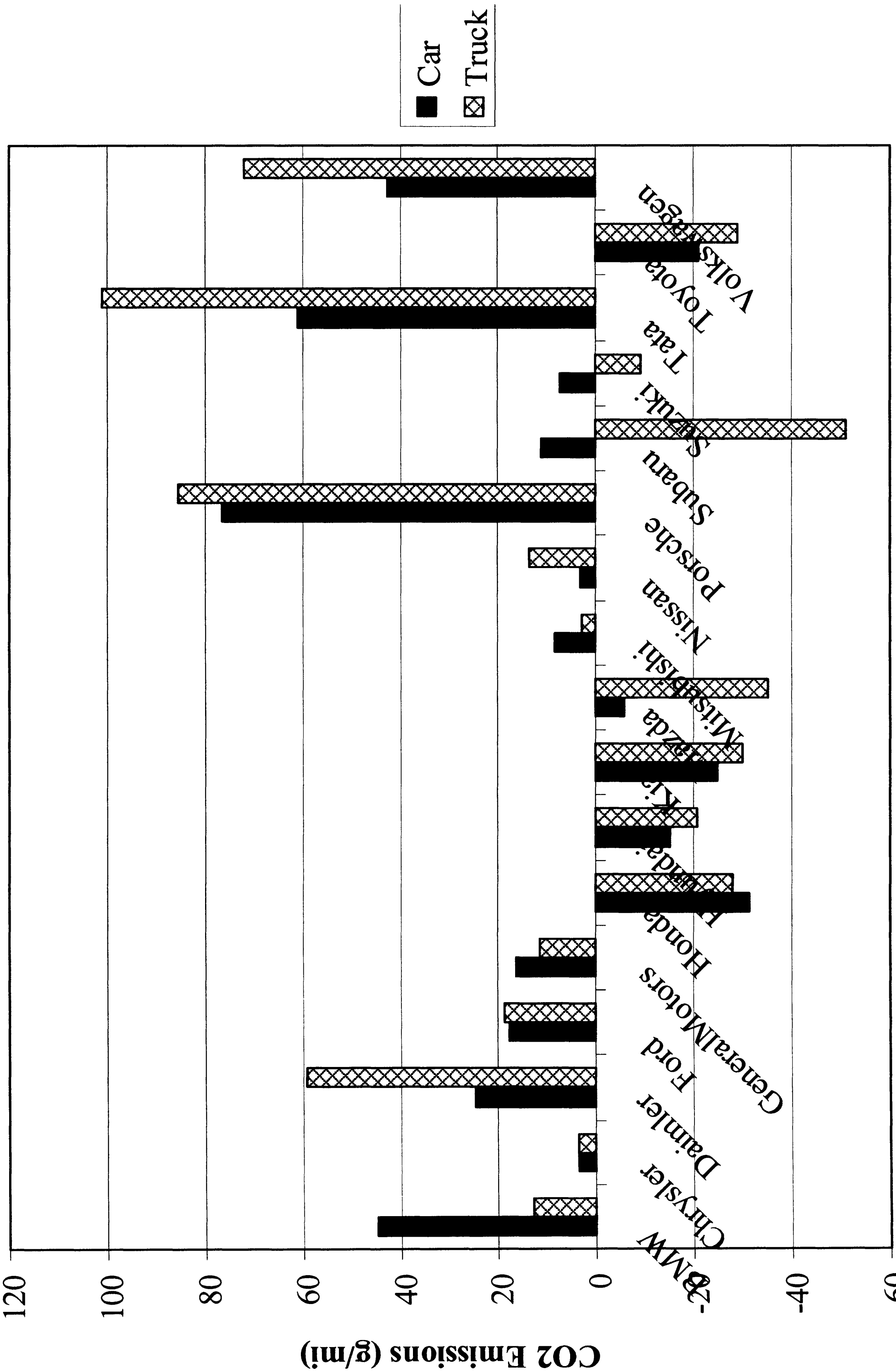


Figure III.D.6-1 CO_2 Emissions Relative to Fleet Adjusted for Technology and Footprint

As can be seen in Table III.D.6–3 the manufacturers projected to require the greatest levels of technology also show the highest offsets relative to the industry. The greatest offset shown in Figure III.D.6–1 is for Tata's trucks (Land Rover). These vehicles are estimated to have 100 g/mi greater CO_2 emissions than the average 2008 MY truck after accounting for differences in the use of fuel saving technology and footprint. The lowest adjustment is for Subaru's trucks, which have 50 g/mi CO_2 lower emissions than the average truck.

While this comparison confirms the differences in the technology penetrations shown in Table III.D.6–3, it does not yet explain why these differences exist. Two well known factors affecting vehicle fuel efficiency are vehicle weight and performance. The footprint-based form of the proposed CO_2 standard accounts for most of the difference in vehicle weight seen in the 2008 MY fleet. However, even at the same footprint, vehicles can have varying weights. Higher performing vehicles also tend to have higher CO_2 emissions over the two-cycle test procedure. So manufacturers with higher average performance levels will tend to have higher average CO_2 emissions for any given footprint.

The impact of these two factors on each manufacturer's ''no technology'' CO_2 emissions was estimated. First, the ''no technology'' CO_2 emissions levels were statistically analyzed to determine the average impact of weight and the ratio of horsepower to weight on CO_2 emissions. Both factors were found to be statistically significant at the 95 percent confidence level. Together, they explained over 80 percent of the variability in vehicles' CO_2 emissions for cars and over 70 percent for trucks. These relationships were then used to adjust each vehicle's ''no technology'' CO_2 emissions to the average weight for its footprint value and to the average horsepower to weight ratio of either the car or truck fleet. The comparison was repeated as shown in Figure III.D.6–1. The results are shown in Figure III.D.6–2.

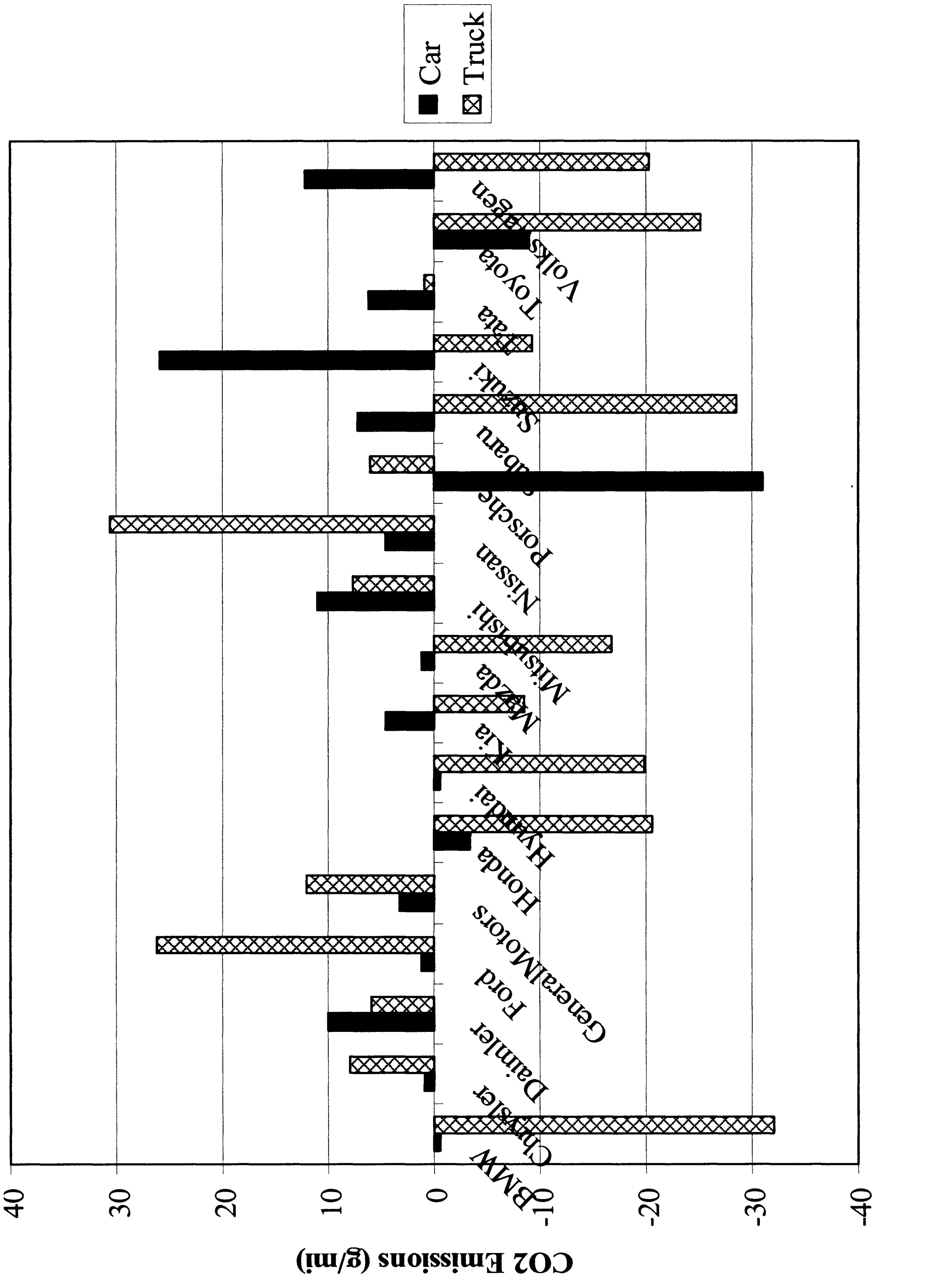


Figure III.D.6-2 CO_2 Emissions Relative to Fleet Adjusted for Technology, Footprint, Weight at Footprint, and Performance

BILLING CODE 4910–59–C

First, note that the scale in Figure III.D.6–2 is much smaller by a factor of 3 than that in Figure III.D.6–1. In other words, accounting for differences in vehicle weight (at constant footprint) and performance dramatically reduces the differences in various manufacturers' CO_2 emissions. Most of the manufacturers with high offsets in Figure III.D.6–1 now show low or negative offsets. For example, BMW's and VW's trucks show very low CO_2 emissions. Tata's emissions are very close to the industry average. Daimler's vehicles are no more than 10 g/mi above the average for the industry. This analysis indicates that the primary reasons for the differences in technology penetrations shown for the various manufacturers in Table III.D.6–3 are weight and performance. EPA has not determined why some manufacturers' vehicle weight is relatively high for its footprint value, or whether this weight provides additional utility for the consumer. Performance is more straightforward. Some consumers desire high performance and some manufacturers orient their sales towards these consumers. However, the cost in terms of CO_2 emissions is clear. Producing relatively heavy or high performance vehicles increases CO_2 emissions and will require greater levels of technology in order to meet the proposed CO_2 standards.

As can be seen from Table III.D.6–3 above, widespread use of several technologies is projected due to the proposed standards. The vast majority of engines are projected to be converted to direct injection, with some of these engines including cylinder deactivation or turbocharging and downsizing. More than 60 percent of all transmissions are projected to be either high speed automatic transmissions or dual-clutch automated manual transmissions. More than one third of the fleet is projected to be equipped with 42 volt start-stop capability. This technology was not utilized in 2008 vehicles, but as discussed above, promises significant fuel efficiency improvement at a moderate cost.

EPA foresees no significant technical or engineering issues with the projected deployment of these technologies across the fleet, with their incorporation being folded into the vehicle redesign process. All of these technologies are commercially available now. The automotive industry has already begun to convert its port fuel-injected gasoline engines to direct injection. Cylinder deactivation and turbocharging technologies are already commercially available. As indicated in Table III.D.6–1, high speed transmissions are already widely used. However, while more common in Europe, automated manual transmissions are not currently used extensively in the U.S. Widespread use of this technology would require significant capital investment but does not present any significant technical or engineering issues. Start-stop systems also represent a significant challenge because of the complications involved in a changeover to a higher voltage electrical architecture. However, with appropriate capital investments (which are captured in the costs), these technology penetration rates are achievable within the timeframe of this rule. While most manufacturers have some plans for these systems, our projections indicate that their use may exceed 35 percent of sales, with some manufacturers requiring higher levels.

Most manufacturers would not have to hybridize any vehicles due to the proposed standards. The hybrids shown for Toyota are projected to be sold even in the absence of the proposed standards. However the relatively high hybrid penetrations (15%) projected for BMW, Daimler, Porsche, Tata and Volkswagen deserve further discussion. These manufacturers are all projected by the OMEGA model to utilize the maximum application of full hybrids allowed by our model in this time frame, which is 15 percent.

As discussed in the EPA DRIA, a 2016 technology penetration rate of 85% is projected for the vast majority of available technologies, however, for full hybrid systems the projection shows that given the available lead-time full hybrids can only be applied to approximately 15% of a manufacturer's fleet. This number of course can vary by manufacturer.

While the hybridization levels of BMW, Daimler, Porsche, Tata and Volkswagen are relatively high, the sales levels of these five manufacturers are relatively low. Thus, industry-wide, hybridization reaches only 8 percent, compared with 3 percent in the reference case. This 8 percent level is believed to be well within the capability of the hybrid component industry by 2016. Thus, the primary challenge for these five companies would be at the manufacturer level, redesigning a relatively large percentage of sales to include hybrid technology. The proposed TLAAS provisions will provide significant aid to these manufacturers in pre-2016 compliance, since all qualified companies are expected to be able to take advantage of these provisions. By 2016, it is likely that these manufacturers would also be able to change vehicle characteristics which currently cause their vehicles to emit much more CO_2 than similar sized vehicles produced by other manufacturers. These factors may include changes in model mix, further lightweighting, downpowering, electric and/or plug-in hybrid vehicles, or downsizing (our current baseline fleet assumes very little change in footprint from 2012–2016), as well as technologies that may not be included in our packages. Also, companies may have technology penetration rates of less costly technologies (listed in the above tables) greater than 85%, and they may also be able to apply hybrid technology to more than 15 percent of their fleet (as the 15% for hybrid technology is an industry average). For example, a switch to a low GWP alternative refrigerant in a large fraction of a fleet can replace many other much more costly technologies, but this option is not captured in the modeling. In addition, these manufacturers can also take advantage of flexibilities, such as early credits for air conditioning and trading with other manufacturers. The EPA expects that there will be certain high volume manufacturers that will earn a significant amount of early GHG credits starting in 2009 and 2010 that will expire 5 years later, by 2014 and 2015, unused. The EPA believes that these manufacturers will be willing to sell these expiring credits to manufacturers with whom there is no direct competition. Furthermore, some of these manufacturers have also stated either publicly or in confidential discussions with EPA that they will be able to comply with 2016 standards. Because of the confidential nature of this information sharing, EPA is unable to capture these packages specifically in our modeling. The following companies have all submitted letters in support of the national program, including the 2016 MY levels discussed above: BMW, Chrysler, Daimler, Ford, GM, Honda, Mazda, Toyota, and Volkswagen. This supports the view that the emissions reductions needed to achieve the standards are technically and economically feasible for all these companies, and that EPA's projection of non-compliance for four of the companies is based on an inability of our model to fully account for the full flexibilities of the EPA program as well as the potentially unique technology approaches or new product offerings which these manufactures are likely to employ.

In addition, manufacturers do not need to apply technology exactly according to our projections. Our projections simply indicate one path which would achieve compliance. Those manufacturers whose vehicles are heavier and higher performing than average in particular have additional options to facilitate compliance and reduce their technological burden closer to the industry average. These options include decreasing the mass of the vehicles and/or decreasing the power output of the engines. Finally, EPA allows compliance to be shown through the use of emission credits obtained from other manufacturers. Especially for the lower volume sales of some manufacturers that could be one component of an effective compliance strategy, reducing the technology that needs to be employed on their vehicles.

For the vast majority of light-duty cars and trucks, manufacturers have available to them a range of technologies that are currently commercially available and can feasibly be employed in their vehicles by MY 2016. Our modeling projects widespread use of these technologies as a technologically feasible approach to complying with the proposed standards.

In sum, EPA believes that the emissions reductions called for by the proposed standards are technologically feasible, based on projections of widespread use of commercially available technology, as well as use by some manufacturers of other technology approaches and compliance flexibilities not fully reflected in our modeling.

EPA also projected the cost associated with these projections of technology penetration. Table III.D.6–4 shows the cost of technology in order for manufacturers to comply with the 2011 MY CAFE standards, as well as those associated with the proposed 2016 CO_2 emission standards. The latter costs are incremental to those associated with the 2011 MY standards and also include $60 per vehicle, on average, for the cost of projected use of improved air-conditioning systems.[163]

TABLE III.D.6–4—COST OF TECHNOLOGY PER VEHICLE IN 2016 ($2007)

	2011 MY CAFE standards			Proposed 2016 CO_2 standards		
	Cars	Trucks	All	Cars	Trucks	All
BMW	$319	$479	$361	$1,701	$1,665	$1,691
Chrysler	7	125	59	1,331	1,505	1,408
Daimler	431	632	495	1,631	1,357	1,543
Ford	28	211	109	1,435	1,485	1,457
General Motors	28	136	73	969	1,782	1,311
Honda	0	0	0	606	695	633
Hyundai	0	76	14	739	1,680	907
Kia	0	48	8	741	1,177	812
Mazda	0	0	0	946	1,030	958
Mitsubishi	96	322	123	1,067	1,263	1,090
Nissan	0	19	6	1,013	1,194	1,064
Porsche	535	1,074	706	1,549	666	1,268
Subaru	64	100	77	903	1,329	1,057
Suzuki	99	231	133	1,093	1,263	1,137
Tata	691	1,574	1,161	1,270	674	952
Toyota	0	0	0	600	436	546
Volkswagen	269	758	354	1,626	949	1,509
Overall	47	141	78	968	1,214	1,051

As can be seen, the industry average cost of complying with the 2011 MY CAFE standards is quite low, $78 per vehicle. The range of costs across manufacturers is quite large, however. Honda, Mazda and Toyota are projected to face no cost, while Daimler, Porsche and Tata face costs of at least $495 per vehicle. As described above, these last three manufacturers face such high costs to meet even the 2011 MY CAFE standards due to both their vehicles' weight per unit footprint and performance. Also, these cost estimates apply to sales in the 2016 MY. These three manufacturers, as well as others like Volkswagen, may choose to pay CAFE fines prior to this or even in 2016.

As shown in the last row of Table III.D.6–4, the average cost of technology to meet the proposed 2016 standards for cars and trucks combined relative to the 2011 MY CAFE standards is $1051 per vehicle. The projection shows that the average cost for cars would be slightly lower than that for trucks. Toyota and Honda show projected costs significantly below the average, while BMW, Porsche, Tata and Volkswagen show significantly higher costs. On average, the $1051 per vehicle cost is significant, representing roughly 5% of the total cost of a new vehicle. However, as discussed below, the fuel savings associated with the proposed standards exceeds this cost significantly.

While the CO_2 emission compliance modeling using the OMEGA model focused on the proposed 2016 MY standards, EPA believes that the proposed standards for 2012–2015 would also be feasible. As discussed above, EPA believes that manufacturers develop their vehicle designs with several model years in view. Generally, the technology estimated above for 2016 MY vehicles represents the technology which would be added to those vehicles which are being redesigned in 2012–2015. The proposed CO_2 standards for 2012–2016 reduce CO_2 emissions at a fairly steady rate. Thus, manufacturers which redesign their vehicles at a fairly steady rate will automatically comply with the interim standard as they plan for compliance in 2016.

Manufacturers which redesign much fewer than 20% of their sales in the early years of the proposed program would face a more difficult challenge, as simply implementing the ''2016 MY'' technology as vehicles are redesigned may not enable compliance in the early years. However, even in this case, manufacturers would have several options to enable compliance. One, they could utilize the proposed debit carry-forward provisions described above. This may be sufficient alone to enable compliance through the 2012–2016 MY time period, if their redesign schedule exceeds 20% per year prior to 2016. If not, at some point, the manufacturer might need to increase their use of technology beyond that projected above in order to generate the credits necessary to balance the accrued debits. For most manufacturers representing the vast majority of U.S. sales, this would simply mean extending the same technology to a greater percentage of sales. The added cost of this in the later years of the program would be balanced by lower costs in the earlier years. Two, the manufacturer could buy credits from another manufacturer. As indicated above, several manufacturers are projected to require less stringent technology than the average. These manufacturers would be in a position to provide credits at a reasonable technology cost. Thus, EPA believes the proposed standards for 2012–2016 would be feasible.

7. What Other Fleet-Wide CO_2 Levels Were Considered?

Two alternative sets of CO_2 standards were considered. One set would reduce

[163] Note that the actual cost of the A/C technology is estimated at $78 per vehicle as shown in Table III.D.2–3. However, we expect only 85 percent of the fleet to add that technology. Therefore, the cost of the technology when spread across the entire fleet is $66 per vehicle ($78×85%=$66).

CO_2 emissions at a rate of 4 percent per year. The second set would reduce CO_2 emissions at a rate of 6 percent per year. The analysis of these standards followed the exact same process as described above for the proposed standards. The only difference was the level of CO_2 emission standards. The footprint-based standard coefficients of the car and truck curves for these two alternative control scenarios were discussed above. The resultant CO_2 standards in 2016 for each manufacturer under these two alternative scenarios and under the proposal are shown in Table III.D.7–1.

TABLE III.D.7–1—OVERALL AVERAGE CO_2 EMISSION STANDARDS BY MANUFACTURER IN 2016

	4% per year	Proposed	6% per year
BMW	245	241	222
Chrysler	266	262	241
Daimler	257	253	233
Ford	270	266	245
General Motors	272	268	247
Honda	243	239	219
Hyundai	235	231	212
Kia	237	234	215
Mazda	231	227	208
Mitsubishi	226	223	204
Nissan	251	247	227
Porsche	234	230	210
Subaru	237	233	213
Suzuki	227	223	203
Tata	267	263	241
Toyota	247	243	223
Volkswagen	233	230	211
Overall	254	250	230

Tables III.D.7–2 and III.D.7–3 show the technology penetration levels for the 4 percent per year and 6 percent per year standards in 2016.

TABLE III.D.7–2—TECHNOLOGY PENETRATION—4% PER YEAR CO_2 STANDARDS IN 2016: CARS AND TRUCKS COMBINED

	GDI	GDI+ deac	GDI+ turbo	6 Speed auto trans	Dual clutch trans	Start-stop	Hybrid	Mass reduction (%)
BMW	4%	35%	47%	15%	71%	71%	14%	5
Chrysler	47	25	3	33	48	48	0	5
Daimler	3	44	39	11	73	72	13	5
Ford	33	32	13	23	61	61	0	5
General Motors	33	25	7	19	48	48	0	5
Honda	20	1	0	6	19	19	2	2
Hyundai	27	2	12	2	39	39	0	3
Kia	31	0	4	1	34	34	0	2
Mazda	34	2	16	10	43	43	0	3
Mitsubishi	65	2	7	28	60	60	0	6
Nissan	34	22	2	40	51	51	1	5
Porsche	7	36	49	10	70	70	15	4
Subaru	46	4	14	10	54	46	0	3
Suzuki	72	5	2	15	63	63	0	4
Tata	4	81	0	14	70	70	15	6
Toyota	25	2	0	30	33	5	13	1
Volkswagen	9	26	58	12	72	70	15	4
Overall	28	17	9	20	45	40	4	4
Increase over 2011 CAFE	21	15	9	−5	42	38	1	4

TABLE III.D.7–3—TECHNOLOGY PENETRATION—6% PER YEAR ALTERNATIVE STANDARDS IN 2016: CARS AND TRUCKS COMBINED

	GDI	GDI+ deac	GDI+ turbo	6 Speed auto trans	Dual clutch trans	Start-stop	Hybrid	Weight reduction (%)
BMW	4%	35%	47%	15%	71%	71%	14%	5
Chrysler	29	50	6	4	85	85	0	8
Daimler	3	44	39	11	73	72	13	5
Ford	8	37	40	4	74	74	11	7
General Motors	24	54	8	6	81	81	0	8
Honda	38	1	15	8	50	50	2	4
Hyundai	36	9	28	7	66	66	0	5
Kia	48	0	25	18	55	55	0	4
Mazda	65	2	16	4	81	76	0	6

TABLE III.D.7–3—TECHNOLOGY PENETRATION—6% PER YEAR ALTERNATIVE STANDARDS IN 2016: CARS AND TRUCKS COMBINED—Continued

	GDI	GDI+ deac	GDI+ turbo	6 Speed auto trans	Dual clutch trans	Start-stop	Hybrid	Weight reduction (%)
Mitsubishi	59	7	19	7	80	80	5	8
Nissan	34	17	35	9	76	76	10	7
Porsche	7	36	49	10	70	70	15	4
Subaru	66	4	14	0	85	80	0	6
Suzuki	2	12	71	0	80	80	5	7
Tata	4	81	0	14	70	70	15	6
Toyota	40	7	11	25	50	50	13	3
Volkswagen	9	26	58	12	72	70	15	4
Overall	28	24	23	11	67	67	7	6
Increase over 2011 CAFE	22	23	22	−15	65	65	4	6

With respect to the 4 percent per year standards, the levels of requisite control technology decreased relative to those under the proposed standards, as would be expected. Industry-wide, the largest decrease was a 2 percent decrease in the application of start-stop technology. On a manufacturer specific basis, the most significant decreases were a 6 percent decrease in hybrid penetration for BMW and a 2 percent drop for Daimler. These are relatively small changes and are due to the fact that the 4 percent per year standards only require 4 g/mi CO_2 less control than the proposed standards in 2016. Porsche, Tata and Volkswagen continue to be unable to comply with the CO_2 standards in 2016.

With respect to the 6 percent per year standards, the levels of requisite control technology increased relative to those under the proposed standards, as again would be expected. Industry-wide, the largest increase was an 8 percent increase in the application of start-stop technology. On a manufacturer specific basis, the most significant increases were a 42 percent increase in hybrid penetration for BMW and a 38 percent increase for Daimler. These are more significant changes and are due to the fact that the 6 percent per year standards require 20 g/mi CO_2 more control than the proposed standards in 2016. Porsche, Tata and Volkswagen continue to be unable to comply with the CO_2 standards in 2016. However, BMW joins this list, as well, though just by 1 g/mi. Most manufacturers experience the increase in start-stop technology application, with the increase ranging from 5 to 17 percent.

Table III.D.7–4 shows the projected cost of the two alternative sets of standards.

TABLE III.D.7–4—TECHNOLOGY COST PER VEHICLE IN 2016—ALTERNATIVE STANDARDS ($2007)

	4 Percent per year standards			6 Percent per year standards		
	Cars	Trucks	All	Cars	Trucks	All
BMW	$1,701	$1,665	$1,691	$1,701	$1,665	$1,691
Chrysler	1,340	1,211	1,283	1,642	2,211	1,893
Daimler	1,631	1,357	1,543	1,631	1,357	1,543
Ford	1,429	1,305	1,374	2,175	2,396	2,273
General Motors	969	1,567	1,221	1,722	2,154	1,904
Honda	633	402	564	777	1,580	1,016
Hyundai	685	1,505	832	1,275	1,680	1,347
Kia	741	738	741	1,104	1,772	1,213
Mazda	851	914	860	1,369	1,030	1,320
Mitsubishi	1,132	247	1,028	1,495	2,065	1,563
Nissan	910	1,194	991	1,654	2,274	1,830
Porsche	1,549	666	1,268	1,549	666	1,268
Subaru	903	1,131	985	1,440	1,615	1,503
Suzuki	1,093	1,026	1,076	1,718	2,219	1,846
Tata	1,270	674	952	1,270	674	952
Toyota	518	366	468	762	1,165	895
Volkswagen	1,626	949	1,509	1,626	949	1,509
Overall	940	1,054	978	1,385	1,859	1,544

As can be seen, the average cost of the 4 percent per year standards is only $73 per vehicle less than that for the proposed standards. In contrast, the average cost of the 6 percent per year standards is nearly $500 per vehicle more than that for the proposed standards. Compliance costs are entering the region of non-linearity. The $73 cost savings of the 4 percent per year standards relative to the proposal represents $18 per g/mi CO_2 increase. The $493 cost increase of the 6 percent per year standards relative to the proposal represents $25 per g/mi CO_2 increase.

EPA does not believe the 4% per year alternative is an appropriate standard for the MY2012–2016 time frame. As discussed above, the 250 g/mi proposal is technologically feasible in this time frame at reasonable costs, and provides higher GHG emission reductions at a modest cost increase over the 4% per year alternative (less than $100 per vehicle). In addition, the 4% per year alternative does not result in a harmonized National Program for the country. Based on California's letter of May 18, 2009, the emission standards under this alternative would not result in the State of California revising its regulations such that compliance with

EPA's GHG standards would be deemed to be in compliance with California's GHG standards for these model years. Thus, the consequence of promulgating a 4% per year standard would be to require manufacturers to produce two vehicle fleets: a fleet meeting the 4% per year *Federal* standard, and a separate fleet meeting the more stringent California standard for sale in California and the section 177 States. This further increases the costs of the 4% per year standard and could lead to additional difficulties for the already stressed automotive industry.

EPA also does not believe the 6% per year alternative is an appropriate standard for the MY 2012–2016 time frame. As shown in Tables III.D.7–3 and III.D.7–4, the 6% per year alternative represents a significant increase in both the technology required and the overall costs compared to the proposed standards. In absolute percent increases in the technology penetration, compared to the proposed standards the 6% per year alternative requires for the industry as a whole: an 18% increase in GDI fuel systems, an 11% increase in turbo-downsize systems, a 6% increase in dual-clutch automated manual transmissions (DCT), and a 9% increase in start-stop systems. For a number of manufacturers the expected increase in technology is greater: for GM, a 15% increase in both DCTs and start-stop systems, for Nissan a 9% increase in full hybrid systems, for Ford an 11% increase in full hybrid systems, for Chrysler a 34% increase in both DCT and start-stop systems and for Hyundai a 23% increase in the overall penetration of DCT and start-stop systems. For the industry as a whole, the per-vehicle cost increase for the 6% per year alternative is nearly $500. On average this is a 50% increase in costs compared to the proposed standards. At the same time, CO_2 emissions would be reduced by about 8%, compared to the 250 g/mi target level.

These technology and cost increases are significant, given the amount of lead-time between now and model years 2012–2016. In order to achieve the levels of technology penetration for the proposed standards, the industry needs to invest significant capital and product development resources right away, in particular for the 2012 and 2013 model year, which is only 2–3 years from now. For the 2014–2016 time frame, significant product development and capital investments will need to occur over the next 2–3 year in order to be ready for launching these new products for those model years. Thus a major part of the required capital and resource investment will need to occur in the next few years, under the proposed standards. EPA believes that the proposal (a target of 250 gram/mile in 2016) already requires significant investment and product development costs for the industry, focused on the next few years.

It is important to note, and as discussed later in this preamble, as well as in the draft Joint Technical Support Document and the draft EPA Regulatory Impact Analysis document, the average model year 2016 per-vehicle cost increase of nearly $500 includes an estimate of both the increase in capital investments by the auto companies and the suppliers as well as the increase in product development costs. These costs can be significant, especially as they must occur over the next 2–3 years. Both the domestic and transplant auto firms, as well as the domestic and world-wide automotive supplier base, is experiencing one of the most difficult markets in the U.S. and internationally that has been seen in the past 30 years. One major impact of the global downturn in the automotive industry and certainly in the U.S. is the significant reductions in product development engineers and staffs, as well as a tightening of the credit markets which allow auto firms and suppliers to make the near-term capital investments necessary to bring new technology into production. EPA is concerned that the significantly increased pressure on capital and other resources from the 6% per year alternative may be too stringent for this time frame, given both the relatively limited amount of lead-time between now and model years 2012–2016, the need for much of these resources over the next few years, as well the current financial and related circumstances of the automotive industry. EPA is not concluding that the 6% per year alternative standards are technologically infeasible, but EPA believes such standards for this time frame would be overly stringent given the significant strain it would place on the resources of the industry under current conditions. EPA believes this degree of stringency is not warranted at this time. Therefore EPA does not believe the 6% per year alternative would be an appropriate balance of various relevant factors for model years 2012–1016.

These alternative standards represent two possibilities out of many. The EPA believes that the current proposed standards represent an appropriate balance of the factors relevant under section 202(a). For further discussion of this issue, see Chapter 4 of the DRIA.

E. Certification, Compliance, and Enforcement

1. Compliance Program Overview

This section of the preamble describes EPA's proposal for a comprehensive program to ensure compliance with EPA's proposed emission standards for carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4), as described in Section III.B. An effective compliance program is essential to achieving the environmental and public health benefits promised by these mobile source GHG standards. EPA's proposal for a GHG compliance program is designed around two overarching priorities: (1) To address Clean Air Act (CAA) requirements and policy objectives; and (2) to streamline the compliance process for both manufacturers and EPA by building on existing practice wherever possible, and by structuring the program such that manufacturers can use a single data set to satisfy both the new GHG and Corporate Average Fuel Economy (CAFE) testing and reporting requirements. The program proposed by EPA and NHTSA recognizes, and replicates as closely as possible, the compliance protocols associated with the existing CAA Tier 2 vehicle emission standards, and with CAFE standards. The certification, testing, reporting, and associated compliance activities closely track current practices and are thus familiar to manufacturers. EPA already oversees testing, collects and processes test data, and performs calculations to determine compliance with both CAFE and CAA standards. Under this proposed coordinated approach, the compliance mechanisms for both programs are consistent and non-duplicative.

Vehicle emission standards established under the CAA apply throughout a vehicle's full useful life. In this case EPA is proposing fleet average standards where compliance with the fleet average is determined based on the testing performed at time of production, as with the current CAFE fleet average. EPA is also proposing in-use standards that apply throughout a vehicle's useful life, with the standard determined by adding a 10% adjustment factor to the model-level emission results used to calculate the fleet average. Therefore, EPA's proposed program must not only assess compliance with the fleet average standards described in Section III.B, but must also assess compliance with the in-use standards. As it does now, EPA would use a variety of compliance mechanisms to conduct these assessments, including pre-production certification and post-production, in-use monitoring once vehicles enter customer service. Specifically, EPA is proposing a compliance program for the fleet average that utilizes CAFE program protocols with respect to testing, a certification procedure that operates in conjunction with the existing CAA Tier 2 certification procedures, and assessment of compliance with the in-use standards concurrent with existing EPA and manufacturer Tier 2 emission compliance testing programs. Under the proposed compliance program manufacturers would also be afforded numerous flexibilities to help achieve compliance, both stemming from the program design itself in the form of a manufacturer-specific CO_2 fleet average standard, as well as in various credit banking and trading opportunities, as described in Section III.C. EPA's proposed compliance program is outlined in further detail below. EPA requests comment on all aspects of the compliance program design including comments about whether differences between the proposed compliance scheme for GHG and the existing compliance scheme for other regulated pollutants are appropriate.

2. Compliance With Fleet-Average CO_2 Standards

Fleet average emission levels can only be determined when a complete fleet profile becomes available at the close of the model year. Therefore, EPA is proposing to determine compliance with the fleet average CO_2 standards when the model year closes out, as is currently the protocol under EPA's Tier 2 program as well as under the current CAFE program. The compliance determination would be based on actual production figures for each model and on model-level emissions data collected through testing over the course of the model year. Manufacturers would submit this information to EPA in an end-of-year report which is discussed in detail in Section III.E.5.h below.

Manufacturers currently conduct their CAFE testing over an entire model year to maximize efficient use of testing and engineering resources. Manufacturers submit their CAFE test results to EPA and EPA conducts confirmatory fuel economy testing at its laboratory on a subset of these vehicles under EPA's Part 600 regulations. EPA is proposing that manufacturers continue to perform the model level testing currently required for CAFE fuel economy performance and measure and report the CO_2 values for all tests conducted. Thus, manufacturers will submit one data set in satisfaction of both CAFE and GHG requirements such that EPA's proposed program would not impose additional timing or testing requirements on manufacturers beyond that required by the CAFE program. For example, manufacturers currently submit fuel economy test results at the subconfiguration and configuration levels to satisfy CAFE requirements. Under this proposal manufacturers would also submit CO_2 values for the same vehicles. Section III.E.3 discusses how this will be implemented in the certification process.

a. Compliance Determinations

As described in Section III.B above, the fleet average standards would be determined on a manufacturer by manufacturer basis, separately for cars and trucks, using the proposed footprint attribute curves. Under this proposal, EPA would calculate the fleet average emission level using actual production figures and, for each model type, CO_2 emission test values generated at the time of a manufacturer's CAFE testing. EPA would then compare the actual fleet average to the manufacturer's footprint standard to determine compliance, taking into consideration use of averaging and/or other types of credits.

Final determination of compliance with fleet average CO_2 standards may not occur until several years after the close of the model year due to the flexibilities of carry-forward and carry-back credits and the remediation of deficits (*see* Section III.C). A failure to meet the fleet average standard after credit opportunities have been exhausted could ultimately result in penalties and injunctive orders under the CAA as described in Section III.E.6 below.

EPA periodically provides mobile source emissions and fuel economy information to the public, for example through the annual Compliance Report [164] and Fuel Economy Trends Report.[165] EPA plans to expand these reports to include GHG performance and compliance trends information, such as annual status of credit balances or debits, use of various credit programs, attained versus projected fleet average emission levels, and final compliance status for a model year after credit reconciliation occurs. We seek comment on all aspects of public dissemination of GHG compliance information

b. Required Minimum Testing for Fleet Average CO_2

As noted, EPA is proposing that the same test data required for determining a manufacturer's compliance with the CAFE standard also be used to determine the manufacturer's compliance with the fleet average CO_2 emissions standard. CAFE requires manufacturers to submit test data representing at least 90% of the manufacturer's model year production, by configuration.[166] The CAFE testing covers the vast majority of models in a manufacturer's fleet. Manufacturers industry-wide currently test more than 1,000 vehicles each year to meet this requirement. EPA believes this minimum testing requirement is necessary and applicable for calculating accurate CO_2 fleet average emissions. Manufacturers may test additional vehicles, at their option. As described above, EPA would use the emissions results from the model-level testing to calculate a manufacturer's fleet average CO_2 emissions and to determine compliance with the CO_2 standard.

EPA is proposing to continue to allow certain testing flexibilities that exist under the CAFE program. EPA has always permitted manufacturers some ability to reduce their test burden in tradeoff for lower fuel economy numbers. Specifically the practice of ''data substitution'' enables manufacturers to apply fuel economy test values from a ''worst case'' configuration to other configurations in lieu of testing them. The substituted values may only be applied to configurations that would be expected to have better fuel economy and for which no actual test data exist. Substituted data would only be accepted for the GHG program if it is also used for CAFE purposes.

EPA's regulations for CAFE fuel economy testing permit the use of analytically derived fuel economy data in lieu of an actual fuel economy test in certain situations.[167] Analytically derived data is generated mathematically using expressions determined by EPA and is allowed on a limited basis when a manufacturer has not tested a specific vehicle configuration. This has been done as a means to reduce some of the testing burden on manufacturers without sacrificing accuracy in fuel economy measurement. EPA has issued guidance that provides details on analytically

[164] 2007 Progress Report Vehicle and Engine Compliance Activities; EPA–420–R–08–011; October 2008. This document is available electronically at *http://www.epa.gov/otaq/about/420r08011.pdf*.

[165] Light-Duty Automotive Technology and Fuel-Economy Trends: 1975 Through 2008; EPA–420–S–08–003; September 2008. This document is available electronically at *http://www.epa.gov/otaq/fetrends.htm*.

[166] *See* 40 CFR 600.010–08(d).

[167] 40 CFR 600.006–08(e).

derived data and that specifies the conditions when analytically derived fuel economy may be used. EPA would also apply the same guidance to the GHG program and would allow any analytically derived data used for CAFE to also satisfy the GHG data reporting requirements. EPA would, however, need to revise the terms in the current equations for analytically derived fuel economy to specify them in terms of CO_2. Analytically derived CO_2 data would not be permitted for the Emission Data Vehicle representing a test group for pre-production certification, only for the determination of the model level test results used to determine actual fleet-average CO_2 levels.

EPA is retaining the definitions needed to determine CO_2 levels of each model type (such as ''subconfiguration,'' ''configuration,'' ''base level,'' *etc.*) as they are currently defined in EPA's fuel economy regulations.

3. Vehicle Certification

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.[168]

Under Tier 2 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.[169] 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 emission standard at issue. Emission results from the test vehicle are used to assign the test group to one of several specified bins of emissions levels, identified in the Tier 2 rule, and this bin level becomes the in-use emissions standard for that test group.[170]

[168] CAA section 206(a)(1).

[169] 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.

[170] Initially in-use standards were different from the bin level determined at certification as the useful life level. The current in-use standards, however, are the same as the bin levels. In all cases, the bin level, reflecting useful life levels, has been used for determining compliance with the fleet average.

Since compliance with the Tier 2 fleet average depends on actual test group sales volumes and bin levels, it is not possible to determine compliance at the time the manufacturer applies for and receives a certificate of conformity for a test group. Instead, 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 with the emissions bin assigned, and (2) contribute to fleetwide compliance with the Tier 2 average 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 Tier 2.

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 Tier 2 program is an efficient way for manufacturers to conduct the needed testing well in advance of certification, and to receive the needed certificates in a time frame which allows for the orderly production of vehicles. The use of a condition on the certificate has been an effective way to ensure compliance with the Tier 2 fleet average.

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.

a. Compliance Plans

EPA is proposing that manufacturers submit a compliance plan to EPA prior to the beginning of the model year and prior to the certification of any test group. This plan would include the manufacturer's estimate of its footprint-based standard (Section III.B), along with a demonstration of compliance with the standard based on projected model-level CO_2 emissions, and production estimates. Manufacturers would submit the same information to NHTSA in the pre-model year report required for CAFE compliance. However, the GHG compliance plan could also include additional information relevant only to the EPA program. For example, manufacturers seeking to take advantage of air conditioning or other credit flexibilities (Section III.C) 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 would review the compliance plan for technical viability and conduct a certification preview discussion with the manufacturer. EPA 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. EPA requests comment on the proposal to evaluate manufacturer compliance plans prior to the beginning of model year certification. EPA also requests comment on what criteria the agency should use to evaluate the sufficiency of the plan and on what steps EPA should take if it determines that a plan is unlikely to offset a deficit.

b. Certification Test Groups and Test Vehicle Selection

Manufacturers currently 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.[171] The factors considered for determining test groups include 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.[172] Cars and trucks may be included in the same test group as long as they have similar emissions performance (manufacturers frequently produce cars and trucks that have identical engine designs and emission controls).

EPA is proposing to retain the current Tier 2 test group structure for cars and light trucks in the certification requirements for CO_2. At the time of certification, manufacturers would use the CO_2 emission level from the Tier 2 Emission Data Vehicle as a surrogate to represent all of the models in the test group. However, following certification

[171] 40 CFR 86.1827–01.

[172] EPA provides for other groupings in certain circumstances, and can establish its own test groups in cases where the criteria do not apply. 40 CFR 86.1827–01(b), (c) and (d).

further testing would generally be required 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. Further discussion of these requirements is presented in Section III.E.6.

EPA recognizes that the Tier 2 test group criteria do not necessarily relate to CO_2 emission levels. 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 catalyst, may not. In fact, there are many vehicle design factors that impact CO_2 generation and emission but are not included in EPA's test group criteria.[173] Most important among these may be vehicle weight, horsepower, aerodynamics, vehicle size, and performance features.

EPA considered, but is not proposing, a requirement for separate CO_2 test groups established around criteria more directly related to CO_2 emissions. Although CO_2-specific test groups might more consistently predict CO_2 emissions of all vehicles in the test group, the addition of a CO_2 test group requirement would greatly increase the pre-production certification burden for both manufacturers and EPA. For example, a current Tier 2 test group would need to be split into two groups if automatic and manual transmissions models had been included in the same group. Two- and four-wheel drive vehicles in a current test group would similarly require separation, as would weight differences among vehicles. This would at least triple the number of test groups. EPA believes that the added burden of creating separate CO_2 test groups is not warranted or necessary to maintain an appropriately rigorous certification program because the test group data are later replaced by model specific data which are used as the basis for determining compliance with a manufacturer's fleet average standard.

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 would generally be the same as those used to control the criteria pollutants.

As just discussed, the "worst case" vehicle a manufacturer selects as the Emissions Data Vehicle to represent a test group under Tier 2 (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.

Therefore, in lieu of a separate CO_2-specific test group, EPA considered requiring manufacturers to select a CO_2 test vehicle from within the Tier 2 test group that would be expected, based on good engineering judgment, to have the highest CO_2 emissions within that test group. The CO_2 emissions results from this vehicle would be used to establish an in-use CO_2 emission standard for the test group. The requirement for a separate, worst case CO_2 vehicle would provide EPA with some assurance that all vehicles within the test group would have CO_2 emission levels at or below those of the selected vehicle, even if there is some variation in the CO_2 control strategies within the test group (such as different transmission types). Under this approach, the test vehicle might or might not be the same one that would be selected as worst case for criteria pollutants. Thus, manufacturers might be required to test two vehicles in each test group, rather than a single vehicle. This would represent an added timing burden to manufacturers because they might need to build additional test vehicles at the time of certification that previously weren't required to be tested.

Instead, EPA is proposing to require a single Emission Data Vehicle that would represent the test group for both Tier 2 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 CAFE testing that occurs later in the model year. 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 already occurs and data are already being submitted to EPA for CAFE and labeling purposes, so it would be an unusual situation that would cause a manufacturer to ignore these data and choose to accept a higher CO_2 fleet average.

EPA requests comment regarding whether the Tier 2 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 (*see* Section III.E.6) 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.

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% higher than the level used for that model in calculating the fleet average. The certificate would cover both of these standards, and the manufacturer would have 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 below in Section III.E.4.

c. Certification Testing Protocols and Procedures

To be consistent with CAFE, EPA proposes to combine the CO_2 emissions results from the FTP and HFET tests using the same calculation method used to determine fuel economy for CAFE purposes. This approach is appropriate for CO_2 because CO_2 and fuel economy are so closely related. Other than the fact that fuel economy is calculated using a harmonic average and CO_2 emissions can be calculated using a conventional average, the calculation methods are very similar. The FTP CO_2

[173] 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 at 38677 (Sept. 10, 1976).

data will be weighted at 55%, and the highway CO_2 data at 45%, and then averaged to determine the combined number. *See* Section III.B.1 for more detailed information on CO_2 test procedures, Section III.C.1 on Air Conditioning Emissions, and Section III.B.6 for N_2O and CH_4 test procedures.

For the purposes of compliance with the fleet average and in-use standards, the emissions measured from each test vehicle will include hydrocarbons (HC) and carbon monoxide (CO), in addition to CO_2. All three of these exhaust constituents are currently measured and used to determine the amount of fuel burned over a given test cycle using a ''carbon balance equation'' defined in the regulations, and thus measurement of these is an integral part of current fuel economy testing. As explained in Section III.C, it is important to account for the total carbon content of the fuel. Therefore the carbon-related combustion products HC and CO must be included in the calculations along with CO_2. CO emissions are adjusted by a coefficient that reflects the carbon weight fraction (CWF) of the CO molecule, and HC emissions are adjusted by a coefficient that reflects the CWF of the fuel being burned (the molecular weight approach doesn't work since there are many different hydrocarbons being accounted for). Thus, EPA is proposing that the carbon-related exhaust emissions of each test vehicle be calculated according to the following formula, where HC, CO, and CO_2 are in units of grams per mile:

Carbon-related exhaust emissions (grams/mile) = CWF*HC + 1.571*CO + CO_2

As part of the current CAFE and Tier 2 compliance programs, EPA selects a subset of vehicles for confirmatory testing at its National Vehicle and Fuel Emissions Laboratory. The purpose of confirmatory testing is to validate the manufacturer's emissions and/or fuel economy data. Under this proposal, EPA would add CO_2, N_2O, and CH_4 to the emissions measured in the course of Tier 2 and CAFE confirmatory testing. The emission values measured at the EPA laboratory would continue to stand as official, as under existing regulatory programs.

As is the current practice with fuel economy testing, if during EPA's confirmatory testing the EPA CO_2 value differs from the manufacturer's value by more than 3%, manufacturers could request a re-test. Also as with current practice, the results of the re-test would stand as official, even if they differ from the manufacturer value by more than 3%. EPA is proposing to allow a re-test request based on a 3% or greater disparity since a manufacturer's fleet average emissions level would be established on the basis of model level testing only (unlike Tier 2 for which a fixed bin standard structure provides the opportunity for a compliance buffer). EPA requests comment on whether the 3% value currently used during CAFE confirmatory testing is appropriate and should be retained under the proposed GHG program.

4. Useful Life Compliance

Section 202(a)(1) of the CAA requires emission standards to apply to vehicles throughout their statutory useful life, as further described in Section III.A. For emission programs that have fleet average standards, such as Tier 2 and the proposed CO_2 standards, the useful life requirement applies to individual vehicles rather than to the fleet average standard. For example, in Tier 2 the useful life requirements apply to the individual emission standard levels or ''bins'' that the vehicles are certified to, not the fleet average standard. For Tier 2, the useful life requirement is 10 years or 120,000 miles with an optional 15 year or 150,000 mile provision. For each model, the proposed CO_2 standards in-use are the model specific levels used in calculating the fleet average, adjusted to be 10% higher. EPA is proposing the 10% adjustment factor to provide some margin for production and test-to-test variability that could result in differences between initial model-level emission results used in calculating the fleet average and any subsequent in-use testing. EPA requests comment on whether a separate in-use standard is an appropriate means of addressing issues of variability and whether 10% is an appropriate adjustment.

This in-use standard would apply for the same useful life period as in Tier 2. Section 202(i)(3)(D) of the CAA allows EPA to adopt useful life periods for light-duty vehicles and light-duty trucks which differ from those in section 202(d). Similar to Tier 2, the useful life requirements would be applicable to the model-level CO_2 certification values (similar to the Tier 2 bins), not to the fleet average standard.

EPA believes that the useful life period established for criteria pollutants under Tier 2 is also appropriate for CO_2. Data from EPA's current in-use compliance test program indicate that CO_2 emissions from current technology vehicles increase very little with age and in some cases may actually improve slightly. The stable CO_2 levels are expected because unlike criteria pollutants, CO_2 emissions in current technology vehicles are not controlled by after treatment systems that may fail with age. Rather, vehicle CO_2 emission levels depend primarily on fundamental vehicle design characteristics that do not change over time. Therefore, vehicles designed for a given CO_2 emissions level would be expected to sustain the same emissions profile over their full useful life.

The CAA requires emission standards to be applicable for the vehicle's full useful life. Under Tier 2 and other vehicle emission standard programs, EPA requires manufacturers to demonstrate at the time of certification that the new vehicles being certified will continue to meet emission standards throughout their useful life. EPA allows manufacturers several options for predicting in-use deterioration, including full vehicle testing, bench-aging specific components, and application of a deterioration factor based on data and/or engineering judgment.

In the specific case of CO_2, EPA does not currently anticipate notable deterioration and is therefore proposing that an assigned deterioration factor be applied at the time of certification. EPA is further proposing an additive assigned deterioration factor of zero, or a multiplicative factor of one. EPA anticipates 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 may consider technology-specific deterioration factors, should data indicate that certain CO_2 control technologies deteriorate differently than others.

During compliance plan discussions prior to the beginning of the certification process, EPA would explore with each manufacturer any new technologies that could warrant use of a different deterioration factor. Manufacturers would not be allowed to use the assigned deterioration factor but rather would be required to establish an appropriate factor for any vehicle model determined likely to experience increases in CO_2 emissions over the vehicle's useful life. If such an instance were to occur, EPA is also proposing to allow manufacturers to use the whole-vehicle mileage accumulation method currently offered in EPA's regulations.

EPA requests comments on the proposal to allow manufacturers to use an EPA-assigned deterioration factor for CO_2 useful life compliance, and to set that factor at zero (additive) or one (multiplicative). Particularly helpful would be data from in-use vehicles that demonstrate the rate of change in CO_2 emissions over a vehicle's useful life, separated according to vehicle technology.

N_2O and CH_4 emissions are directly affected by vehicle emission control systems. Any of the durability options offered under EPA's current compliance program can be used to determine how emissions of N_2O and CH_4 change over time.

a. Ensuring Useful Life Compliance

The CAA requires a vehicle to comply with emission standards over its regulatory useful life and affords EPA broad authority for the implementation of this requirement. As such, EPA has authority to require a manufacturer to remedy any noncompliance issues. The remedy can range from the voluntary or mandatory recall of any noncompliant vehicles to the recalculation of a manufacturers fleet average emissions level. This provides manufacturers with a strong incentive to design and build complying vehicles.

Currently, EPA regulations require manufacturers to conduct in-use testing as a condition of certification. Specifically, manufacturers must commit to later procure and test privately-owned vehicles that have been normally used and maintained. 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 (IUVP) testing, which was first implemented as part of EPA's CAP 2000 certification program.[174] The emissions data collected from IUVP serves several purposes. It provides EPA with annual real-world in-use data representing the majority of certified vehicles. EPA uses IUVP data to identify in-use problems, validate the accuracy of the certification program, verify the manufacturer's durability processes, and support emission modeling efforts. Manufacturers are required to test low mileage and high mileage vehicles over the FTP and US06 test cycles. They are also required to provide evaporative emissions and on-board diagnostics (OBD) data.

Manufacturers are required to provide data for all regulated criteria pollutants. Some manufacturers voluntarily submit CO_2 data as part of IUVP. EPA is proposing that for IUVP testing, all manufacturers will provide emission data for CO_2 and also for N_2O and CH_4. EPA is also proposing that manufacturers perform the highway test cycle as part of IUVP. Since the proposed CO_2 standard reflects a combined value of FTP and highway results, it is necessary to include the highway emission test in IUVP to enable EPA to compare an in-use CO_2 level with a vehicle's in-use standard. EPA requests comments on adding the highway test cycle as part of the IUVP requirements.

Another component of the CAP 2000 certification program is the In-Use Confirmatory Program (IUCP). This is a manufacturer-conducted recall quality in-use test program that can be used as the basis for EPA to order an emission recall. In order to qualify for IUCP, there is a threshold of 1.30 times the certification emission standard and an additional requirement that at least 50% of the test vehicles for the test group fail for the same pollutant. EPA is proposing to exclude IUVP data for CO_2, N_2O, and CH_4 emissions from the IUCP thresholds. At this time, EPA does not have sufficient data to determine if the existing thresholds are appropriate or even applicable to those emissions. Once EPA can gather more data from the IUVP program and from EPA's internal surveillance program described below, EPA will reassess the need to exclude IUCP thresholds, and if warranted, propose a separate rulemaking establishing IUCP threshold criteria which may include CO_2, N_2O, and CH_4 emissions. EPA requests comment on the proposal to exclude CO_2, N_2O, and CH_4 from the IUCP threshold.

EPA has also administered its own in-use testing program for light-duty vehicles under authority of section 207(c) of the CAA for more than 30 years. In this program, EPA procures and tests representative privately owned vehicles to determine whether they are complying with emission standards. When testing indicates noncompliance, EPA works with the manufacturer to determine the cause of the problem and to conduct appropriate additional testing to determine its extent or the effectiveness of identified remedies. This program operates in conjunction with the IUVP program and other sources of information to provide a comprehensive picture of the compliance profile for the entire fleet and address compliance problems that are identified. EPA proposes to add CO_2, N_2O, and CH_4 to the emissions measurements it collects during surveillance testing.

b. In-Use Compliance Standard

For Tier 2, the in-use standard and the certification standard are the same. In-use compliance for an individual vehicle is determined by comparing the vehicle's in-use emission results with the emission standard levels or ''bin'' to which the vehicle is certified rather than to the Tier 2 fleet average standard for the manufacturer. This is because as part of a fleet average standard, individual vehicles can be certified to various emission standard levels, which could be higher or lower than the fleet average standard. Thus, comparing an individual vehicle to the fleet average, where that vehicle was certified to an emission level that could be different than the fleet average level, would be inappropriate.

This would also be true for the proposed CO_2 fleet average standard. Therefore, to ensure that an individual vehicle complies with the proposed CO_2 standards in-use, it is necessary to compare the vehicle's in-use CO_2 emission result with the appropriate model-level certification CO_2 level used in determining the manufacturer's fleet average result.

There is a fundamental difference between the proposed CO_2 standards and Tier 2 standards. For Tier 2, the certification standard is one of eight different emission levels, or ''bins,'' whereas for the proposed CO_2 fleet average standard, the certification standard is the model-level certification CO_2 result. The Tier 2 fleet average standard is calculated using the ''bin'' emission level or standard, not the actual certification emission level of the certification test vehicle. So no matter how low a manufacturer's actual certification emission results are, the fleet average is still calculated based on the ''bin'' level rather than the lower certification result. In contrast, EPA is proposing that the CO_2 fleet average standard would be calculated using the actual vehicle model-level CO_2 values from the certification test vehicles. With a known certification emission standard, such as the Tier 2 ''bins,'' manufacturers typically attempt to over-comply with the standard to give themselves some cushion for potentially higher in-use testing results due to emissions performance deterioration and/or variability that could result in higher emission levels during subsequent in-use testing. For our proposed CO_2 standards, the certification standard is the actual certification vehicle test result, thus manufacturers cannot over comply since the certification test vehicle result will always be the value used in determining the CO_2 fleet average. If the manufacturer attempted to design the vehicle to achieve a lower CO_2 value, similar to Tier 2 for in-use purposes, the new lower CO_2 value would simply become the new certification standard.

The CO_2 fleet average standard is based on the performance of pre-production technology that is

[174] 64 FR 23906, May 4, 1999.

representative of the point of production, and while there is expected to be limited if any deterioration in effectiveness for any vehicle during the useful life, the fleet average standard does not take into account the test to test variability or production variability that can affect in-use levels. Therefore, EPA believes that unlike Tier 2, it is necessary to have a different in-use standard for CO_2 to account for these variabilities. EPA is proposing to set the in-use standard at 10% higher than the appropriate model-level certification CO_2 level used in determining the manufacturer's fleet average result.

As described above, manufacturers typically design their vehicles to emit at emission levels considerably below the standards. This intentional difference between the actual emission level and the emission standard is referred to as ''certification margin,'' since it is typically the difference between the certification emission level and the emission standard. The certification margin can provide manufacturers with some protection from exceeding emission standards in-use, since the in-use standards are typically the same as the certification standards. For Tier 2, the certification margin is the delta between the specific emission standard level, or ''bin,'' to which the vehicle is certified, and the vehicle's certification emission level.

Since the level of the fleet average standard does not reflect this kind of variability, EPA believes it is appropriate to set an in-use standard that provides manufacturers with an in-use compliance factor of 10% that will act as a surrogate for a certification margin. The factor would only be applicable to CO_2 emissions, and would be applied to the model-level test results that are used to establish the model-level in-use standard.

If the in-use emission result for the vehicle exceeds the model-level CO_2 certification result multiplied by the in-use compliance factor of 10%, then the vehicle would have exceeded the in-use emission standard. The in-use compliance factor would apply to all in-use compliance testing including IUVP, selective enforcement audits, and EPA's internal test program.

The intent of the separate in-use standard, based on a 10% compliance factor adjustment, is to provide a reasonable margin such that vehicles are not automatically deemed as exceeding standards simply because of normal variability in test results. EPA has some concerns however that this in-use compliance factor could be perceived as providing manufacturers with the ability to design their fleets to generate CO_2 emissions up to 10% higher than the actual values they use to certify and to calculate the year end fleet average value that determines compliance with the fleet average standard. This concern provides additional rationale for requiring FTP and HFET IUVP data for CO_2 emissions to ensure that in-use values are not regularly 10% higher than the values used in the fleet average calculation. If in the course of reviewing a manufacturer's IUVP data it becomes apparent that a manufacturer's CO_2 results are consistently higher than the values used for certification, EPA would discuss the matter with the manufacturer and consider possible resolutions such as changes to ensure that the emissions test data more accurately reflects the emissions level of vehicles at the time of production, increased EPA confirmatory testing, and other similar measures.

EPA selected a value of 10% for the in-use standard based on a review of EPA's fuel economy labeling and CAFE confirmatory test results for the past several vehicle model years. The EPA data indicate that it is common for test variability to range between three to six percent and only on rare occasions to exceed 10%. EPA believes that a value of 10% should be sufficient to account for testing variability and any production variability that a manufacturer may encounter. EPA considered both higher and lower values. The Tier 2 fleet as a whole, for example, has a certification margin approaching 50%.[175] However, there are some fundamental differences between CO_2 emissions and other criteria pollutants in the magnitude of the pollutants. Tier 2 NMOG and NO_X emission standards are hundredths of a gram per mile (*e.g.,* 0.07 g/mi NO_X & 0.09 g/mi NMOG), whereas the CO_2 standards are four orders of magnitude greater (*e.g.,* 250 g/mi). Thus EPA does not believe it is appropriate to consider a value on the order of 50 percent. In addition, little deterioration in emissions control is expected in-use. The adjustment factor addresses only one element of what is usually built into a compliance margin.

EPA requests comments regarding a proposed in-use standard that uses an in-use compliance factor. Specifically, is a factor the best way to address the technical and other feasibility of the in-use standard; is 10% the appropriate factor; can EPA expect variability to decrease as manufacturing experience increases, in which case would it be appropriate for the in-use compliance factor of 10% to decrease over time? EPA especially requests any data to support such comments.

[175] *See* pages 39–41 of EPA's Vehicle and Engine Compliance Activities 2007 Progress Report (EPA–420–R–08–011) published in October 2008. This document is available electronically at *http://epa.gov/otaq/about/420r08011.pdf.*

5. Credit Program Implementation

As described in Section III.E.2 above, for each manufacturer's model year production, EPA is proposing that the manufacturer would average the CO_2 emissions within each of the two averaging sets (passenger cars and trucks) and compare that with its respective fleet average CO_2 standards (which in turn would have been determined from the appropriate footprint curve applicable to that model year). In addition to this within-company averaging, EPA is proposing that when a manufacturer's fleet average CO_2 emissions of vehicles produced in an averaging set over-complies compared to the applicable fleet average standard, the manufacturer could generate credits that it could save for later use (banking) or could transfer to another manufacturer (trading). Section III.C discusses opportunities that EPA is proposing for manufacturers to earn additional credits, beyond those simply calculated by ''over-achieving'' their applicable standard. Implementation of the credit program generally involves two steps: calculation of the credit amount and reporting the amount and the associated data and calculations to EPA.

Of the various credit programs being proposed by EPA, there are two broad types. One type of credit directly lowers a manufacturer's actual fleet average by virtue of being applied to the methodology for calculating the fleet average emissions. Examples of this type of credit include the credits available for alternative fuel vehicles and for advanced technology vehicles. The second type of credit is independent of the calculation of a manufacturer's fleet average. Rather than giving credit by lowering a manufacturer's fleet average via a credit mechanism, these credits (in megagrams) are calculated separately and are simply added to the manufacturer's overall ''bank'' of credits (or debits). Using a fictional example, the remainder of this section will step through the different types of credits and show where and how they are calculated and how they impact a manufacturer's available credits.

a. Basic Credits for a Fleet With Average CO_2 Emissions Below the Standard

Basic credits are earned by doing better than the applicable standard. Manufacturers calculate their standards (separate standards are calculated for cars and trucks) using the footprint-based equations described in Section III.B. A manufacturer's actual end-of-year fleet average CO_2 is calculated similarly to the way in which CAFE values are currently calculated; in fact, the regulations are essentially identical. The current CAFE calculation methods are in 40 CFR Part 600. EPA is proposing to amend key subparts and sections of Part 600 to require that fleet average CO_2 be calculated in a manner parallel to the way CAFE values are calculated. First manufacturers would determine a CO_2-equivalent value for each model type. The CO_2-equivalent value is a summation of the carbon-containing constituents of the exhaust emissions, with each weighted by a coefficient that reflects the carbon weight fraction of that constituent. For gasoline and diesel vehicles this simply involves measurement of total hydrocarbons and carbon monoxide in addition to CO_2, but becomes somewhat more complex for alternative fuel vehicles due to the different nature of their exhaust emissions. For example, for ethanol-fueled vehicles, the emission tests must measure ethanol, methanol, formaldehyde, and acetaldehyde in addition to CO_2. However, all these measurements are necessary to determine fuel economy and thus no new testing or data collection would be required. Second, manufacturers would calculate a fleet average by weighting the CO_2-equivalent value for each model type by the production of that model type, as they currently do for the CAFE program. Again, this would be done separately for cars and trucks. Finally, the manufacturer would compare the calculated standard with the average that is actually achieved to determine the credits (or debits). Both the determination of the applicable standard and the actual fleet average would be done after the model year is complete and using final model year production data.

Consider a basic example where Manufacturer ''A'' has calculated a car standard of 300 grams/mile and a fleet average of 290 grams/mile (Figure III.E.5–1). Further assume that the manufacturer produced 500,000 cars. The credit is calculated by taking the difference between the standard and the fleet average (300–290=10) and multiplying it by the production of 500,000. This result is then multiplied by the lifetime vehicle miles travelled (for cars this is 190,971 miles), then finally divided by 1,000,000 to convert from grams to total megagrams. The result is the number of CO_2 megagrams of credit (or deficit, if the manufacturer was not able to comply with the fleet average standard) generated by the manufacturer's car fleet. In this example, the result is 954,855 megagrams.

BILLING CODE 4910–59–P

Summary for Manufacturer A: Earning Basic Credits			
		CO_2	**Totals**
Total production	Conventional: 500,000		500,000
Fleet average standard		300 g/mi	
Fleet average		290 g/mi	
Credits	[(300-290) × 500,000 × 190,971] ÷ 1,000,000	=	954,855 Mg

Figure III.E.5-1 Summary for Manufacturer A: Earning Basic Credits

b. Advanced Technology Credits

Advanced technology credits directly impact a manufacturer's fleet average, thus increasing the amount of credits they earn (or reducing the amount of debits that would otherwise accrue). To earn these credits, manufacturers that produce electric vehicles, plug-in hybrid electric vehicles, or fuel cell electric vehicles would include these vehicles in the fleet average calculation with their model type emission values (0 g/m for electric vehicles and fuel cell electric vehicles, and a measured CO_2 value for plug-in hybrid electric vehicles), but would apply the proposed multiplier of 2.0 to the production volume of each of these vehicles. This approach would thus enhance the impact that each of these low-CO_2 advanced technology vehicles has on the manufacturer's fleet average.

EPA is proposing to limit availability of advanced technology credits to the technologies noted above, with the additional limitation that the vehicles must be certified to Tier 2 Bin 5 emission standards or cleaner (this obviously applies primarily to plug-in hybrid electric vehicles). EPA is proposing to use the following definitions to determine which vehicles are eligible for the advanced technology credits:

• *Electric vehicle* means a motor vehicle that is powered solely by an electric motor drawing current from a rechargeable energy storage system, such as from storage batteries or other portable electrical energy storage devices, including hydrogen fuel cells, provided that:

○ (1) Recharge energy must be drawn from a source off the vehicle, such as residential electric service; and

○ (2) The vehicle must be certified to the emission standards of Bin #1 of Table S04–1 in paragraph (c)(6) of § 86.1811.

• *Fuel cell electric vehicle* means a motor vehicle propelled solely by an electric motor where energy for the motor is supplied by a fuel cell.

• *Fuel cell* means an electrochemical cell that produces electricity via the reaction of a consumable fuel on the anode with an oxidant on the cathode in the presence of an electrolyte.

• *Plug-in hybrid electric vehicle (PHEV)* means a hybrid electric vehicle that: (1) Has the capability to charge the battery from an off-vehicle electric source, such that the off-vehicle source cannot be connected to the vehicle while the vehicle is in motion, and (2) has an equivalent all-electric range of no less than 10 miles.

With some simplifying assumptions, assume that 25,000 of Manufacturer A's fleet are now plug-in hybrid electric vehicles with CO_2 emissions of 100 g/mi, and the remaining 475,000 are conventional technology vehicles with average CO_2 emissions of 290 grams/mile. By applying the factor of 2.0 to the electric vehicle production numbers in the appropriate places in the fleet average calculation formula Manufacturer A now has more than 2.6 million credits (Figure III.E.5–2). Without the use of the multiplier Manufacturer A's fleet average would be 281 instead of 272, which would generate about 1.8 million credits.

Summary for Manufacturer A: Earning Basic and Advanced Technology Credits			
		CO_2	Totals
Total production	Conventional: 475,000 PHEV: 25,000	290 g/mi 100 g/mi	500,000
Fleet average standard		300 g/mi	
Fleet average	[(475,000 × 290) + ((2x25,000) × 100)] ÷ [475,000+(2×25,000)]	272 g/mi	
Credits	[(300-272) × 500,000 × 190,971] ÷ 1,000,000	=	2,673,594 Mg

Figure III.E.5-2 Summary for Manufacturer A: Earning Basic and Advanced Technology Credits

c. Flexible-Fuel Vehicle Credits

As noted in Section III.C, treatment of flexible-fuel vehicle (FFV) credits differs between 2012 to 2015 and 2016 and later. For the 2012 through 2015 model years the FFV credits will be calculated as they are in the CAFE program for the same model years, except that formulae in the regulations would be modified as needed to do the calculations in terms of grams per mile of CO_2 rather than miles per gallon. Like the advanced technology vehicle credits, these credits are integral to the fleet average calculation, but rather than crediting the vehicles with an artificially inflated quantity as in the advanced technology credit program described above, the FFV credit program allows the vehicles to be represented by artificially reduced emissions. To use this credit program, the CO_2 emissions of FFVs will be represented by the average of two things: the CO_2 emissions while operating on gasoline, and the CO_2 emissions operating on the alternative fuel multiplied by 0.15.

For example, Manufacturer A now makes 30,000 FFVs with CO_2 emissions of 280 g/mi using gasoline and 260 g/mi using ethanol. The CO_2 emissions that would represent the FFVs in the fleet average calculation would be calculated as follows:

FFV emissions = (280 + 260×0.15) ÷ 2
= 160 g/mi

Including these FFVs with the applicable credit in Manufacturer A's fleet average, as shown below in Figure III.E.5–3, further reduces the fleet average to 256 grams/mile and increases the manufacturer's credits to about 4.2 million megagrams.

Summary for Manufacturer A:
Earning Basic, Advanced Technology, and Flexible Fuel Vehicle Credits

		CO_2	Totals
Total production	Conventional: 445,000 PHEV: 25,000 FFV: 30,000	290 g/mi 100 g/mi 160 g/mi	500,000
Fleet average standard		300 g/mi	
Fleet average	[(445,000 × 290) + ((2x25,000) × 100) + 30,000 x 160] ÷ [475,000+(2×25,000)]	256 g/mi	
Credits	[(300-256) × 500,000 × 190,971] ÷ 1,000,000	=	4,201,362 Mg

Figure III.E.5-3 Summary for Manufacturer A: Earning Basic and Advanced Technology, and Flexible Fuel Vehicle Credits

In the 2016 and later model years the calculation of FFV emissions would be much the same except that the determination of the CO_2 value to represent an FFV model type would be based upon the actual use of the alternative fuel and on actual CO_2 emissions while operating on that fuel. EPA's default assumption in the regulations is that the alternative fuel is used negligibly, and the CO_2 value that would apply to an FFV by default would be the value determined for operation on conventional fuel. However, if the manufacturer believes that the alternative fuel is used in real-world driving and that accounting for this use could improve the fleet average, the manufacturer would have two options. First, the regulations would allow a manufacturer to request that EPA determine an appropriate weighting value for an alternative fuel to reflect the degree of use of that fuel in FFVs relative to real-world use of the conventional fuel. Section III.C describes how EPA might make this determination. Any value determined by EPA would be published via guidance letter to manufacturers, and that weighting value would be available for all manufacturers to use for that fuel. A second option proposed in the regulations would allow a manufacturer to determine the degree of alternative fuel use for their own vehicle(s), using a variety of potential methods. Both the method and the use of the final results would have to be approved by EPA before their use would be allowed. In either case, whether EPA supplies the weighting factors or the manufacturer determines them, the CO_2 emissions of an FFV in 2016 and later would be as follows (assuming non-zero use of the alternative fuel):

$$(W1 \times CO_2conv)+(W2 \times CO_2alt),$$

Where,

W1 and W2 are the proportion of miles driven using conventional fuel and alternative fuel, respectively, CO_2conv is the CO_2 value while using conventional fuel, and CO_2alt is the CO_2 value while using the alternative fuel.

d. Dedicated Alternative Fuel Vehicle Credits

Like the FFV credit program described above, these credits would be treated differently in the first years of the program than in the 2016 and later model years. In fact, these credits are essentially identical to the FFV credits except for two things: (1) There is no need to average CO_2 values for gasoline and alternative fuel, and (2) in 2016 and later there is no demonstration needed to get a benefit from the alternative fuel. The CO_2 values are essentially determined the same way they are for FFVs operating on the alternative fuel. For the 2012 through 2015 model years the CO_2 test results are multiplied by the credit adjustment factor of 0.15, and the result is production-weighted in the fleet average calculation. For example, assume that Manufacturer A now produces 20,000 dedicated CNG vehicles with CO_2 emissions of 220 grams/mile, in addition to the FFVs and PHEVs already included in their fleet (Figure III.E.5–4). Prior to the 2016 model year the CO_2 emissions representing these CNG vehicles would be 33 grams/mile (220×0.15).

Summary for Manufacturer A:
Earning Basic, Advanced Technology, and Flexible Fuel Vehicle Credits

		CO_2	Totals
Total production	Conventional: 425,000 PHEV: 25,000 FFV: 30,000 CNG: 20,000	290 g/mi 100 g/mi 160 g/mi 33 g/mi	500,000
Fleet average standard		300 g/mi	
Fleet average	[(425,000 × 290) + ((2x25,000) × 100) + (30,000 × 160) + (20,000 × 33)] ÷ [475,000+(2×25,000)]	247 g/mi	
Credits	[(300-247) × 500,000 × 190,971] ÷ 1,000,000	=	5,060,732 Mg

Figure III.E.5-4 Summary for Manufacturer A:
Earning Basic, Advanced Technology, and Flexible Fuel Vehicle Credits

BILLING CODE 4910–59–C

The calculation for 2016 and later would be exactly the same except the 0.15 credit adjustment factor would be removed from the equation, and the CNG vehicles would simply be production-weighted in the equation using their actual emissions value of 220 grams/mile instead of the ''credited'' value of 33 grams/mile.

e. Air Conditioning Leakage Credits

Unlike the credit programs described above, air conditioning-related credits do not affect the overall calculation of the fleet average. Whether a manufacturer generates zero air conditioning credits or many, the calculated fleet average remains the same. Air conditioning credits are calculated and added to any credits (or deficit) that results from the fleet average calculation. Thus, these credits can increase a manufacturer's credit balance or offset a deficit, but their calculation is external to the fleet average calculation. As noted in Section III.C, manufacturers could generate credits for reducing the leakage of refrigerant from their air conditioning systems. To do this the manufacturer would identify an air conditioning system improvement, indicate that they intend to use the improvement to generate credits, and then calculate an annual leakage rate (grams/year) for that system based on the method defined by the proposed regulations. Air conditioning credits would be determined separately for cars and trucks using the car and truck-specific equations described in Section III.C.

In order to put these credits on the same basis as the basic and other credits describe above, the air conditioning leakage credits would need to be calculated separately for cars and trucks. Thus, the resulting grams per mile credit determined from the appropriate car or truck equation would be multiplied by the lifetime VMT (190,971 for cars; 221,199 for trucks), and then divided by 1,000,000 to get the total megagrams of CO_2 credits generated by the improved air conditioning system. Although the calculations are done separately for cars and trucks, the total megagrams would be summed and then added to the overall credit balance maintained by the manufacturer.

For example, assume that Manufacturer A has improved an air conditioning system that is installed in 250,000 cars and that the calculated leakage rate is 12 grams/year. Assume that the manufacturer has also implemented a new refrigerant with a Global Warming Potential of 850. In this case the credit per air conditioning unit, rounded to the nearest gram per mile would be:

$[13.8 \times [1—(12/16.6 \times 850/1430)] = 7.9$ g/mi.

Total megagrams of credits would then be:

$[7.9 \times 250{,}000 \times 190971] \div 1{,}000{,}000 = 377{,}168$ Mg.

These credits would be added directly to a manufacturer's total balance; thus in this example Manufacturer A would now have, after consideration of all the above credits, a total of 5,437,900 Megagrams of credits.

f. Air Conditioning Efficiency Credits

As noted in Section III.C.1.b, manufacturers could earn credits for improvements in air conditioning efficiency that reduce the impact of the air conditioning system on fuel consumption. These credits are similar to the air conditioning leakage credits described above, in that these credits are determined independently from the manufacturer's fleet average calculation, and the resulting credits are added to the manufacturer's overall balance for the respective model year. Like the air conditioning leakage credits, these credits can increase a manufacturer's credit balance or offset a deficit, but their calculation is external to the fleet average calculation.

In order to put these credits on the same basis as the basic and other credits describe above, the air conditioning leakage credits would need to be calculated separately for cars and trucks. Thus, the resulting grams per mile credit determined in the above equation would be multiplied by the lifetime VMT (190,971 for cars; 221,199 for trucks), and then divided by 1,000,000 to get the total megagrams of CO_2 credits generated by the improved air conditioning system. Although the calculations are done separately for cars and trucks, the total megagrams can be summed and then added to the overall credit balance maintained by the manufacturer.

As described in Section III.C, manufacturers would determine their credit based on selections from a menu of technologies, each of which provides a gram per mile credit amount. The credits would be summed for all the technologies implemented by the manufacturer, but could not exceed 5.7 grams per mile. Once this is done, the calculation is a straightforward translation of a gram per mile credit to total car or truck megagrams, using the same methodology described above. For example, if Manufacturer A implements enough technologies to get the maximum 5.7 grams per mile for an air conditioning system that sells 250,000 units in cars, the calculation of total credits would be as follows:

$[5.7 \times 250{,}000 \times 190971] \div 1{,}000{,}000 = 272{,}134$ Mg.

These credits would be added directly to a manufacturer's total balance; thus in this example Manufacturer A would now have, after consideration of all the above credits, a total of 5,710,034 Megagrams of credits.

g. Off-Cycle Technology Credits

As described in Section III.C, these credits would be available for certain technologies that achieve real-world CO_2 reductions that aren't adequately captured on the city or highway test cycles used to determine compliance with the fleet average standards. Like the air conditioning credits, these credits are independent of the fleet average calculation. Section III.C.4 describes two options for generating these credits: either using EPA's 5-cycle fuel economy labeling methodology, or if that method fails to capture the CO_2-reducing impact of the technology, the manufacturer could propose and use, with EPA approval, a different analytical approach to determining the credit amount. Like the air conditioning credits above, these credits would have to be determined separately for cars and trucks because of the differing lifetime mileage assumptions between cars and trucks.

Using the 5-cycle approach would be relatively straightforward, and because the 5-cycle formulae account for nationwide variations in driving conditions, no additional adjustments to the test results would be necessary. The manufacturer would simply calculate a 5-cycle CO_2 value with the technology installed and operating and compare it with a 5-cycle CO_2 value determined without the technology installed and/or operating. Existing regulations describe how to calculate 5-cycle fuel economy values, and the proposed regulations contain provisions that describe how to calculate 5-cycle CO_2 values. The manufacturer would have to design a test program that accounts for vehicle differences if the technology is installed in different vehicle types, and enough data would have to be collected to address data uncertainty issues. A description of such a test program and the results would be submitted to EPA for approval.

As noted in Section III.C.4, a manufacturer-developed testing, data collection and analysis program would require some additional EPA approval and oversight. Once the demonstration of the CO_2 reduction of an off-cycle technology is complete, however, and the resulting value accounts for variations in driving, climate and other conditions across the country, the two approaches are treated fundamentally the same way and in a way that parallels the approach for determining the air conditioning credits described above. Once a gram per mile value is approved by the EPA, the manufacturer would determine the total credit value by multiplying the gram per mile per vehicle credit by the volume of vehicles with that technology and approved for use of the credit. This would then be multiplied by the lifetime vehicle miles for cars or trucks, whichever applies, and divided by 1,000,000 to obtain total Megagrams of CO_2 credits. These credits would then be added to the manufacturer's total balance for the given model year. Just like the above air conditioning case, an off-cycle technology that is demonstrated to achieve an average CO_2 reduction of 4 grams/mile and that is installed in 175,000 cars would generate credits as follows:

$[4 \times 175{,}000 \times 190971] \div 1{,}000{,}000 = 133{,}680$ Mg.

h. End-of-Year Reporting

In general, implementation of the averaging, banking, and trading (ABT) program, including the calculation of credits and deficits, would be accomplished via existing reporting mechanisms. EPA's existing regulations define how manufacturers calculate fleet average miles per gallon for CAFE compliance purposes, and EPA is proposing to modify these regulations to also require the parallel calculation of fleet average CO_2 levels for car and light truck compliance categories. These regulations already require an end-of-year report for each model year, submitted to EPA, which details the test results and calculations that determine each manufacturer's CAFE levels. EPA is proposing to require that this report also include fleet average CO_2 levels. In addition to requiring reporting of the actual fleet average achieved, this end-of-year report would also contain the calculations and data determining the manufacturer's applicable fleet average standard for that model year. As under the existing Tier 2 program, the report would be required to contain the fleet average standard, all values required to calculate the fleet average standard, the actual fleet average CO_2 that was achieved, all values required to calculate the actual fleet average, the number of credits generated or debits incurred, all the values required to calculate the credits or debits, and the resulting balance of credits or debits.

Because of the multitude of credit programs that are available, the end-of-year report will be required to have more data and a more defined and specific structure than the CAFE end–of-year report does today. Although requiring ''all the data required'' to calculate a given value should be inclusive, the proposed report would contain some requirements specific to certain types of credits.

For advanced technology credits that apply to vehicles like electric vehicles and plug-in hybrid electric vehicles, manufacturers would be required to identify the number and type of these vehicles and the effect of these credits on their fleet average. The same would be true for credits due to flexible-fuel and alternative-fuel vehicles, although for 2016 and later flexible-fuel credits manufacturers would also have to provide a demonstration of the actual use of the alternative fuel in-use and the resulting calculations of CO_2 values for such vehicles. For air conditioning leakage credits manufacturers would have to include a summary of their use of such credits that would include which air conditioning systems were subject to such credits, information regarding the vehicle models which were equipped with credit-earning air conditioning systems, the production volume of these air conditioning systems, the leakage score of each air conditioning system generating credits, and the resulting calculation of leakage credits. Air conditioning efficiency reporting will be somewhat more complicated given the phase-in of the efficiency test, and reporting would have to detail compliance with the phase-in as well as the test results and the resulting efficiency credits generated. Similar reporting requirements would also apply to the variety of possible off-cycle credit options, where manufacturers would have to report the applicable technology, the amount of credit per unit, the production volume of the technology, and the total credits from that technology.

Although it is the final end-of-year report, when final production numbers are known, that will determine the degree of compliance and the actual values of any credits being generated by manufacturers, EPA is also proposing that manufacturers be prepared to discuss their compliance approach and their potential use of the variety of credit options in pre-certification meetings that EPA routinely has with manufacturers. In addition, and in conjunction with a pre-model year report required under the CAFE program, the manufacturer would be required to submit projections of all of the elements described above.

Finally, to the extent that there are any credit transactions, the manufacturer would have to detail in the end-of-year report documentation on all credit transactions that the manufacturer has engaged in. Information for each transaction would include: The name of the credit provider, the name of the credit recipient, the date the transfer occurred, the quantity of credits transferred, and the model year in which the credits were earned. Failure by the manufacturer to submit the annual report in the specified time period would be considered to be a violation of section 203(a)(1) of the Clean Air Act.

6. Enforcement

As discussed above in Section III.E.5 under the proposed program, manufacturers would report to EPA their fleet average standard for a given model year (reporting separately for each of the car and truck averaging sets), the credits or deficits generated in the current year, the balance of credit balances or deficits (taking into account banked credits, deficit carry-forward, etc. *see* Section III.E.5), and whether they were in compliance with the fleet average standard under the terms of the regulations. EPA would review the annual reports, figures, and calculations submitted by the manufacturer to determine any nonconformance. EPA requests comments on the above approach for monitoring and enforcement of the fleet average standard.

Each certificate, required prior to introduction into commerce, would be conditioned upon the manufacturer attaining the CO_2 fleet average standard. If a manufacturer failed to meet this condition and had not generated or purchased enough credits to cover the fleet average exceedance following the three year deficit carry-forward (Section III.B.4, then EPA would review the manufacturer's sales for the most recent model year and designate which vehicles caused the fleet average standard to be exceeded. EPA would designate as nonconforming those vehicles with the highest emission values first, continuing until a number of vehicles equal to the calculated number of non-complying vehicles as determined above is reached and those vehicles would be considered to be not covered by the certificates of conformity covering those model types. In a test group where only a portion of vehicles would be deemed nonconforming, EPA would determine the actual nonconforming vehicles by counting backwards from the last vehicle sold in that model type. A manufacturer would be subject to penalties and injunctive orders on an individual vehicle basis for sale of vehicles not covered by a certificate. This is the same general mechanism used for the National LEV and Tier 2 corporate average standards, except that these programs operate slightly differently in that the non-compliant vehicles would be designated not in the most recent model year, but in the model year in which the deficit originated. EPA requests comment on which approach is most appropriate; the Tier 2 approach of penalizing vehicles from the year in which the deficit was generated, or the proposed approach that would penalize vehicles from the year in which the manufacturer failed to make up the deficit as required.

Section 205 of the CAA authorizes EPA to assess penalties of up to $37,500 per vehicle for violations of the requirements or prohibitions of this proposed rule.[176] This section of the

[176] 42 U.S.C. 7524(a), Civil Monetary Penalty Inflation Adjustment, 69 FR 7121 (Feb. 13, 2004)

Continued

CAA provides that the agency shall take the following penalty factors into consideration in determining the appropriate penalty for any specific case: The gravity of the violation, the economic benefit or savings (if any) resulting from the violation, the size of the violator's business, the violator's history of compliance with this title, action taken to remedy the violation, the effect of the penalty on the violator's ability to continue in business, and such other matters as justice may require.

EPA recognizes that it may be appropriate, should a manufacturer fail to comply with the NHTSA fuel economy standards as well as the CO_2 standard proposed today in a case arising out of the same facts and circumstances, to take into account the civil penalties that NHTSA has assessed for violations of the CAFE standards when determining the appropriate penalty amount for violations of the CO_2 emissions standards. This approach is consistent with EPA's broad discretion to consider ''such other matters as justice may require,'' and will allow EPA to exercise its discretion to prevent injustice and ensure that penalties for violations of the CO_2 rule are assessed in a fair and reasonable manner.

The statutory penalty factor that allows EPA to consider ''such other matters as justice may require'' vests EPA with broad discretion to reduce the penalty when other adjustment factors prove insufficient or inappropriate to achieve justice.[177] The underlying principle of this penalty factor is to operate as a safety mechanism when necessary to prevent injustice.[178]

In other environmental statutes, Congress has specifically required EPA to consider penalties assessed by other government agencies where violations arise from the same set of facts. For instance, section 311(b)(8) of the Clean Water Act, 33 U.S.C. 1321(b)(8) authorizes EPA to consider any other penalty for the same incident when determining the appropriate Clean Water Act penalty. Likewise, section 113(e) of the CAA authorizes EPA to consider ''payment by the violator of penalties previously assessed for the same violation'' when assessing penalties for certain violations of Title I of the Act.

7. Prohibited Acts in the CAA

Section 203 of the Clean Air Act describes acts that are prohibited by law. This section and associated regulations apply equally to the greenhouse standards proposed today as to any other regulated pollutant.

8. Other Certification Issues

a. Carryover/Carry Across Certification Test Data

EPA's certification program for vehicles 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 expects that this policy could also apply to CO_2, N_2O and CH_4 certification test data. A manufacturer may also be eligible to use carryover and carry across data to demonstrate CO_2 fleet average compliance if they had done so for CAFE purposes.

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 proposed rule and may amend its fees regulations in the future to include any warranted new costs.

c. Small Entity Deferment

EPA is proposing to defer CO_2 standards for certain small entities, and these entities (necessarily) would not be subject to the certification requirements of this proposal.

As discussed in Section III.B.7, businesses meeting the Small Business Administration (SBA) criterion of a small business as described in 13 CFR 121.201 would not be subject to the proposed GHG requirements, pending future regulatory action. EPA is proposing that such entities submit a declaration to EPA containing a detailed written description of how that manufacturer qualifies as a small entity under the provisions of 13 CFR 121.201 in order to ensure EPA is aware of the deferred companies. This declaration would have to be signed by a chief officer of the company, and would have to be made at least 30 days prior to the introduction into commerce of any vehicles for each model year for which the small entity status is requested, but not later than December of the calendar year prior to the model year for which deferral is requested. For example, if a manufacturer will be introducing model year 2012 vehicles in October of 2011, then the small entity declaration would be due in September of 2011. If 2012 model year vehicles are not planned for introduction until March of 2012, then the declaration would have to be submitted in December of 2011. Such entities are not automatically exempted from other EPA regulations for light-duty vehicles and light-duty trucks; therefore, absent this annual declaration EPA would assume that each entity was not deferred from compliance with the proposed greenhouse gas standards.

d. Onboard Diagnostics (OBD) and CO_2 Regulations

The light-duty on-board diagnostics (OBD) regulations require manufacturers to detect and identify malfunctions in all monitored emission-related powertrain systems or components.[179] Specifically, the OBD system is required to monitor catalysts, oxygen sensors, engine misfire, evaporative system leaks, and any other emission control systems directly intended to control emissions, such as exhaust gas recirculation (EGR), secondary air, and fuel control systems. The monitoring threshold for all of these systems or components is 1.5 times the applicable standards, which typically include NMHC, CO, NO_X, and PM. EPA is confident that many of the emission-related systems and components currently monitored would effectively catch any malfunctions related to CO_2 emissions. For example, malfunctions resulting from engine misfire, oxygen sensors, the EGR system, the secondary air system, and the fuel control system would all have an impact on CO_2 emissions. Thus, repairs made to any of these systems or components should also result in an improvement in CO_2 emissions. In addition, EPA does not have data on the feasibility or effectiveness of monitoring various emission systems and components for CO_2 emissions and does not believe it would be prudent to include CO_2 emissions without such information. Therefore, at this time, EPA does not plan to require CO_2 emissions as one of the applicable standards required for the OBD monitoring threshold. EPA plans to evaluate OBD monitoring technology, with regard to monitoring CO_2 emissions-related systems and components, and may choose to propose to include CO_2 emissions as part of the OBD requirements in a future regulatory

and Civil Monetary Penalty Inflation Adjustment Rule, 73 FR 75340 (Dec. 11, 2008).

[177] *In re Spang & Co.,* 6 E.A.D. 226, 249 (EAB 1995).

[178] *B.J. Carney Industries,* 7 E.A.D. 171, 232, n. 82 (EAB 1997).

[179] 40 CFR 86.1806–04.

action. EPA requests comment as to whether this is appropriate at this time, and specifically requests any data that would support the need for CO_2-related components that could or should be monitored via an OBD system.

e. Applicability of Current High Altitude Provisions to Greenhouse Gases

EPA is proposing that vehicles covered by this proposal meet the CO_2, N_2O and CH_4 standard at altitude. The CAA requires emission standards under section 202 to apply at all altitudes.[180] EPA does not expect vehicle CO_2, CH_4, or N_2O emissions to be significantly different at high altitudes based on vehicle calibrations commonly used at all altitudes. Therefore, EPA is proposing to retain its current high altitude regulations so manufacturers would not normally be required to submit vehicle CO_2 test data for high altitude. Instead, they would 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 would need to be included in the auxiliary emission control device (AECD) descriptions submitted by manufacturers at certification. In addition, any AECD specific to high altitude would be required to include emissions data to allow EPA evaluate and quantify any emission impact and validity of the AECD. EPA requests comment on this approach, and specifically requests data on impact of altitude on FTP and HFET CO_2 emissions.

f. Applicability of Standards to Aftermarket Conversions

With the exception of the small entity deferment option EPA is proposing, EPA's emission standards, including the proposed greenhouse gas standards, would continue to apply as stated in the applicability sections of the relevant regulations. The proposed greenhouse gas standards are being incorporated into 40 CFR part 86, subpart S, the provisions of which include exhaust and evaporative emission standards for criteria pollutants. Subpart S includes requirements for new light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, Otto-cycle complete heavy-duty vehicles, and some incomplete light-duty trucks. Subpart S is currently specifically applicable to aftermarket conversion systems, aftermarket conversion installers, and aftermarket conversion certifiers, as those terms are defined in 40 CFR 85.502. EPA expects that some aftermarket conversion companies would qualify for and seek the small entity deferment, but those that do not qualify would be required to meet the applicable emission standards, including the proposed greenhouse gas standards.

9. Miscellaneous Revisions to Existing Regulations

a. Revisions and Additions to Definitions

EPA is proposing to amend its definitions of ''engine code,'' ''transmission class,'' and ''transmission configuration'' in its vehicle certification regulations (Part 86) to conform with the definitions for those terms in its fuel economy regulations (Part 600). The exact terms in Part 86 are used for reporting purposes and are not used for any compliance purpose (*e.g.,* an engine code would not determine which vehicle was selected for emission testing). However, the terms are used for this purpose in Part 600 (*e.g.,* engine codes, transmission class, and transmission configurations are all criteria used to determine which vehicles are to be tested for the purposes of establishing corporate average fuel economy). Here, EPA is proposing that the same vehicles tested to determine corporate average fuel economy also be tested to determine fleet average CO_2, so the same definitions should apply. Thus EPA is proposing to amend its Part 86 definitions of the above terms to conform to the definitions in Part 600.

To bring EPA's fuel economy regulations in Part 600 into conformity with this proposal for fleet average CO_2 and NHTSA's reform truck regulations two amendments are proposed. First, the definition of ''footprint'' that is proposed in this rule is also being proposed for addition to EPA's Part 86 and 600 regulations. This definition is based on the definition promulgated by NHTSA at 49 CFR 523.2. Second, EPA is proposing to amend its model year CAFE reporting regulations to include the footprint information necessary for EPA to determine the reformed truck standards and the corporate average fuel economy. This same information is proposed to be included in this proposal for fleet average CO_2 and fuel economy compliance.

b. Addition of Ethanol Fuel Economy Calculation Procedures

EPA is proposing to add calculation procedures to part 600 for determining the carbon-related exhaust emissions and calculating the fuel economy of vehicles operating on ethanol fuel. Manufacturers have been using these procedures as needed, but the regulatory language—which specifies how to determine the fuel economy of gasoline, diesel, compressed natural gas, and methanol fueled vehicles—has not previously been brought up-to-date to provide procedures for vehicles operating on ethanol. Thus EPA is proposing a carbon balance approach similar to other fuels for the determination of carbon-related exhaust emissions for the purpose of determining fuel economy and for compliance with the proposed fleet average CO_2 standards. The carbon balance formula is similar to that for methanol, except that ethanol-fueled vehicles must also measure the emissions of ethanol and acetaldehyde. The proposed carbon balance equation for determining fuel economy is as follows, where CWF is the carbon weight fraction of the fuel and CWF_{exHC} is the carbon weight fraction of the exhaust hydrocarbons:

$$mpg = (CWF \times SG \times 3781.8)/((CWF_{exHC} \times HC) + (0.429 \times CO) + (0.273 \times CO_2) + (0.375 \times CH_3OH) + (0.400 \times HCHO) + (0.521 \times C_2H_5OH) + (0.545 \times C_2H_4O))$$

The proposed equation for determining the total carbon-related exhaust emissions for compliance with the CO_2 fleet average standards is the following, where CWF_{exHC} is the carbon weight fraction of the exhaust hydrocarbons:

$$CO_2\text{-}eq = (CWF_{exHC} \times HC) + (0.429 \times CO) + (0.375 \times CH_3OH) + (0.400 \times HCHO) + (0.521 \times C_2H_5OH) + (0.545 \times C_2H_4O) + CO_2.$$

EPA requests comment on the use of these formulae to determine fuel economy and carbon emissions.

c. Revision of Electric Vehicle Applicability Provisions

In 1980 EPA issued a rule that provided for the inclusion of electric vehicles in the CAFE program.[181] EPA now believes that certain provisions of the regulations should be updated to reflect the current state of motor vehicle emission and fuel economy regulations. In particular, EPA believes that the exemption of electric vehicles in certain cases from fuel economy labeling and CAFE requirements should be reevaluated and revised.

The rule created an exemption for electric vehicles from fuel economy labeling in the following cases: (1) If the electric vehicles are produced by a company that produces only electric vehicles; and (2) if the electric vehicles are produced by a company that

[180] *See* CAA 206(f).

[181] 45 FR 49256, July 24, 1980.

produces fewer than 10,000 vehicles of all kinds worldwide. EPA believes that this exemption language is no longer appropriate and proposes to delete it from the affected regulations. First, since 1980 many regulatory provisions have been put in place to address the concerns of small manufacturers and enable them to comply with fuel economy and emission programs with reduced burden. EPA believes that all small volume manufacturers should compete on a fair and level regulatory playing field and that there is no longer a need to treat small volume electric vehicles any differently than small volume manufacturers of other types of vehicles. Current regulations contain streamlined certification procedures for small companies, and because electric vehicles emit no direct pollution there is effectively no certification emission testing burden. For example, the proposed greenhouse gas regulations contain a provision allowing the exemption of certain small entities. Meeting the requirements for fuel economy labeling and CAFE will entail a testing, reporting, and labeling burden, but these burdens are not extraordinary and should be applied equally to all small volume manufacturers, regardless of the fuel that moves their vehicles. EPA has been working with existing electric vehicle manufacturers on fuel economy labeling, and EPA believes it is important for the consumer to have impartial, accurate, and useful label information regarding the energy consumption of these vehicles. Second, EPCA does not provide for an exemption of electric vehicles from NHTSA's CAFE program, and NHTSA regulations regarding the applicability of the CAFE program do not provide an exemption for electric vehicles. Third, the blanket exemption for any manufacturer of only electric vehicles assumed at the time that these companies would all be small, but the exemption language inappropriately did not account for size and would allow large manufacturers to be exempt as well. Finally, because of growth expected in the electric vehicle market in the future, EPA believes that the labeling and CAFE regulations need to be designed to more specifically accommodate electric vehicles and to require that consumers be provided with appropriate information regarding these vehicles. For these reasons EPA is proposing revisions to 40 CFR Part 600 applicability regulations such that these electric vehicle exemptions are deleted starting with the 2012 model year.

d. Miscellaneous Conforming Regulatory Amendments

Throughout the regulations EPA has made a number of minor amendments to update the regulations as needed or to conform with amendments discussed in this preamble. For example, for consistency with the ethanol fuel economy calculation procedures discussed above, EPA has amended regulations where necessary to require the collection of emissions of ethanol and acetaldehyde. Other changes are made to applicability sections to remove obsolete regulatory requirements such as phase-ins related to EPA's Tier 2 emission standards program, and still other changes are made to better accommodate electric vehicles in EPA emission control regulations. Not all of these minor amendments are noted in this preamble, thus the reader should carefully evaluate the proposed regulatory text to ensure a complete understanding of the regulatory changes being proposed by EPA.

10. Warranty, Defect Reporting, and Other Emission-Related Components Provisions

Under section 207(a) of the CAA, manufacturers must warrant that a vehicle is designed to comply with the standards and will be free from defects that may cause it to not comply over the specified period which is 2 years/24,000 miles (whichever is first) or, for major emission control components, 8 years/80,000 miles. Under certain conditions, manufacturers may be liable to replace failed emission components at no expense to the owner. EPA regulations define ''emission related parts'' for the purpose of warranty. This definition includes parts which must function properly to assure continued compliance with the emission standards.[182]

The air conditioning system and its components have not previously been covered under the CAA warranty provisions. However, the proposed A/C leakage and A/C-related CO_2 emission standards are dependent upon the proper functioning of a number of components on the A/C system, such as rings, fittings, compressors, and hoses. Therefore, EPA is proposing that these components be included under the CAA section 207(a) emission warranty provisions, with a warranty of 2 years/24,000 miles.

EPA requests comment as to whether any other parts or components should be designated as ''emission related parts'' subject to warranty and defect reporting provisions under this proposal.

11. Light Duty Vehicles and Fuel Economy Labeling

American consumers need accurate and meaningful information about the environmental and fuel economy performance of new light vehicles. EPA believes it is important that the fuel-economy label affixed to the new vehicles provide consumers with the critical information they need to make smart purchase decisions. This is a special challenge in light of the expected increase in market share of electric and other advanced technology vehicles. Consumers may need new and different information than today's vehicle labels provide in order to help them understand the energy use and associated cost of owning these electric and advanced technology vehicles. As discussed below, these two issues are key to determining whether the current MPG-based fuel-economy label is adequate.

Therefore, as part of this action, EPA seeks comments on issues surrounding consumer vehicle labeling in general, and labeling of advanced technology vehicles in particular. EPA also plans to initiate a separate rulemaking to explore in detail the information displayed on the fuel economy label and the methodology for deriving that information. The purposes of this new rulemaking would be to ensure that American consumers continue to have the most accurate, meaningful, and useful information available to them when purchasing new vehicles, and that the information is presented to them in clear and understandable terms.

a. Background

EPA has considerable experience in providing vehicle information to consumers through its fuel-economy labeling activities and related web-based programs. Under 49 U.S.C. 32908(b) EPA is responsible for developing the fuel economy labels that are posted on window stickers of all new light duty cars and trucks sold in the U.S. and, beginning with the 2011 model year, on all new medium-duty passenger vehicles (a category that includes large sport-utility vehicles and passenger vans). The statutory requirements established by EPCA require that the label contain the following:

- The fuel economy of the vehicle;[183]
- The estimated annual fuel cost of operating the vehicle;

[182] 40 CFR 85.2102(14).

[183] ''Fuel economy'' per the statute is miles per gallon of gasoline (or equivalent amount of other fuel).

- The range of fuel economy of comparable vehicles among all manufacturers;
- A statement that a fuel economy booklet is available from the dealer; [184] and
- The amount of the ''gas guzzler'' tax imposed on the vehicle by the Internal Revenue Service.
- Other information required or authorized by EPA that is related to the information required above.

Fuel economy is defined as the number of miles traveled by an automobile for each gallon of gasoline (or equivalent amount of other fuel). It is relatively easy to determine the miles per gallon (MPG) for vehicles that use liquid fuels (*e.g.,* gasoline or diesel), but an expression that uses gallons—whether miles per gallon or gallons per mile—may not be a useful metric for vehicles that have limited to no operation on liquid fuel such as electric or compressed natural gas vehicles. The mpg metric is the one generally used today to provide comparative fuel economy information to consumers.

As part of its vehicle certification, CAFE, and fuel economy labeling authorities, EPA works with stakeholders on the testing and other regulatory requirements necessary to bring advanced technology vehicles to market. With increasing numbers of advanced technology vehicles beginning to be sold, EPA believes it is now appropriate to address potential regulatory and certification issues associated with these technologies including how best to provide relevant consumer information about their environmental impact, energy consumption, and cost.

b. Test Procedures

As discussed in this notice, there are explicit and very long-standing test procedures and calculation methodologies associated with CAFE that EPA uses to test conventionally-fueled vehicles and to calculate their fuel economy. These test procedures and calculations also generally apply to advanced technology vehicles (*e.g.,* an electric (EV) or plug-in hybrid vehicle (PHEV)).

The basic test procedure for an electric vehicle follows a standardized practice—an EV is fully charged and then driven over the city cycle (Urban Dynamometer Drive Schedule) until the vehicle can no longer maintain the required drive cycle vehicle speed. For some vehicles, this could require operation over multiple drive cycles. The EV is then fully recharged and the AC energy to the charger is recorded.

To derive the CAFE value for electric vehicles, the amount of AC energy needed to recharge the battery is divided by the range the vehicle reached in the repeated city drive cycle. This calculation provides a raw CAFE energy consumption value expressed in kilowatt hours per 100 miles. The raw CAFE number is then converted to miles per gallon of equivalent gasoline using a Department of Energy (DOE) conversion factor of 82,700 Kwhr/gallon of gasoline.[185] The DOE conversion factor combines several adjustments including: an adjustment similar to the statutory 6.67 multiplier credit [186] used in deriving the final CAFE value for alternative fueled vehicles; a factor representing the gasoline-equivalent energy content of electricity; and various adjustments to account for the relative efficiency of producing and transporting the electricity. The resulting value after the DOE conversion factor is applied becomes the final CAFE city value.

The label value calculation for an EV uses a different conversion factor than the CAFE value calculation. To come up with the final city fuel economy label value for an EV, a conversion factor of 33,705 Kwhr/gallon of gasoline equivalent is applied to the raw consumption number instead of the 82,700 Kwhr/gallon used for CAFE. The conversion factor used for labeling purposes represents only the gasoline-equivalent energy content of electricity, without the multiplier credit and other adjustments used in the CAFE calculation. The consumption, now expressed as a fuel economy in miles per gallon equivalent, is then applied to the derived 5-cycle equation required under EPA's fuel economy labeling regulations. The above process is then repeated for the EV highway fuel economy label number. Finally, the combined city/highway numbers for the EV use the same 55/45 weighting as conventional vehicles to determine the final fuel economy label values. CAFE numbers end up being significantly higher for EVs than the associated fuel economy label values, both because a higher adjustment factor applies under CAFE regulations and also because other real-world adjustments such as the 5-cycle test are not applied to the CAFE values.

For PHEVs, a similar process would be followed, except that PHEVs require testing in both charge sustain (CS) and charge depleting (CD) modes to capture how these vehicles operate. For charge sustain modes, PHEVs essentially operate as conventional Hybrid Electric Vehicles (HEVs). PHEVs therefore test in all 5-cycles (for further information on these test cycles, *see* Section III.C.4) just as HEVs do for CS fuel economy. For CD fuel economy, PHEVs are only required to test on the Urban Dynamometer Drive Schedule and Highway Fuel Economy cycles just like other alternative fueled vehicles—the 5-cycle fuel economy testing is optional in the CD mode. There are additional processes that address different PHEV modes, such as for PHEVs that operate solely on electricity throughout the CD mode.

As this discussion shows, the CAFE and fuel economy labeling test procedures and calculations for advanced technology vehicles such as EVs and PHEVs can be very complicated. EPA is interested in comments on these processes, including views on the appropriate use of adjustment factors. Currently in guidance, EPA references SAE J1634 for EV range and consumption test procedures. EPA currently includes the ''California Exhaust Emission Standards and Test Procedures for 2003 and Subsequent Model Zero-Emission Vehicles, in the Passenger Car, Light Truck, and Medium-duty Vehicle Classes'' by reference in 40 CFR 86.1. As California requirements and SAE test procedures are updated these may be included by reference in the future.

c. Current Fuel Economy Label

In 2006 EPA redesigned the window stickers to make them more informative for consumers. More particular, the redesigned stickers more prominently feature annual fuel cost information, to provide contemporary and easy-to-use graphics for comparing the fuel economy of different vehicles, to use clearer text, and to include a Web site reference to *www.fueleconomy.gov* which provides additional information. In addition, EPA updated how the city and highway fuel economy values were calculated, to reflect typical real-world driving patterns.[187] This rulemaking involved significant stakeholder outreach in determining how best to calculate and display this new information. The feedback EPA has received to date on the new label design and values has been generally very positive.

During the 2006 label rulemaking process EPA requested comments on

[184] EPA and DOE jointly publish the annual Fuel Economy Guide and distribute it to dealers.

[185] 49 U.S.C. 32904 and 10 CFR 474.3.

[186] 49 U.S.C. 32905.

[187] 71 FR 77872 (December 27, 2006). Fuel Economy Labeling of Motor Vehicles: Revisions to Improve Calculations of Fuel Economy Estimates. U.S. EPA.

how a fuel consumption metric (such as gallons per 100 miles) could be used and represented to the public, including presentation in the annual Fuel Economy Guide. EPA received a number of comments from both vehicle manufacturers and consumer organizations, suggesting that the MPG measures can be misleading and that a fuel consumption metric might be more meaningful to consumers than the established MPG metric found on fuel economy labels. The reason is that fuel consumption metric, directly measures the amount of fuel used and is thus directly related to cost that consumers incur when filling up.

The problem with the MPG metric is that it is inversely related to fuel consumption and cost. As higher MPG values are reached, the relative impact of these higher values on fuel consumption and fuel costs decreases. For example, a 25 percent increase in gallons per 100 miles will always lead to a 25 percent increase in the fuel cost, but a similar 25 percent increase in MPG will have varying impacts on actual fuel cost depending on whether the percent increase occurs to a low or high MPG value. Many consumers do not understand this nonlinear relationship between MPG and fuel costs. Evidence suggest that people tend to see the MPG as being linear with fuel cost, which will lead to erroneous decisions regarding vehicle purchases. Figure III.E.11–1 below illustrates the issue; one can see that changes in MPG at low MPG levels can result in large changes in the fuel cost, while changes in MPG values at high MPG levels result in small changes in the fuel cost. For example, a change from 10 to 15 MPG will reduce the 10-mile fuel cost from $2.50 to $1.60, but a similar increase in MPG from 20 to 25 MPG will only reduce the 10-mile fuel cost by less than $0.30.

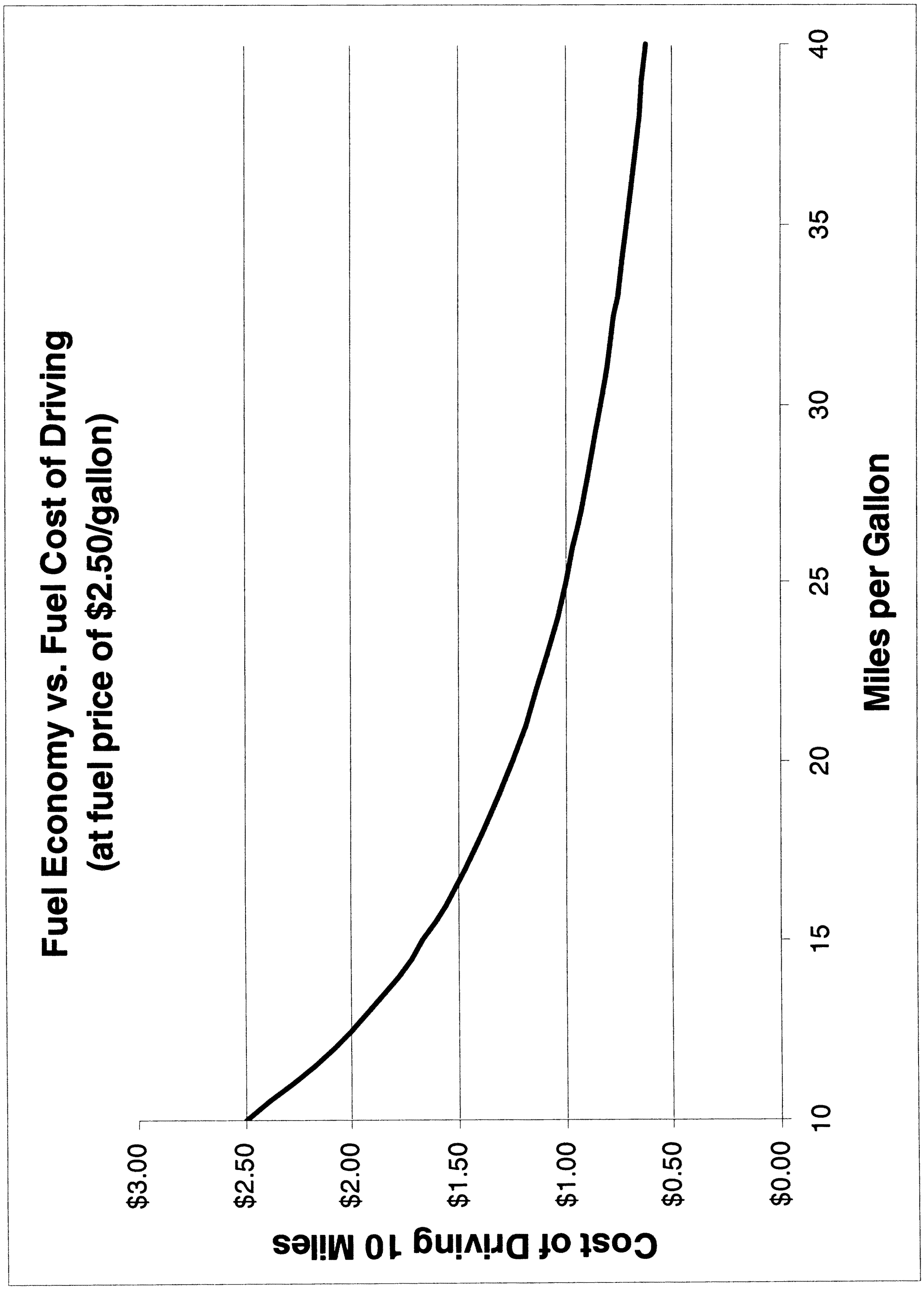


Figure III.E.11-1 Fuel Economy vs. Fuel Cost of Driving

Because of the potential for consumers to misunderstand this MPG/cost relationship, commenters on the 2006 labeling rule universally agreed that any change to the label metric should involve a significant public education campaign directed toward both dealers and consumers.

In 2006, EPA did not include a consumption-based metric on the redesigned fuel economy label in 2006. It was concerned about potential confusion associated with introducing a second metric on the label (MPG is a required element, as noted above). EPA has developed an interactive feature on *www.fueleconomy.gov* which allows consumers, while viewing data on a specific vehicle, to switch units between the MPG and gallons per 100 miles metrics. The tool also displays the cost and the amount of fuel needed to drive 25 miles. As indicated above, however, EPA is alert to the problems with the MPG measure and the importance of providing consumers with a clear sense of the consequences of their purchasing decisions; a gallon-per mile measure would have significant advantages. EPA plans to seek comment and engage in extensive public debate about fuel consumption and other appropriate consumer information metrics as part of a new labeling rule initiative. EPA also welcomes comments on this topic in response to this GHG proposal.

d. Labeling for Advanced Technology Vehicles

Even though a fuel consumption metric may more directly represent likely fuel costs than a fuel economy metric, any expression that uses gallons—whether miles per gallon or gallons per mile—is not a useful metric for vehicles that have limited to no operation on liquid fuel (*e.g.*, electricity or compressed natural gas). For example, PHEVs and extended range electric vehicles (EREVs) can use two types of energy sources: (1) An onboard battery, charged by plugging the vehicle into the electrical grid via a conventional wall outlet, to power an electric motor, as well as (2) a gas or diesel-powered engine to propel the vehicle or power a generator used to provide electricity to the electric motor. Depending on how these vehicles are operated, they can use electricity exclusively, never use electricity and operate like a conventional hybrid, or operate in some combination of these two modes. The use of a MPG figure alone would not account for the electricity used to propel the vehicle.

EPA has worked closely with numerous stakeholders including vehicle manufacturers, the Society of Automotive Engineers (SAE), the State of California, the Department of Energy (DOE) and others to develop possible approaches for both estimating fuel economy and labeling vehicles that can operate using more than one energy source. At the present time, EPA believes the appropriate method for estimating fuel economy of PHEVs and EREVs would be a weighted average of fuel economy for the two modes of operation. A methodology developed by SAE and DOE to predict the fractions of total distance driven in each mode of operation (electricity and gas) uses a term known as a utility factor (UF). By using a utility factor, it is possible to determine a weighted average for fuel economy of the electric and gasoline modes. For example, a UF of 0.8 would indicate that a PHEV or EREV operates in an all electric mode 80% of the time and uses the gasoline engine the other 20% of the time. In this example, the weighted average fuel economy value would be influenced more by the electrical operation than the gasoline operation.

Under this approach, a UF could be assigned to each successive fuel economy test until the battery charge was depleted and the PHEV or EREV needed power from the gasoline engine to propel the vehicle or to recharge the battery. One minus the sum of all the utility factors would then represent the fraction of driving performed in this ''gasoline mode.'' Fuel economy could then be expressed as:

$$FE_{MPG} = \frac{1}{\sum \frac{UF_i}{FE_i} + \frac{1-\sum UF_i}{FE_{gasoline}}}$$

Likewise, the electrical consumption would be expressed by adding the fuel consumption from each mode. Since there is no electrical consumption in hybrid mode, the equation for electricity consumption would be as follows:

$$FC_{Kwhr/100miles} = \sum UF_i \times FC_i$$

Utility factors could be cycle specific not only due to different battery ranges on different test cycles but also due to the fact that ''highway'' type driving may imply longer trips than urban driving. That is to say that the average city trip could be shorter than the average highway trip.

e. Request for Comments

EPA is interested in comments on both topics raised in this section. For the methodology, we are interested in comments addressing how the utility factor is calculated and which data should be used in establishing the UF. Additionally, commenters should address: The appropriateness of this approach for estimating fuel economy for PHEVs and EREVs, including the concept of using a UF to determine the fuel economy for vehicles operated in multiple modes; the appropriate form and value of the factor, including the type of data that would be necessary to confidently develop it accurately; and availability of other potential methodologies for determining fuel economy for vehicles that can operate in multiple modes, such as ''all electric'' and ''hybrid,'' including the use of fuel consumption, cost, GHG emissions, or other metrics in addition to miles per gallon.

EPA is also requesting comment on how the agency can satisfy statutory labeling requirements while providing relevant information to consumers. For example, the statute indicates that EPA may provide other related items on the label beyond those that are required.[188] EPA is interested in receiving comments on the potential approaches and supporting data we might consider for adding additional information regarding fuel economics while maintaining our statutory obligation to report MPG on the label.

There are a number of different metrics that are available that could be useful in this regard. Two possible options would be to show consumption in fuel use per distance (*e.g.*, gallons/100 miles) or in cost per distance (*e.g.*, $/100 miles). As discussed above, these two metrics have benefits over a straight mpg value in showing a more direct relationship between fuel consumption and cost. The cost/distance metric has an added potential benefit of providing a common basis for comparing differently fueled or powered vehicles, for example being able to show the cost of gasoline used over a specified distance or time for a conventional gasoline-powered vehicle in comparison to the gasoline and electricity used over the same period for a plug-in hybrid vehicle. Another approach would be to use a metric that provides information about a vehicle's greenhouse gas emissions per unit of travel, such as carbon dioxide equivalent grams per mile (g CO_2e/mi). This type of metric would allow consumers to directly compare among vehicles on the basis of their overall greenhouse gas impact. A total annual energy cost would be another way to look at this information, and is currently used on the fuel economy label. As is currently done, EPA would need to determine and show a common set of fuel costs used to calculate such values, recognizing that energy costs vary across the country.

The Agency is also interested in comments on the usefulness of adding other types of information, such as an estimated driving range for electric vehicles. The label design is also an important issue to consider and any changes to the existing label would need to show information in a technologically accurate, meaningful and understandable manner, while ensuring that the label does not become overcrowded and difficult for consumers to comprehend. EPA is also interested in what and how other information paths, such as web-based programs, could be used to enhance the consumer education process.

[188] 49 U.S.C. 3290(b)(F).

F. How Would This Proposal Reduce GHG Emissions and Their Associated Effects?

This action is an important step towards curbing steady growth of GHG emissions from cars and light trucks. In the absence of control, GHG emissions worldwide and in the U.S. are projected to continue steady growth; Table III.F–1 shows emissions of CO_2, methane, nitrous oxide and air conditioning refrigerants on a CO_2-equivalent basis for calendar years 2010, 2020, 2030, 2040 and 2050. U.S. GHGs are estimated to make up roughly 15 percent of total worldwide emissions, and the contribution of direct emissions from cars and light trucks to this U.S. share is growing over time, reaching an estimated 20 percent of U.S. emissions by 2030 in the absence of control. As discussed later in this section, this steady rise in GHG emissions is associated with numerous adverse impacts on human health, food and agriculture, air quality, and water and forestry resources.

TABLE III.F–1—REFERENCE CASE GHG EMISSIONS BY CALENDAR YEAR

[$MMTCO_2$ Eq]

	2010	2020	2030	2040	2050
All Sectors (Worldwide) [a]	41,016	48,059	52,870	56,940	60,209
All Sectors (U.S. Only) [a]	7,118	7,390	7,765	8,101	8,379
U.S. Cars/Light Truck Only [b]	1,359	1,332	1,516	1,828	2,261

[a] ADAGE model projections, U.S. EPA.[189]
[b] MOVES (2010), OMEGA Model (2020–50) U.S. EPA. *See* DRIA Chapter 5.3 for modeling details.

EPA's proposed GHG rule, if finalized, will result in significant reductions as newer, cleaner vehicles come into the fleet, and the rule is estimated to have a measurable impact on world global temperatures. As discussed in Section I, this GHG proposal is part of a joint National Program such that a large majority of the projected benefits would be achieved jointly with NHTSA's proposed CAFE standards which are described in detail in Section IV of this preamble. EPA estimates the reductions attributable to the GHG program over time assuming the proposed 2016 standards continue indefinitely post-2016,[190] compared to a baseline scenario in which the 2011 model year fuel economy standards continue beyond 2011.

Using this approach, EPA estimates these standards would cut annual fleetwide car and light truck tailpipe CO_2 emissions 21 percent by 2030, when 90 percent of car and light truck miles will be travelled by vehicles meeting the new standards. Roughly 20 percent of these reductions are due to emission reductions from gasoline extraction, production and distribution processes as a result of reduced gasoline demand associated with this proposal. Some of the overall emission reductions also come from projected improvements in the efficiency of vehicle air conditioning systems, which will substantially reduce direct emissions of HFCs, one of the most potent greenhouse gases, as well as indirect emissions of tailpipe CO_2 emissions attributable to reduced engine load from air conditioning. In total, EPA estimates that compared to a baseline of indefinite 2011 model year standards, net GHG emission reductions from the proposed program would be 325 million metric tons CO_2-equivalent ($MMTCO_2eq$) annually by 2030, which represents a reduction of 4 percent of total U.S. GHG emissions and 0.6 percent of total worldwide GHG emissions projected in that year. This estimate accounts for all upstream fuel production and distribution emission reductions, vehicle tailpipe emission reductions including air conditioning benefits, as well as increased vehicle miles travelled (VMT) due to the ''rebound'' effect discussed in Section III.H. EPA estimates this would be the equivalent of removing nearly 60 million cars and light trucks from the road in this timeframe.

EPA projects the total reduction of the program over the full life of model year 2012–2016 vehicles is about 950 $MMTCO_2eq$, with fuel savings of 76 billion gallons (1.8 billion barrels) of gasoline over the life of these vehicles, assuming that some manufacturers take advantage of low-cost HFC reduction strategies to help meet these proposed standards.

These reductions are projected to reduce global mean temperature by approximately 0.007–0.016°C by 2100, and global mean sea level rise is projected to be reduced by approximately 0.06–0.15 cm by 2100.

1. Impact on GHG Emissions

a. Calendar Year Reductions Due to GHG Standards

This action, if finalized, will reduce GHG emissions emitted directly from vehicles due to reduced fuel use and more efficient air conditioning systems. In addition to these ''downstream'' emissions, reducing CO_2 emissions translates directly to reductions in the emissions associated with the processes involved in getting petroleum to the pump, including the extraction and transportation of crude oil, and the production and distribution of finished gasoline (termed ''upstream'' emissions). Reductions from tailpipe GHG standards grow over time as the fleet turns over to vehicles affected by the standards, meaning the benefit of the program will continue as long as the oldest vehicles in the fleet are replaced by newer, lower CO_2 emitting vehicles.

EPA is not projecting any reductions in tailpipe CH_4 or N_2O emissions as a result of these proposed emission caps, which are meant to prevent emission backsliding and to bring diesel vehicles equipped with advanced technology aftertreatment into alignment with current gasoline vehicle emissions.

As detailed in the DRIA, EPA estimated calendar year tailpipe CO_2 reductions based on pre- and post-control CO_2 gram per mile levels from EPA's OMEGA model and assumed to continue indefinitely into the future, coupled with VMT projections from AEO2009. These estimates reflect the real-world CO_2 emissions reductions projected for the entire U.S. vehicle fleet in a specified calendar year, including the projected effect of air conditioning credits, TLAASP credits and FFV credits. EPA also estimated full lifetime reductions for model years 2012–2016

[189] U.S. EPA (2009). ''EPA Analysis of the American Clean Energy and Security Act of 2009: H.R. 2454 in the 111th Congress.'' U.S. Environmental Protection Agency, Washington, DC, USA. (*www.epa.gov/climatechange/economics/economicanalyses.html*)

[190] This analysis does not include the EISA requirement for 35 MPG through 2020 or California's Pavley 1 GHG standards. The proposed standards are intended to supersede these requirements, and the baseline case for comparison is the emissions that would result without further action above the currently promulgated fuel economy standards.

using pre- and post-control CO_2 levels projected by the OMEGA model, coupled with projected vehicle sales and lifetime mileage estimates. These estimates reflect the real-world CO_2 emissions reductions projected for model years 2012 through 2016 vehicles over their entire life.

This proposal would allow manufacturers to earn credits for improved vehicle air conditioning efficiency. Since these improvements are relatively low cost, EPA projects that manufacturers will take advantage of this flexibility, leading to reductions from emissions associated with vehicle air conditioning systems. As explained above, these reductions will come from both direct emissions of air conditioning refrigerant over the life of the vehicle and tailpipe CO_2 emissions produced by the increased load of the A/C system on the engine. In particular, EPA estimates that direct emissions of HFCs, one of the most potent greenhouse gases, would be reduced 40 percent from light-duty vehicles when the fleet has turned over to more efficient vehicles. The fuel savings derived from lower tailpipe CO_2 would also lead to reductions in upstream emissions. Our estimated reductions from the A/C credits program are based on our analysis of how manufacturers are expected to take advantage of this credit opportunity in complying with the CO_2 fleetwide average tailpipe standards.

Upstream emission reductions associated with the production and distribution of fuel were estimated using emission factors from DOE's GREET1.8 model, with some modifications as detailed in the DRIA. 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 proposed GHG standards. Thus, significant portions of the upstream GHG emission reductions will occur outside of the U.S.; a breakdown of projected international versus domestic reductions is included in the DRIA.

Table III.F.1–1 shows reductions estimated from these proposed GHG standards assuming a pre-control case of 2011 MY standards continuing indefinitely beyond 2011, and a post-control case in which 2016 MY standards continue indefinitely beyond 2016. These reductions are broken down by upstream and downstream components, including air conditioning improvements, and also account for the offset from a 10 percent VMT ''rebound'' effect as discussed in Section III.H. Including the reductions from upstream emissions, total reductions are estimated to reach 325 $MMTCO_2eq$ annually by 2030 (a 21 percent reduction in U.S. car and light truck emissions), and grow to over 500 $MMTCO_2eq$ in 2050 as cleaner vehicles continue to come into the fleet (a 23 percent reduction in U.S. car and light truck emissions).

TABLE III.F.1–1—PROJECTED NET GHG REDUCTIONS

[$MMTCO_2$ Eq per year]

	Calendar year			
	2020	2030	2040	2050
Net Reduction Due to Tailpipe Standards *	165.2	324.6	417.5	518.5
Tailpipe Standards	*107.7*	*211.4*	*274.1*	*344.0*
A/C—indirect CO_2	*11.0*	*21.1*	*27.3*	*34.2*
A/C—direct HFCs	*13.5*	*27.2*	*32.1*	*34.9*
Upstream	*33.1*	*64.9*	*84.1*	*105.5*
Percent reduction relative to U.S. reference (cars + light trucks)	*12.4%*	*21.4%*	*22.8%*	*22.9%*
Percent reduction relative to U.S. reference (all sectors)	*2.2%*	*4.2%*	*5.2%*	*6.2%*
Percent reduction relative to worldwide reference	*0.3%*	*0.6%*	*0.7%*	*0.9%*

* Includes impacts of 10% VMT rebound rate presented in Table III.F.1–3.

b. Lifetime Reductions for 2012–2016 Model Years

EPA also analyzed the emission reductions over the full life of the 2012–2016 model year cars and trucks affected by this proposal.[191] These results, including both upstream and downstream GHG contributions, are presented in Table III.F.1–2, showing lifetime reductions of nearly 950 $MMTCO_2eq$, with fuel savings of 76 billion gallons (1.8 billion barrels) of gasoline.

TABLE III.F.1–2—PROJECTED NET GHG REDUCTIONS

[$MMTCO_2$ Eq per year]

Model year	Lifetime GHG reduction (MMT CO_2 EQ)	Lifetime fuel savings (billion gallons)
2012	81.4	6.6
2013	125.0	10.0
2014	174.1	13.9
2015	243.2	19.5
2016	323.6	26.3
Total Program Benefit	947.4	76.2

[191] As detailed in the DRIA, for this analysis the full life of the vehicle is represented by average lifetime mileages for cars (190,000 miles) and trucks (221,000 miles) averaged over calendar years 2012 through 2030, a function of how far vehicles drive per year and scrappage rates.

c. Impacts of VMT Rebound Effect

As noted above and discussed more fully in Section III.H., the effect of fuel cost on VMT (''rebound'') was accounted for in our assessment of economic and environmental impacts of this proposed rule. A 10 percent rebound case was used for this analysis, meaning that VMT for affected model years is modeled as increasing by 10 percent as much as the increase in fuel economy; *i.e.*, a 10 percent increase in fuel economy would yield a 1.0 percent increase in VMT. Results are shown in Table III.F.1–3; using the 10 percent rebound rate results in an overall emission increase of 26.4 MMTCO_2eq annually in 2030 (this increase is accounted for in the reductions presented in Tables III.F.1–1 and III.F.1–2). Our estimated changes in CH_4 or N_2O emissions as a result of these proposed vehicle GHG standards are attributed solely to this rebound effect.

As discussed in Section III.H, EPA will be reassessing the appropriate rate of VMT rebound for the final rule. Although EPA has not directly quantified the GHG emissions effect of using a lower rebound rate for this analysis, lowering the rebound rate would reduce the emission increases in Tables III.F.1–1 and III.F.1–2 in proportion (*i.e.*, zero rebound equals zero emissions effect), and, thus, would increase our estimates of emission reductions due to these proposed standards.

TABLE III.F.1–3—GHG IMPACT OF 10% VMT REBOUND [a]

[MMTCO_2 Eq per year]

	2020	2030	2040	2050
Total GHG Increase	13.6	26.4	34.2	42.9
Tailpipe & Indirect A/C CO_2	*10.6*	*20.6*	*26.6*	*33.4*
Upstream GHGs [b]	*2.95*	*5.74*	*7.43*	*9.32*
Tailpipe N_2O	*0.040*	*0.085*	*0.113*	*0.142*
Tailpipe CH_4	*0.008*	*0.016*	*0.021*	*0.027*

[a] These impacts are included in the reductions shown in Table III.F.1–1 and III.F.1–2.
[b] Upstream rebound impact calculated as upstream total CO_2 effect times ratio of downstream tailpipe rebound CO_2 effect to downstream tailpipe total CO_2 effect.

d. Analysis of Alternatives

EPA analyzed two alternative scenarios, including 4% and 6% annual increases in 2 cycle (CAFE) fuel economy. In addition to this annual increase, EPA assumed that manufacturers would use air conditioning improvements in identical penetrations as in the primary scenario. Under these assumptions, EPA expects achieved fleetwide average emission levels of 254 g/mile CO_2 EQ (4%), and 230 g/mile CO_2 EQ (6%) in 2016.

As in the primary scenario, EPA assumed that the fleet complied with the standards. For full details on modeling assumptions, please refer to DRIA Chapter 5.

TABLE III.F.1–4—CALENDAR YEAR IMPACTS OF ALTERNATIVE SCENARIOS

		Calendar year			
	Scenario	CY 2020	CY 2030	CY 2040	CY 2050
Total GHG Reductions (MMT CO_2EQ)	Primary	165.2	324.6	417.5	518.5
	4%	152.8	305.9	394.1	489.3
	6%	215.2	426.2	549.3	683.9
Fuel Savings (Billion Gallons Gasoline Equivalent)	Primary	13.4	26.2	33.9	42.6
	4%	12.2	24.5	31.8	39.9
	6%	17.8	35.1	45.5	57.1

TABLE III.F.1–5—MODEL YEAR IMPACTS OF ALTERNATIVE SCENARIOS

		Model year lifetime					
	Scenario	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
Total GHG Reductions (MMT CO_2EQ).	Primary	81.4	125.0	174.1	243.2	323.6	947.4
	4%	41.8	93.5	160.8	231.0	305.2	832.3
	6%	60.2	146.4	239.9	333.3	424.9	1,204.7
Fuel Savings (Billion Gallons Gasoline Equivalent).	Primary	6.6	10.0	13.9	19.5	26.3	76.2
	4%	3.1	7.2	12.7	18.4	24.7	66.1
	6%	4.7	11.9	19.7	27.4	35.2	99.0

2. Overview of Climate Change Impacts From GHG Emissions

Once emitted, greenhouse gases (GHG) 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. Greenhouse gas emissions come mainly from the combustion of fossil fuels (coal, oil, and gas), with additional contributions from the clearing of forests and agricultural activities. The transportation sector accounts for a portion, 28%, of US GHG emissions.[192]

This section provides a broad overview of some of the impacts of GHG emissions. The best sources of information include the major assessment reports of both the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Global Change Research Program (USGCRP, formerly referred to as the U.S. Climate Change Science Program). The IPCC and USGCRP assessments base their findings on the large body of individual, peer-reviewed studies in the literature, and then the IPCC and USGCRP assessments themselves go through a transparent peer-reviewed process. The USGCRP reports, where possible, are specific to impacts in the U.S. and therefore represent the best available syntheses of relevant impacts.

Most recently, the USGCRP released a report entitled ''Global Climate Change Impacts in the United States''.[193] The report summarizes the science and the impacts of climate change on the United States, now and in the future. It focuses on climate change impacts in different regions of the U.S. and on various aspects of society and the economy such as energy, water, agriculture, and human health. It's also a report written in plain language, with the goal of better informing public and private decision making at all levels. The foundation of this report is a set of 21 Synthesis and Assessment Products (SAPs), which were designed to address key policy-relevant issues in climate science. The report was extensively reviewed and revised based on comments from experts and the public. The report was approved by its lead USGCRP Agency, the National Oceanic and Atmospheric Administration, the other USGCRP agencies, and the Committee on the Environment and Natural Resources on behalf of the National Science and Technology Council. This report meets all Federal requirements associated with the Information Quality Act, including those pertaining to public comment and transparency. Readers are encouraged to review this report.

The source document for the section below is the draft endangerment Technical Support Document (TSD). In EPA's Proposed Endangerment and Cause or Contribute Findings Under the Clean Air Act,[194] EPA provides a summary of the USGCRP and IPCC reports in a draft TSD. The draft 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 serves as an important support document to EPA's proposed Endangerment Finding; however, the document is a draft and is still undergoing comment and review as part of EPA's rulemaking process, and is subject to change based upon comments to the final endangerment finding.

a. Changes in Atmospheric Concentrations of GHGs From Global and U.S. Emissions

Concentrations of six key GHGs (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) are at unprecedented levels compared to the recent and distant past. 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.

Based on data from the most recent Inventory of U.S. Greenhouse Gas Emissions and Sinks (2008),[195] total U.S. GHG emissions increased by 905.9 teragrams of CO_2-equivalent (Tg CO_2 Eq), or 14.7%, between 1990 and 2006. U.S. transportation sources subject to control under section 202(a) of the Clean Air Act (passenger cars, light duty trucks, other trucks and buses, motorcycles, and cooling [196]) emitted 1665 Tg CO_2 Eq in 2006, representing almost 24% of the total U.S. GHG emissions. Total global emissions, calculated by summing emissions of the six greenhouse gases by country, for 2005 was 38,725.9 Tg CO_2 Eq. This represents an increase of 26% from the 1990 level. See the EPA report ''Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006'',[197] Section 2 of the proposed Endangerment TSD, and IPCC's Working Group I (WGI) Fourth Assessment Report (AR4) [198] for a more complete discussion of GHG emissions and concentrations.

b. Observed Changes in Climate

i. Temperature

The warming of the climate system is unequivocal, as is now evident from observations of increases in global air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. 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. The global mean surface temperature [199] over the last 100 years (1906–2005) has risen by about 0.74 °C (1.5 °F) +/− 0.18 °C, and climate model simulations suggest that natural variation alone (*e.g.*, changes in solar irradiance) cannot explain the observed warming. The rate of warming over the last 50 years is almost double that over the last 100 years. Most of the observed increase in global mean surface temperature since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations.

It can be stated with confidence that 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. Like global mean surface temperatures, U.S. surface temperatures also warmed during the 20th and into the 21st century. U.S. average annual temperatures are now approximately 0.69°C (1.25°F) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. Temperatures in winter have risen more than any other season, with winters in the Midwest and northern Great Plains increasing more than 7 °F.[200] Some of these changes have been faster than previous assessments had suggested.

For additional information, please see Section 4 of the proposed Endangerment

[192] U.S. EPA (2008) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006. EPA–430–R–08–005, Washington, DC. *http://www.epa.gov/climatechange/emissions/usgginv_archive.html.*

[193] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009. *http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts.*

[194] See **Federal Register**/Vol. 74, No. 78/Friday, April 24, 2009/Proposed Rules; also Docket Number EPA–HQ–OAR–2009–0171; FRL–8895–5.

[195] U.S. EPA (2008) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006. EPA–430–R–08–005, Washington, DC.

[196] Cooling refers to refrigerants/air conditioning from all transportation sources and is related to HFCs.

[197] U.S. EPA (2008) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006. EPA–430–R–08–005, Washington, DC. *http://www.epa.gov/climatechange/emissions/usgginv_archive.html*.

[198] 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.

[199] Surface temperature is calculated by processing data from thousands of world-wide observation sites on land and sea.

[200] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.) Cambridge University Press, 2009.

TSD, IPCC WGI AR4,[201] and the report ''Global Climate Change Impacts in the United States''.[202]

ii. Precipitation

Observations show that changes are occurring in the amount, intensity, frequency and type of precipitation. Global, long-term trends from 1900 to 2005 have been observed in the amount of precipitation over many large regions. Patterns in precipitation change are more spatially and seasonally variable than temperature change, but where significant precipitation changes do occur they are consistent with measured changes in stream flow. Significantly increased precipitation has been observed in eastern parts of North and South America, northern Europe and northern and central Asia.[200] More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics. It is likely there has been an increase in heavy precipitation events (*e.g.*, 95th percentile) within many land regions, even in those where there has been a reduction in total precipitation amount, consistent with a warming climate and observed significant increasing amounts of water vapor in the atmosphere. Rising temperatures have generally resulted in rain rather than snow in locations and seasons such as in northern and mountainous regions where the average (1961–1990) temperatures were close to 0 °C. Over the contiguous U.S., total annual precipitation increased at an average rate of 6.5% from 1901–2006, with the greatest increases in precipitation in the East and North Central climate regions (11.2% per century).

For additional information, please see Section 4 of the proposed Endangerment TSD, IPCC WGI AR4,[203] and the USGCRP report ''Global Climate Change Impacts in the United States''.[204]

iii. Extreme Events

Changes in climate extremes have been observed related to temperature, precipitation, tropical cyclones, and sea level. In the last 50 years, there have been widespread changes in extreme temperatures observed across the globe. For example, cold days, cold nights, and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent. Globally, a reduction in the number of daily cold extremes has been observed in 70 to 75% of the land regions where data is available. Cold nights (lowest or coldest 10% of nights, based on the period 1961–1990) have become rarer over the last 50 years.

Observational evidence indicates an increase in intense tropical cyclone (*i.e.*, tropical storms and/or hurricanes) activity in the North Atlantic. Since about 1970, increases in cyclone developments that affect the U.S. East and Gulf Coasts have been correlated with increases of tropical sea surface temperatures In the contiguous U.S., studies find statistically significant increases in heavy precipitation (the heaviest 5%) and very heavy precipitation (the heaviest 1%) of 14 and 20%, respectively. Much of this increase occurred during the last three decades of the 20th century and is most apparent over the eastern parts of the country. Trends in drought also have strong regional variations. In much of the Southeast and large parts of the western U.S., the frequency of drought has increased coincident with rising temperatures over the past 50 years. Although there has been an overall increase in precipitation and no clear trend in drought for the nation as a whole, increasing temperatures have made droughts more severe and widespread than they would have otherwise been.

For additional information, please see Section 4 of the proposed Endangerment TSD, the CCSP report ''Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands'',[205] IPCC WGI AR4,[206] and the report ''Global Climate Change Impacts in the United States''.[207]

iv. Physical and Biological Changes

Observations show that climate change is currently affecting U.S. physical and biological systems in significant ways. Observations of the cryosphere (the ''frozen'' component of the climate system) have revealed changes in sea ice, glaciers and snow cover, freezing and thawing, and permafrost. Satellite data since 1978 show that annual average Arctic sea ice extent has shrunk by 2.7% (+/− 0.6%) per decade, with larger decreases in summer. Subtropical and tropical corals in shallow waters have already suffered major bleaching events that are primarily driven by increases in sea surface temperatures. Heat stress from warmer ocean water can cause corals to expel the microscopic algae that live inside them which are essential to their survival. Another stressor on coral populations is ocean acidification which occurs as CO_2 is absorbed from the atmosphere by the oceans. About one-third of the carbon dioxide emitted by human activities has been absorbed by the ocean, resulting in a decrease in the ocean's pH. A lower pH affects the ability of living things to create and maintain shells or skeletons of calcium carbonate. Other documented bio-physical impacts include a significant lengthening of the growing season and increase in net primary productivity[208] in higher latitudes of North America. Over the last 19 years, global satellite data indicate an earlier onset of spring across the temperate latitudes by 10 to 14 days.

[201] 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.

[202] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009. *http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts*.

[203] 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.

[204] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009. *http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts*.

[205] *Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Thomas R. Karl, Gerald A. Meehl, Christopher D. Miller, Susan J. Hassol, Anne M. Waple, and William L. Murray (eds.)]. Department of Commerce, NOAA's National Climatic Data Center, Washington, D.C., USA, 164 pp.

[206] 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.

[207] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009. *http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts*.

[208] Net primary productivity is the rate at which an ecosystem accumulates energy or biomass, excluding the energy it uses for the process of respiration.

For additional information, please *see* Section 4 of the proposed Endangerment TSD and IPCC WGI AR4.[209]

c. Projected Changes in Climate

Most future scenarios that assume no explicit GHG mitigation actions (beyond those already enacted) project increasing global GHG emissions over the century, with corresponding climbing GHG concentrations. Carbon dioxide is expected to remain the dominant anthropogenic GHG over the course of the 21st century. The radiative forcing [210] associated with the non-CO_2 GHGs is still significant and increasing over time. As a result, warming over this century is projected to be considerably greater than over the last century and climate related changes are expected to continue while new ones develop. Described below are projected changes in climate for the U.S.

See Section 6 of the proposed Endangerment TSD, IPCC WGI AR4,[211] the USGCRP report ''Global Climate Change Impacts in the United States'',[212] and the CCSP report ''Weather and Climate Extremes in a Changing Climate, Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands'' [213] for a more complete discussion of projected changes in climate.

[209] IPCC (2007a) 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.

[210] Radiative forcing is a measure of the change that a factor causes in altering the balance of incoming (solar) and outgoing (infrared and reflected shortwave) energy in the Earth-atmosphere system and thus shows the relative importance of different factors in terms of their contribution to climate change.

[211] 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.

[212] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009. *http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts*.

[213] *Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Thomas R. Karl, Gerald A. Meehl, Christopher D. Miller, Susan J. Hassol, Anne M. Waple, and William L. Murray (eds.)]. Department of Commerce, NOAA's National Climatic Data Center, Washington, DC, USA, 164 pp.

i. Temperature

Future warming over the course of the 21st century, even under scenarios of low emissions growth, is very likely to be greater than observed warming over the past century. The range of IPCC SRES scenarios provides a global warming range of 1.8 °C to 4.0 °C (3.2 °F to 7.2 °F) with an uncertainty range of 1.1 °C to 6.4 °C (2.0 °F to 11.5 °F). All of the U.S. is very likely to warm during this century, and most areas of the U.S. are expected to warm by more than the global average. The average warming in the U.S. through 2100 is projected by nearly all the models used in the IPCC assessment to exceed 2 °C (3.6 °F) for all scenarios, with 5 out of 21 models projecting average warming in excess of 4 °C (7.2 °F) for the mid-range emissions scenario. The number of days with high temperatures above 90 °F is projected to increase throughout the U.S. Temperature increases in the next couple of decades will be primarily determined by past emissions of heat-trapping gases. As a result, there is less difference in projected temperature scenarios in the near-term (around 2020) than in the middle (2050) and end of the century, which will be determined more by future emissions.

ii. Precipitation

Increases in the amount of precipitation are very likely in higher latitudes, while decreases are likely in most subtropical latitudes and the southwestern U.S., continuing observed patterns. The mid-continental area is expected to experience drying during the summer, indicating a greater risk of drought. Climate models project continued increases in the heaviest downpours during this century, while the lightest precipitation is projected to decrease. With more intense precipitation expected to increase, the risk of flooding and greater runoff and erosion will also increase. In contrast, droughts are likely to become more frequent and severe in some regions. The Southwest, in particular, is expected to experience increasing drought as changes in atmospheric circulation patterns cause the dry zone just outside the tropics to expand farther northward into the United States.

iii. Extreme Events

It is likely that hurricanes will become more intense, especially along the Gulf and Atlantic coasts, with stronger peak winds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures. Heavy rainfall events are expected to increase, increasing the risk of flooding, greater runoff and erosion, and thus the potential for adverse water quality effects. These projected trends can increase the number of people at risk from suffering disease and injury due to floods, storms, droughts, and fires. Severe heat waves are projected to intensify, which can increase heat-related mortality and sickness.

iv. Physical and Biological Changes

IPCC projects a six-inch to two-foot rise in sea level during the 21st century from processes such as thermal expansion of sea water and the melting of land-based polar ice sheets. Ocean acidification is projected to continue, resulting in the reduced biological production of marine calcifiers, including corals. In addition to ocean acidification, coastal waters are very likely to continue to warm by as much as 4 to 8 °F in this century, both in summer and winter. This will result in a northward shift in the geographic distribution of marine life along the coasts. Warmer ocean temperatures will also contribute to increased coral bleaching.

d. Key Climate Change Impacts and Risks

The effects of climate changes observed to date and/or projected to occur in the future include: More frequent and intense heat waves, more wildfires, degraded air quality, more heavy downpours and flooding, increased drought, greater sea level rise, more intense storms, water quantity and quality problems, and negative impacts to human health, water supply, agriculture, forestry, coastal areas, wildlife and ecosystems, and many other aspects of society and the natural environment.

i. Human Health

Warm temperatures and extreme weather already cause and contribute to adverse human health outcomes through heat-related mortality and morbidity, storm-related fatalities and injuries, and disease. In the absence of effective adaptation, these effects are likely to increase with climate change. Health effects related to climate change include increased deaths, injuries, infectious diseases, and stress-related disorders and other adverse effects associated with social disruption and migration from more frequent extreme weather. Severe heat waves are projected to intensify in magnitude and duration over the portions of the U.S. where these events already occur, with potential increases in mortality and morbidity, especially among the elderly, young and other sensitive populations.

However, reduced human mortality from cold exposure is projected through 2100. It is not clear whether reduced mortality from cold will be greater or less than increased heat-related mortality, especially among the elderly, young and frail. Public health effects from climate change will likely disproportionately impact the health of certain segments of the population, such as the poor, the very young, the elderly, those already in poor health, the disabled, those living alone and/or indigenous populations dependent on one or a few resources. Increases are expected in potential ranges and exposure of certain diseases affected by temperature and precipitation changes, including vector and waterborne diseases (*i.e.*, malaria, dengue fever, West Nile virus). See the CCSP Report ''Analyses of the effects of global change on human health and welfare and human systems'',[214] IPCC's Working Group II (WG2) AR4,[215] and Section 7 of the proposed Endangerment TSD for a more complete discussion regarding climate change and impacts on human health.

ii. Air Quality

Climate change can be expected to influence the concentration and distribution of air pollutants through a variety of direct and indirect processes, including the modification of biogenic emissions, the change of chemical reaction rates, wash-out of pollutants by precipitation, and modification of weather patterns that influence pollutant build-up. Higher temperatures and weaker circulation patterns associated with climate change are expected to worsen regional ozone pollution in the U.S., with associated risks in respiratory infection, aggravation of asthma, and premature death. In addition to human health effects, elevated levels of tropospheric ozone have significant adverse effects on crop yields, pasture and forest growth, and species composition. See Section 8 of the proposed Endangerment TSD, EPA's report ''*Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone*'', [216] the CCSP report ''Analyses of the effects of global change on human health and welfare and human systems'' [217] and IPCC WGII AR4 [218] for a more complete discussion regarding human health impacts resulting from climate change effects on air quality.

iii. Food and Agriculture

The CCSP concluded 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, 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. *See* Section 9 of the proposed Endangerment TSD, the CCSP report ''The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States'', and the USGCRP report ''Global Climate Change Impacts in the United States'' for a more complete discussion regarding climate science and impacts to food production and agriculture.

iv. Forestry

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. Disturbances like wildfire and insect outbreaks are increasing and are likely to intensify in a warmer future with 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. Overall forest growth for North America as a whole will likely increase modestly (10–20%) as a result of extended growing seasons and elevated CO_2 over the next century, but with important spatial and temporal variation. Forest growth is slowing in areas subject to drought and has been subject to significant loss due insect infestations such as the spruce bark beetle in Alaska. See Section 10 of the proposed Endangerment TSD, the CCSP report ''The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States'', IPCC WGII, and the USGCRP report ''Global Climate Change Impacts in the United States'' for a more complete discussion regarding climate science and impacts to forestry.

v. Water Resources

The vulnerability of freshwater resources in the United States to climate change varies from region to region. Climate change will likely further constrain already over-allocated water resources in some sections of the U.S., increasing competition among agricultural, municipal, industrial, and ecological uses. Although water management practices in the U.S. are generally advanced, particularly in the western U.S climate change may increasingly create conditions well outside of historic observations impacting managed water systems. Rising temperatures will diminish snowpack and increase evaporation, affecting seasonal availability of water. Groundwater systems generally respond more slowly to climate change than surface water systems. In semi-arid and arid areas, groundwater resources are particularly vulnerable because of precipitation and stream flow are concentrated over a few months, year-to-year variability is high, and deep groundwater wells or reservoirs generally do not exist. Availability of groundwater is likely to be influenced by changes in withdrawals (reflecting development, demand, and availability of other sources).

In the Great Lakes and major river systems, lower levels are likely to exacerbate challenges relating to water quality, navigation, recreation,

[214] *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.

[215] *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.

[216] EPA (2009) *Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone.* An Interim Report of the U.S. EPA Global Change Research Program. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–07/094.

[217] *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.

[218] *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.

hydropower generation, water transfers, and bi-national relationships. Decreased water supply and lower water levels are likely to exacerbate challenges relating to aquatic navigation. 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. See Section 11 of the proposed Endangerment TSD, the CCSP report ''The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States'', IPCC WGII, and the USGCRP report ''Global Change Impacts in the United States'' for a more complete discussion regarding climate science and impacts to water resources.

vi. Sea Level Rise and Coastal Areas

Warmer temperatures raise sea level by expanding ocean water, melting glaciers, and possibly increasing the rate at which ice sheets discharge ice and water into the oceans. Rising sea level and the potential for stronger storms pose an increasing threat to coastal cities, residential communities, infrastructure, beaches, wetlands, and ecosystems. Coastal communities and habitats will be increasingly stressed by climate change effects interacting with development and pollution. Sea level is rising along much of the U.S. coast, and the rate of change will increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding, and shoreline erosion. Studies find 75% of the shoreline removed from the influence of spits, tidal inlets and engineering structures is eroding along the U.S. East Coast probably due to sea level rise. Storm impacts are likely to be more severe, especially along the Gulf and Atlantic coasts. Salt marshes, estuaries, other coastal habitats, and dependent species will be further threatened by sea level rise. The interaction with coastal zone development and climate change effects such as sea level rise will further stress coastal communities and habitats. Population growth and rising value of infrastructure in coastal areas increases vulnerability and risk of climate variability and future climate change. Sea level rise and high rates of water withdrawal promote the intrusion of saline water in to groundwater supplies, which adversely affects water quality. *See* Section 12 of the proposed Endangerment TSD, the CCSP report ''Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region'',[219] the USGCRP report ''Global Change Impacts in the United States'', and IPCC WGII for a more complete discussion regarding climate science and impacts to sea level rise and coastal areas.

vii. Energy, Infrastructure and Settlements

Most of the effects of climate change on the U.S. energy sector will be related to energy use and production. The research evidence is relatively clear that climate warming will mean reductions in total U.S. heating requirements and increases in total cooling requirements for building. These changes will vary by region and by season and will affect household and business energy costs. Studies project that temperature increases due to global warming are very likely to increase peak demand for electricity in most regions of the country as rising temperatures are expected to increase energy requirements for cooling residential and commercial buildings. An increase in peak demand for electricity can lead to a disproportionate increase in energy infrastructure investment. Extreme weather events can threaten coastal energy infrastructures and electricity transmission and distribution in the U.S. Increases in hurricane intensity are likely to cause further disruptions to oil and gas operations in the Gulf, like those experienced in 2005 with Hurricane Katrina. Climate change is likely to affect some renewable energy sources across the nation, such as hydropower production in regions subject to changing patterns of precipitation or snowmelt. The U.S. energy sector, which relies heavily on water for both 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 storm water management systems, will be at greater risk of flooding, sea level rise and storm surge, low flows, and other factors that could impair performance. In addition, as water supply is constrained and demand increases it will become more likely that water will have to be transported and moved which will require additional energy capacity. *See* Section 13 of the proposed Endangerment TSD, the CCSP reports ''the Effects of Climate Change on Energy Production in the United States'' [220] and ''Impacts of Climate Change and Variability on Transportation Systems and Infrastructure'',[221] and the USGCRP report ''Global Change Impacts in the United States'' for a more complete discussion regarding climate science and impacts to energy, infrastructure and settlements.

viii. Ecosystems and Wildlife

Disturbances such as wildfires and insect outbreaks are increasing in the U.S. and are likely to intensify in a warmer future with 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 are constrained by development, habitat fragmentation, invasive species, and broken ecological connections. IPCC consequently predicts significant disruption of ecosystem structure, function, and services. *See* Section 14 of the proposed Endangerment TSD, IPCC WGII, the CCSP report ''The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States'', and the USGCRP report ''Global Change Impacts in the United States'' for a more complete discussion regarding climate science and impacts to ecosystems and wildlife.

[219] CCSP (2009) *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region.* A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [James G. Titus (Coordinating Lead Author), K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Stephen K. Gill, Benjamin T. Gutierrez, E. Robert Thieler, and S. Jeffress Williams (Lead Authors)], U.S. Environmental Protection Agency, Washington DC, USA, 320 pp.

[220] CCSP (2007): *Effects of Climate Change on Energy Production and Use in the United States.* A Report by the U.S. Climate Change Science Program and the subcommittee on Global Change Research. Thomas J. Wilbanks, Vatsal Bhatt, Daniel E. Bilello, Stanley R. Bull, James Ekmann, William C. Horak, Y. Joe Huang, Mark D. Levine, Michael J. Sale, David K. Schmalzer, and Michael J. Scott). Department of Energy, Office of Biological & Environmental Research, Washington, DC, USA, 160 pp.

[221] CCSP (2008) *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Savonis, M.J., V.R. Burkett, and J.R. Potter (eds.)]. Department of Transportation, Washington, DC, USA, 445 pp.

3. Changes in Global Mean Temperature and Sea Level Rise Associated With the Proposal's GHG Emissions Reductions

EPA examined [222] the reductions in CO_2 and other GHGs associated with the proposal and analyzed the projected effects on global mean surface temperature and sea level, two common indicators of climate change. The analysis projects that the proposal will reduce climate warming and sea level rise. Although the projected reductions are small in overall magnitude by themselves, they are quantifiable and would contribute to reducing climate change risks.

a. Estimated Projected Reductions in Global Mean Surface Temperatures and Sea Level Rise

EPA estimated changes in the atmospheric CO_2 concentration, global mean surface temperature and sea level to 2100 resulting from the emissions reductions in this proposal using the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC, version 5.3). 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 Intergovernmental Panel on Climate Change (IPCC).

GHG emissions reductions from Section III.F.1a were applied as net reductions to a peer reviewed global reference case (or baseline) emissions scenario to generate an emissions scenario specific to this proposal. For the proposal scenario, all emissions reductions were assumed to begin in 2012, with zero emissions change in 2011 (from the reference case) followed by emissions linearly increasing to equal the value supplied in Section III.F.1.a for 2020 and then continuing to 2100. Details about the reference case scenario and how the emissions reductions were applied to generate the proposal scenario can be found in the DRIA Chapter 7.

The atmospheric CO_2 concentration, temperature, and sea-level increases for both the reference case and the proposal emissions scenarios were computed using MAGICC. To compute the reductions in the atmospheric CO_2 concentrations as well as in temperature and sea level resulting from the proposal, the output from the proposal scenario was subtracted from an existing MiniCAM emission scenario. To capture some key uncertainties in the climate system with the MAGICC model, changes in temperature and sea-level rise were projected across the most current IPCC range for climate sensitivities which ranges from 1.5 °C to 6.0 °C (representing the 90% confidence interval).[223] This wide range reflects the uncertainty in this measure of how much the global mean temperature would rise if the concentration of carbon dioxide in the atmosphere were to double. Details about this modeling analysis can be found in the DRIA Chapter 7.4.

The results of this modeling show small, but quantifiable, reductions in the atmospheric CO_2 concentration, the projected global mean surface temperature and sea level resulting from this proposal (assuming it is finalized), across all climate sensitivities. As a result of this proposal's emission reductions, the atmospheric CO_2 concentration is projected to be reduced by approximately 2.9 to 3.2 parts per million (ppm), the global mean temperature is projected to be reduced by approximately 0.007–0.016 °C by 2100, and global mean sea level rise is projected to be reduced by approximately 0.06–0.15cm by 2100. The reductions are small relative to the IPCC's 2100 "best estimates" for global mean temperature increases (1.8–4.0 °C) and sea level rise (0.20–0.59m) for all global GHG emissions sources for a range of emissions scenarios. EPA used a peer reviewed model, the MAGICC model, to do this analysis. This analysis is specific to the proposed rule and therefore cannot come from some previously published work. The Agency welcomes comment on the use of the MAGICC model for these purposes. Further discussion of EPA's modeling analysis is found in Chapter 7 of the Draft RIA.

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. 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 all climate sensitivities.

4. Weight Reduction and Potential Safety Impacts

In this section, EPA will discuss potential safety impacts of the proposed standards. In the joint technology analysis, EPA and NHTSA agree that automakers could reduce weight as one part of the industry's strategy for meeting the proposed standards. As shown in table III.D.6–3, of this Preamble, EPA's modeling projects that vehicle manufacturers will reduce the weight of their vehicles by 4% on average between 2011 and 2016 although individual vehicles may have greater or smaller weight reduction (NHTSA's results are similar using the Volpe model). The penetration and magnitude of these modeled changes are consistent with the public announcements made by many manufacturers since early 2008 and are consistent with meetings that EPA has had with senior engineers and technical leadership at many of the automotive companies during 2008 and 2009.

EPA also projects that automakers will not reduce footprint in order to meet the proposed CO_2 standards in our modeling analysis. NHTSA and EPA have taken two measures to help ensure that the proposed rules provide no incentive for mass reduction to be accompanied by a corresponding decrease in the footprint of the vehicle (with its concomitant decrease in crush and crumple zones). The first design feature of the proposed rule is that the CO_2 or fuel economy targets are based on the attribute of footprint (which is a surrogate for vehicle size).[224] The second design feature is that the shape of the footprint curve (or function) has been carefully chosen such that it neither encourages manufacturers to increase, nor decrease the footprint of their fleet. Thus, the standard curves are designed to be approximately "footprint neutral" within the sloped portion of the function.[225] For further discussion on this, refer to Section II.C of the preamble, or Chapter 2 of the joint TSD. Thus the agencies are assuming in their

[222] Using the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC, *http://www.cgd.ucar.edu/cas/wigley/magicc/*), EPA estimated the effects of this action's greenhouse gas emissions reductions on global mean temperature and sea level. *Please refer* to Chapter 7.4 of the DRIA for additional information.

[223] 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/.*

[224] As the footprint attribute is defined as wheelbase times track width, the footprint target curves do not discourage manufacturers from reducing vehicle size by reducing front, rear, or side overhang, which can impact safety by resulting in less crush space.

[225] This neutrality with respect to footprint does not extend to the smallest and largest vehicles, because the function is limited, or flattened, in these footprint ranges.

modeling analysis that the manufacturers could reduce vehicle mass without reducing vehicle footprint as one way to respond to the proposed rule.[226]

In Section IV of this preamble, NHTSA presents a safety analysis of the proposed CAFE standards based on the 2003 Kahane analysis. As discussed in Section IV, NHTSA has developed a worse case estimate of the impact of weight reductions on fatalities. The underlying data used for that analysis does not allow NHTSA to analyze the specific impact of weight reduction at constant footprint because historically there have not been a large number of vehicles produced that relied substantially on material substitution. Rather, the data set includes vehicles that were either smaller and lighter or larger and heavier. The numbers in the NHTSA analysis predict the safety-related fatality consequences that would occur in the unlikely event that weight reduction for model years 2012–2016 is accomplished by reducing mass and reducing footprint. EPA concurs with NHTSA that the safety analysis conducted by NHTSA and presented in Section IV is a worst case analysis for fatalities, and that the actual impacts on vehicle safety could be much less. However, EPA and NHTSA are not able to quantify the lower-bound potential impacts at this time.

The agencies believe that reducing vehicle mass without reducing the size of the vehicle or the structural integrity is technically feasible in the rulemaking time frame. Many of the technical options for doing so are outlined in Chapter 3 of the joint TSD and in EPA's DRIA. Weight reduction can be accomplished by the proven methods described below. Every manufacturer will employ these methodologies to some degree, the magnitude to which each will be used will depend on opportunities within individual vehicle design.

- Material Substitution: Substitution of lower density and/or higher strength materials 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 (*e.g.,* the magnesium-alloy front structure used on the 2009 Ford F150 pickups).[227] Light-weight materials with acceptable energy absorption properties can maintain structural integrity and absorption of crash energy relative to previous designs while providing a net decrease in component weight.
- *Smart Design:* Computer aided engineering (CAE) tools can be used to better optimize load paths within structures by reducing stresses and bending moments without adversely affecting structural integrity. 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 with little compromise in vehicle functionality.
- *Reduced Powertrain Requirements:* Reducing vehicle weight sufficiently can allow for the use of a smaller, lighter and more efficient engine while maintaining or even increasing performance. Approximately half of the reduction is due to these reduced powertrain output requirements from reduced engine power output and/or displacement, lighter weight 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.
- Mass Compounding: Following from the point above, the compounded weight reductions of the body, engine and drivetrain can reduce stresses on the suspension components, steering components, brakes, and thus allow further reductions in the weight of these subsystems. The reductions in weight for unsprung masses such as brakes, control arms, wheels and tires can further reduce stresses in the suspension mounting points which can allow still further reductions in weight. For example, lightweighting can allow for the reduction in the size of the vehicle brake system, while maintaining the same stopping distance.

Therefore, EPA believes it is both technically feasible to reduce weight without reducing vehicle size, footprint or structural strength and manufacturers have indicated to the agencies that they will use these approaches to accomplish these tasks. We request written comment on this assessment and this projection, including up-to-date plans regarding the extent of use by each manufacturer of each of the methodologies described above.

For this proposed rule, as noted earlier, EPA's modeling analysis projects that weight reduction by model year 2016 on the order of 4% on average for the fleet will occur (*see* Section III.D.6 for details on our estimated mass reduction). EPA believes that such modeled changes in the fleet could result in much smaller fatality impacts than those in the worst case scenario presented in Section IV by NHTSA, since manufacturers have many safer options for reducing vehicle weight than doing so by simultaneously reducing footprint. The NHTSA analysis, based solely on 4-door vehicles, does not independently differentiate between weight reduction which comes from vehicle downsizing (a physically smaller vehicle) and vehicle weight reduction solely through design and material changes (*i.e.,* making a vehicle weigh less without changing the size of the vehicle or reducing structural integrity).

Dynamic Research Incorporated (DRI) has assessed the independent effects of vehicle weight and size on safety in order to determine if there are tradeoffs between improving vehicle safety and fuel consumption. In their 2005 studies [228] [229] one of which was published as a Society of Automotive Engineers Technical Paper and received peer review through that body, DRI presented results that indicate that vehicle weight reduction tends to decrease fatalities, but vehicle wheelbase and track reduction tends to increase fatalities. The DRI work focused on four major points, with #1 and #4 being discussed with additional detail below:

1. 2–Door vehicles represented a significant portion of the light duty fleet and should not be ignored.
2. Directional control and therefore crash avoidance improves with a reduction in curb weight.
3. The occupants of the impacted vehicle, or ''collision partner'' benefit from being impacted by a lighter vehicle.
4. Rollover fatalities are reduced by a reduction in curb weight due to lower centers of gravity and lower loads on the roof structures.

[226] *See* Chapter 1 of the joint TSD for a description of potential footprint changes in the 2016 reference fleet.

[227] We note that since these MY 2009 F150s have only begun to enter the fleet, there is little real-world crash data available to evaluate the safety impacts of this new design.

[228] ''Supplemental Results on the Independent Effects of Curb Weight, Wheelbase and Track on Fatality Risk'', Dynamic Research, Inc., DRI–TR–05–01, May 2005.

[229] ''An Assessment of the Effects of Vehicle Weight and Size on Fatality Risk in 1985 to 1998 Model Year Passenger Cars and 1985 to 1997 Model Year'', M. Van Auken and J. Zellner, Dynamic Research Inc., Society of Automotive Engineers Technical Paper 2005–01–1354.

The data used for the DRI analysis was similar to NHTSA's 2003 Kahane study, using Fatality Analysis Reporting System (FARS) data for vehicle model years 1985 through 1998 for cars, and 1985 through 1997 trucks. This data overlaps Kahane's FARS data on model year 1991 to 1999 vehicles. However, DRI included 2-door passenger cars, whereas the Kahane study excluded all 2-door vehicles. The 2003 Kahane study excluded 2-door passenger cars because it found that for MY 1991–1999 vehicles, sports and muscle cars constituted a significant proportion of those vehicles. These vehicles have relatively high weight relative to their wheelbase, and are also disproportionately involved in crashes. Thus, Kahane concluded that including these vehicles in the analysis excessively skewed the regression results. However, as of July 1, 1999, 2-door passenger cars represented 29% of the registered cars in the United States. DRI's position was that this is a significant portion of the light duty fleet, too large to be ignored, and conclusions regarding the effects of weight and safety should be based on data for all cars, not just 4-doors. DRI did state in their conclusions that the results are sensitive to removing data for 2-doors and wagons, and that the results for 4-door cars with respect to the effects of wheelbase and track width were no longer statistically significant when 2-door cars were removed. EPA and NHTSA recognize that it is important to properly account for 2-door cars in a regression analysis evaluating the impacts of vehicle weight on safety. Thus, the agencies seek comment on how to ensure that any analysis supporting the final rule accounts as fully as possible for the range of safety impacts due to weight reduction on the variety of vehicles regulated under these proposed standards.

The DRI and Kahane studies also differ with respect to the impact of vehicle weight on rollover fatalities. The Kahane study treated curb weight as a surrogate for size and weight and analyzed them as a single variable. Using this method, the 2003 Kahane analysis indicates that curb weight reductions would increase fatalities due to rollovers. The DRI study differed by analyzing curb weight, wheelbase, and track as multiple variables and concluded that curb weight reduction would decrease rollover fatalities, and wheelbase and track reduction would increase rollover fatalities. DRI offers two potential root causes for higher curb weight resulting in higher rollover fatalities. The first is that a taller vehicle tends to be heavier than a shorter vehicle; therefore heavier vehicles may be more likely to rollover because the vehicle height and weight are correlated with vehicle center of gravity height. The second is that FMVSS 216 for roof crush strength requirements for passenger cars of model years 1995 through 1999 were proportional to the unloaded vehicle weight if the weight is less than 3,333 lbs, however they were a constant if the weight is greater than 3,333 lbs. Therefore heavier vehicles may have had relatively less rollover crashworthiness.

NHTSA has rejected the DRI analysis, and has not relied on it for its evaluation of safety impact changes in CAFE standards. *See* Section IV.G.6 of this Notice, as well as NHTSA's March 2009 Final Rulemaking for MY2011 CAFE standards (see 74 FR at 14402–05).

The DRI and Kahane analyses of the FARS data appear similar in one respect because the results are reproducible between the two studies when using aggregated vehicle attributes for 4-door cars.[230] [231] [232] However, when DRI and NHTSA separately analyzed individual vehicle attributes of mass, wheelbase and track width, DRI and NHTSA obtained different results for passenger cars. NHTSA has raised this as a concern with the DRI study. When 2-door vehicles are removed from the data set EPA is concerned that the results may no longer be statistically significant with respect to independent vehicle attributes due to the small remaining data set, as DRI stated in the 2005 study.

The DRI analysis concluded that there would be a small reduction in fatalities for cars and for trucks for a 100 pound reduction in curb weight without accompanied vehicle footprint or size changes. EPA notes that if DRI's results were to be applied using the curb weight reductions predicted by the OMEGA model, an overall reduction in fatalities would be predicted. EPA invites comment on all aspects of the issue of the impact of this kind of weight reduction on safety, including the usefulness of the DRI study in evaluating this issue.

The agencies are committed to continuing to analyze vehicle safety issues so a more informed evaluation can be made. We request comment on this issue. These comments should include not only further discussion and analysis of the relevant studies but data and analysis which can allow the agencies to more accurately quantify any potential safety issues with the proposed standards.

[230] ''Supplemental Results on the Independent Effects of Curb Weight, Wheelbase and Track on Fatality Risk'', Dynamic Research, Inc., DRI–TR–05–01, May 2005.

[231] ''An Assessment of the Effects of Vehicle Weight and Size on Fatality Risk in 1985 to 1998 Model Year Passenger Cars and 1985 to 1997 Model Year'', M. Van Auken and J. Zellner, Dynamic Research Inc., Society of Automotive Engineers Technical Paper 2005–01–1354.

[232] FR Vol. 74, No. 59, beginning on pg. 14402.

G. How Would the Proposal Impact Non-GHG Emissions and Their Associated Effects?

In addition to reducing the emissions of greenhouse gases, this proposal would influence the emissions of ''criteria'' air pollutants and air toxics (*i.e.,* hazardous air pollutants). The criteria air pollutants include carbon monoxide (CO), fine particulate matter ($PM_{2.5}$), sulfur dioxide (SO_X) and the ozone precursors hydrocarbons (VOC) and oxides of nitrogen (NO_X); the air toxics include benzene, 1,3-butadiene, formaldehyde, acetaldehyde, and acrolein. Our estimates of these non-GHG emission impacts from the proposed program are shown by pollutant in Table III.G–1 and Table III.G–2 in total, and broken down by the two drivers of these changes: (a) ''Upstream'' emission reductions due to decreased extraction, production and distribution of motor gasoline; and (b) ''downstream'' emission increases, reflecting the effects of VMT rebound (discussed in Sections III.F and III.H). Total program impacts on criteria and toxics emissions are discussed below, followed by individual discussions of the upstream and downstream impacts. Those are followed by discussions of the effects on air quality, health, and other environmental concerns.

As discussed in Chapter 5 of the DRIA, the impacts presented here are only from petroleum (*i.e.,* EPA assumes that total volumes of ethanol and other renewable fuels will remain unchanged due to this program). Ethanol use was modeled at the volumes projected in AEO2007 for the reference and control case; thus no changes are projected in upstream emissions related to ethanol production and distribution. However, due to the decreased gasoline volume associated with this proposal, a greater market share of E10 is expected relative to E0, which would be expected to have some effect on fleetwide average non-GHG emission rates. This effect, which is likely small relative to the other effects considered here, has not been accounted for in the downstream emission modeling conducted for this proposal, but EPA does plan to address it in the final rule air quality analysis, for which localized impacts could be more significant. A more comprehensive analysis of the impacts of different ethanol and gasoline volume scenarios is being prepared as part of EPA's RFS2 rulemaking package.[233]

As shown in Table III.G–1, EPA estimates that this program would result in reductions of NO_X, VOC, PM and SO_X, but would increase CO emissions. For NO_X, VOC, PM and SO_X, we estimate net reductions in criteria pollutant emissions because the emissions reductions from upstream sources are larger than the emission increases due to additional driving (*i.e.,* the ''rebound effect''). In the case of CO, we estimate slight emission increases, because there are relatively small reductions in upstream emissions, and thus the projected emission increases due to additional driving are greater than the projected emission decreases due to reduced fuel production. EPA estimates that the proposed program would result in small changes for toxic emissions compared to total U.S. inventories across all sectors. For all pollutants the overall impact of the program would be relatively small compared to total U.S. inventories across all sectors. In 2030 EPA estimates the proposed program would reduce these total NO_X, PM and SO_X inventories by 0.2 to 0.3 percent and reduce the VOC inventory by 1.2 percent, while increasing the total national CO inventory by 0.4 percent.

As shown in Table III.G–2, EPA estimates that the proposed program would result in small changes for toxic emissions compared to total U.S. inventories across all sectors. In 2030 EPA estimates the program would reduce total benzene and formaldehyde by 0.04 percent. Total acrolein, acetaldehyde, and 1,3-butadiene would increase by 0.03 to 0.2 percent.

Other factors which may impact non-GHG emissions, but are not estimated in this analysis, include:

• Vehicle technologies used to reduce tailpipe CO_2 emissions; because the regulatory standards for non-GHG emissions are the primary driver for these emissions, EPA expects the impact of this program to be negligible on non-GHG emission rates per mile.

• The potential for increased market penetration of diesel vehicles; because these vehicles would be held to the same certification and in-use standards for criteria pollutants as their gasoline counterparts, EPA expects their impact to be negligible on criteria pollutants and other non-GHG emissions.

• Early introduction of electric vehicles and plug-in hybrid electric vehicles, which would reduce criteria emissions in cases where they are able to certify to lower certification standards. It would also likely reduce gaseous air toxics.

• Reduced refueling emissions due to less frequent refueling events and reduced annual refueling volumes resulting from the GHG standards.

• Increased hot soak evaporative emissions due to the likely increase in number of trips associated with VMT rebound modeled in this proposal.

• Increased market share of E10 relative to E0 due to the decreased overall gasoline consumption of this proposal combined with an unchanged fuel ethanol volume.

EPA invites comments on the possible contribution of these factors to non-GHG emissions.

BILLING CODE 4910–59–P

[233] 74 FR 24904. *See* also Docket EPA–HQ–OAR–2005–0161.

Table III.G-1 Annual Criteria Emission Impacts of Program (short tons)

	Total Impacts		*Upstream Impacts*		*Downstream Impacts*	
	2020	**2030**	*2020*	*2030*	*2020*	*2030*
VOC	**-73,739**	**-142,347**	*-75,437*	*-147,841*	*1,698*	*5,494*
% of total inventory	**-0.60%**	**-1.2%**	*-0.61%*	*-1.2%*	*0.01%*	*0.05%*
CO	**70,614**	**227,832**	*-7,209*	*-14,107*	*77,823*	*241,939*
% of total inventory	**0.13%**	**0.38%**	*-0.01%*	*-0.02%*	*0.14%*	*0.40%*
NO_X	**-17,206**	**-27,726**	*-22,560*	*-43,286*	*5,354*	*15,560*
% of total inventory	**-0.14%**	**-0.2%**	*-0.18%*	*-0.36%*	*0.04%*	*0.13%*
PM2.5	**-2,856**	**-5,431**	*-3,075*	*-6,003*	*218*	*572*
% of total inventory	**-0.08%**	**-0.16%**	*-0.09%*	*-0.18%*	*0.01%*	*0.02%*
SO_X	**-16,307**	**-31,965**	*-13,804*	*-27,060*	*-2,503*	*-4,906*
% of total inventory	**-0.18%**	**-0.34%**	*-0.16%*	*-0.29%*	*-0.03%*	*-0.05%*

Table III.G-2 Annual Air Toxic Emission Impacts of Program (short tons)

	Total Impacts		*Upstream Impacts*		*Downstream Impacts*	
	2020	**2030**	*2020*	*2030*	*2020*	*2030*
1,3-Butadiene	**11**	**37**	*-1.8*	*-3.4*	*13.2*	*40.2*
% of total inventory	**0.07%**	**0.22%**	*-0.01%*	*-0.02%*	*0.08%*	*0.24%*
Acetaldehyde	**17**	**61**	*-8*	*-15*	*24.8*	*75.5*
% of total inventory	**0.04%**	**0.13%**	*-0.02%*	*-0.03%*	*0.05%*	*0.17%*
Acrolein	**0**	**2**	*-1.1*	*-2.0*	*1.3*	*3.9*
% of total inventory	**0.00%**	**0.03%**	*0.0%*	*0.0%*	*0.02%*	*0.06%*
Benzene	**-84**	**-77**	*-163*	*-320*	*79.6*	*242.2*
% of total inventory	**-0.04%**	**-0.04%**	*-0.08%*	*-0.15%*	*0.04%*	*0.11%*
Formaldehyde	**-28**	**-16**	*-60*	*-112*	*31.8*	*96.3*
% of total inventory	**-0.03%**	**-0.02%**	*-0.07%*	*-0.1%*	*0.04%*	*0.11%*

BILLING CODE 4910–59–C

1. Upstream Impacts of Program

Reducing tailpipe CO_2 emissions from light-duty cars and trucks through tailpipe standards and improved A/C efficiency will result in reduced fuel demand and reductions in the emissions associated with all of the processes involved in getting petroleum to the pump. These upstream emission impacts on criteria pollutants are summarized in Table III.G–1. The upstream reductions grow over time as the fleet turns over to cleaner CO_2 vehicles, so that by 2030 VOC would decrease by 148,000 tons, NO_X by 43,000 tons, and PM2.5 by 6,000 tons. Table III.G–2 shows the corresponding impacts on upstream air toxic emissions in 2030. Formaldehyde decreases by 112 tons, benzene by 320 tons, acetaldehyde by 15 tons, acrolein by 2 tons, and 1,3-butadiene by 3 tons.

To determine 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. 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 of this gasoline 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 that 90 percent of this gasoline 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,[234] but in some cases the GREET values were modified or updated by EPA to be consistent with the National Emission Inventory (NEI).[235] The primary updates for this analysis were to incorporate newer information on gasoline distribution emissions for VOC from the NEI, which were significantly higher than GREET estimates; and the incorporation of upstream emission factors for the air toxics estimated in this analysis: benzene, 1,3-butadiene, acetaldehyde, acrolein, and

[234] Greenhouse Gas, Regulated Emissions, and Energy Use in Transportation model (GREET), U.S. Department of Energy, Argonne National Laboratory, *http://www.transportation.anl.gov/modeling_simulation/GREET/.*

[235] EPA. 2002 National Emissions Inventory (NEI) Data and Documentation, *http://www.epa.gov/ttn/chief/net/2002inventory.html.*

formaldehyde. The development of these emission factors is detailed in DRIA Chapter 5.

2. Downstream Impacts of Program

As discussed in more detail in Section III.H, the effect of fuel cost on VMT (''rebound'') was accounted for in our assessment of economic and environmental impacts of this proposed rule. A 10 percent rebound case was used for this analysis, meaning that VMT for affected model years is modeled as increasing by 10 percent as much as the increase in fuel economy; *i.e.*, a 10 percent increase in fuel economy would yield a 1.0 percent increase in VMT.

Downstream emission impacts of the rebound effect are summarized in Table III.G–1 for criteria pollutants and precursors and Table III.G–2 for air toxics. The emission increases from the rebound effect grow over time as the fleet turns over to cleaner CO_2 vehicles, so that by 2030 VOC would increase by 5,500 tons, NO_X by 16,000 tons, and PM2.5 by 570 tons. Table III.G–2 shows the corresponding impacts on air toxic emissions. The most noteworthy of these impacts in 2030 are 40 additional tons of 1,3-butadiene, 75 tons of acetaldehyde, 240 tons of benzene, 96 tons of formaldehyde, and 4 tons of acrolein.

For this analysis the reference case non-GHG emissions for light duty vehicles and trucks were derived using EPA's MOtor Vehicle Emission Simulator (MOVES) model for VOC, CO, NO_X, PM and air toxics. PM2.5 emission estimates include additional adjustments for low temperatures, discussed in detail in the DRIA. Because this modeling was based on calendar year estimates, estimating the rebound effect required a fleet-weighted rebound factor to be calculated for calendar years 2020 and 2030; these factors are presented in DRIA Chapter 5.

As discussed in Section III.H, EPA will be taking comment on the appropriate level of rebound rate for this analysis. The sensitivity of the downstream emission increases shown in Tables III.G–1 and III.G–2 to the level of rebound would be in direct proportion to the rebound rate itself; since zero rebound would result in zero emission increase, the downstream results presented in Table III.G–1 and Table III.G–2 can be directly scaled to estimate the effect of lower rebound rates.

3. Health Effects of Non-GHG Pollutants

a. Particulate Matter

i. 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 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.

ii. 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 2004 Particulate Matter Air Quality Criteria Document (PM AQCD) and the 2005 PM Staff Paper. [236] [237] [238] Further discussion of health effects associated with PM can also be found in the DRIA for this rule.

Health effects associated with short-term exposures (hours to days) to ambient PM include premature mortality, aggravation of cardiovascular and lung disease (as indicated by increased hospital admissions and emergency department visits), increased respiratory symptoms including cough and difficulty breathing, decrements in lung function, altered heart rate rhythm, and other more subtle changes in blood markers related to cardiovascular health.[239] Long-term exposure to $PM_{2.5}$ and sulfates has also been associated with mortality from cardiopulmonary disease and lung cancer, and effects on the respiratory system such as reduced lung function growth or development of respiratory disease. A new analysis shows an association between long-term $PM_{2.5}$ exposure and a measure of atherosclerosis development.[240] [241]

Studies examining populations exposed over the long term (one or more years) to different levels of air pollution, including the Harvard Six Cities Study

[236] U.S. EPA (2004). *Air Quality Criteria for Particulate Matter.* Volume I EPA600/P–99/002aF and Volume II EPA600/P–99/002bF. Retrieved on March 19, 2009 from Docket EPA–HQ–OAR–2003–0190 at *http://www.regulations.gov/.*

[237] U.S. EPA. (2005). *Review of the National Ambient Air Quality Standard for Particulate Matter: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper.* EPA–452/R–05–005a. Retrieved March 19, 2009 from *http://www.epa.gov/ttn/naaqs/standards/pm/data/pmstaffpaper_20051221.pdf.*

[238] The PM NAAQS is currently under review and the EPA is considering all available science on PM health effects, including information which has been published since 2004, in the development of the upcoming PM Integrated Science Assessment Document (ISA). A second draft of the PM ISA was completed in July 2009 and was submitted for review by the Clean Air Scientific Advisory Committee (CASAC) of EPA's Science Advisory Board. Comments from the general public have also been requested. For more information, *see http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=210586.*

[239] U.S. EPA. (2006). *National Ambient Air Quality Standards for Particulate Matter; Proposed Rule.* 71 FR 2620, January 17, 2006.

[240] Künzli, N., Jerrett, M., Mack, W.J., *et al.* (2004). Ambient air pollution and atherosclerosis in Los Angeles. *Environ Health Perspect., 113,* 201–206.

[241] This study is included in the 2006 Provisional Assessment of Recent Studies on Health Effects of Particulate Matter Exposure. The provisional assessment did not and could not (given a very short timeframe) undergo the extensive critical review by CASAC and the public, as did the PM AQCD. The provisional assessment found that the ''new'' studies expand the scientific information and provide important insights on the relationship between PM exposure and health effects of PM. The provisional assessment also found that ''new'' studies generally strengthen the evidence that acute and chronic exposure to fine particles and acute exposure to thoracic coarse particles are associated with health effects. Further, the provisional science assessment found that the results reported in the studies did not dramatically diverge from previous findings, and taken in context with the findings of the AQCD, the new information and findings did not materially change any of the broad scientific conclusions regarding the health effects of PM exposure made in the AQCD. However, it is important to note that this assessment was limited to screening, surveying, and preparing a provisional assessment of these studies. For reasons outlined in Section I.C of the preamble for the final PM NAAQS rulemaking in 2006 (*see* 71 FR 61148–49, October 17, 2006), EPA based its NAAQS decision on the science presented in the 2004 AQCD.

and the American Cancer Society Study, show associations between long-term exposure to ambient $PM_{2.5}$ and both total and cardiopulmonary premature mortality.[242 243 244] In addition, an extension of the American Cancer Society Study shows an association between $PM_{2.5}$ and sulfate concentrations and lung cancer mortality.[245]

b. Ozone

i. Background

Ground-level ozone pollution is typically formed by the reaction of VOC and NO_X in the lower atmosphere in the presence of heat and 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.[246] 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 of precursor emissions, resulting in elevated ozone levels even in areas with low local VOC or NO_X emissions.

ii. 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 (ozone AQCD) and 2007 Staff Paper.[247 248] Ozone can irritate the respiratory system, causing coughing, throat irritation, and/or uncomfortable sensation in the chest. Ozone can reduce lung function and make it more difficult to breathe deeply; breathing may also become more rapid and shallow than normal, thereby limiting a person's activity. Ozone can also aggravate asthma, leading to more asthma attacks that require medical attention and/or the use of additional medication. 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 the National Research Council (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.[249] 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. 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.

The 2006 ozone AQCD also examined relevant new scientific information that has emerged in the past decade, including the impact of ozone exposure on such health effects as changes in lung structure and biochemistry, inflammation of the lungs, exacerbation and causation of asthma, respiratory illness-related school absence, hospital admissions and premature mortality. Animal toxicological studies have suggested potential interactions between ozone and PM with increased responses observed to mixtures of the two pollutants compared to either ozone or PM alone. The respiratory morbidity observed in animal studies along with the evidence from epidemiologic studies supports 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.

c. NO_X and SO_X

i. 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 vapor 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 III.G.3.a of this preamble. NO_X along with non-methane hydrocarbon (NMHC) are the two major precursors of ozone. The health effects of ozone are covered in Section III.G.3.b.

ii. Health Effects of NO_2

Information on the health effects of NO_2 can be found in the U.S. Environmental Protection Agency Integrated Science Assessment (ISA) for Nitrogen Oxides.[250] The U.S. EPA has concluded that the findings of epidemiologic, controlled human

[242] Dockery, D.W., Pope, C.A. III, Xu, X, *et al.* (1993). An association between air pollution and mortality in six U.S. cities. *N Engl J Med, 329,* 1753–1759. Retrieved on March 19, 2009 from *http://content.nejm.org/cgi/content/full/329/24/1753.*

[243] Pope, C.A., III, Thun, M.J., Namboodiri, M.M., Dockery, D.W., Evans, J.S., Speizer, F.E., and Heath, C.W., Jr. (1995). Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults. *Am. J. Respir. Crit. Care Med, 151,* 669–674.

[244] Krewski, D., Burnett, R.T., Goldberg, M.S., et al. (2000). *Reanalysis of the Harvard Six Cities study and the American Cancer Society study of particulate air pollution and mortality.* A special report of the Institute's Particle Epidemiology Reanalysis Project. Cambridge, MA: Health Effects Institute. Retrieved on March 19, 2009 from *http://es.epa.gov/ncer/science/pm/hei/Rean-ExecSumm.pdf.*

[245] Pope, C.A., III, Burnett, R.T., Thun, M. J., Calle, E.E., Krewski, D., Ito, K., Thurston, G.D., (2002). Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. *J. Am. Med. Assoc., 287,* 1132–1141.

[246] 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. Retrieved on March 19, 2009 from Docket EPA–HQ–OAR–2003–0190 at *http://www.regulations.gov/.*

[247] 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. Retrieved on March 19, 2009 from Docket EPA–HQ–OAR–2003–0190 at *http://www.regulations.gov/.*

[248] 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. Retrieved on March 19, 2009 from Docket EPA–HQ–OAR–2003–0190 at *http://www.regulations.gov/.*

[249] National Research Council (NRC), 2008. *Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution.* The National Academies Press: Washington, DC.

[250] 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. Retrieved on March 19, 2009 from *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=194645.*

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 at exposures as low as 0.26 ppm NO_2 for 30 minutes. 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.

iii. Health Effects of SO_2

Information on the health effects of SO_2 can be found in the U.S. Environmental Protection Agency Integrated Science Assessment for Sulfur Oxides.[251] 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.

d. Carbon Monoxide

Carbon monoxide (CO) forms as a result of incomplete fuel combustion. CO enters the bloodstream through the lungs, forming carboxyhemoglobin and reducing the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Healthy individuals also are affected, but only at higher CO levels. Exposure to elevated CO levels is associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks. Carbon monoxide also contributes to ozone nonattainment since carbon monoxide reacts photochemically in the atmosphere to form ozone.[252] Additional information on CO related health effects can be found in the Carbon Monoxide Air Quality Criteria Document (CO AQCD).[253] [254]

e. Air Toxics

Motor 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 air toxics. [255] These compounds include, but are not limited to, benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, polycyclic organic matter (POM), and naphthalene. These compounds, except acetaldehyde, were identified as national or regional risk drivers in the 2002 National-scale Air Toxics Assessment (NATA) and have significant inventory contributions from mobile sources.[256] Emissions and ambient concentrations of compounds are discussed in the DRIA chapter on emission inventories and air quality (Chapters 5 and 7, respectively).

i. Benzene

The EPA's 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.[257] [258] [259] 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.[260] [261]

A number of adverse noncancer health effects including blood disorders, such as preleukemia and aplastic anemia, have also been associated with

[251] 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. Retrieved on March 18, 2009 from *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=198843.*

[252] U.S. EPA (2000). Air Quality Criteria for Carbon Monoxide, EPA/600/P–99/001F. This document is available in Docket EPA–HQ–OAR–2004–0008.

[253] U.S. EPA (2000). Air Quality Criteria for Carbon Monoxide, EPA/600/P–99/001F. This document is available in Docket EPA–HQ–OAR–2004–0008.

[254] The CO NAAQS is currently under review and the EPA is considering all available science on CO health effects, including information which has been published since 2000, in the development of the upcoming CO Integrated Science Assessment Document (ISA). A first draft of the CO ISA was completed in March 2009 and was submitted for review by the Clean Air Scientific Advisory Committee (CASAC) of EPA's Science Advisory Board. For more information, see *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=203935.*

[255] U. S. EPA. 2002 National-Scale Air Toxics Assessment. *http://www.epa.gov/ttn/atw/nata12002/risksum.html.*

[256] U.S. EPA. 2009. National-Scale Air Toxics Assessment for 2002. *http://www.epa.gov/ttn/atw/nata2002/.*

[257] U.S. EPA. 2000. Integrated Risk Information System File for Benzene. This material is available electronically at *http://www.epa.gov/iris/subst/0276.htm.*

[258] International Agency for Research on Cancer (IARC). 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.

[259] 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.

[260] International Agency for Research on Cancer (IARC). 1987. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29. Supplement 7, Some industrial chemicals and dyestuffs, World Health Organization, Lyon, France.

[261] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at *http://www.ntp.niehs.nih.gov/go/16183.*

long-term exposure to benzene.[262] [263] The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.[264] [265] 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 know [266] [267] [268] [269] EPA's IRIS program has not yet evaluated these new data.

ii. 1,3-Butadiene

EPA has characterized 1,3-butadiene as carcinogenic to humans by inhalation.[270] [271] 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.[272] [273] 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.[274]

iii. Formaldehyde

Since 1987, EPA has classified formaldehyde as a probable human carcinogen based on evidence in humans and in rats, mice, hamsters, and monkeys.[275] EPA is currently reviewing recently published epidemiological data. For instance, research conducted by the National Cancer Institute (NCI) found an increased risk of nasopharyngeal cancer and lymphohematopoietic malignancies such as leukemia among workers exposed to formaldehyde.[276] [277] In an analysis of the lymphohematopoietic cancer mortality from an extended follow-up of these workers, NCI confirmed an association between lymphohematopoietic cancer risk and peak exposures.[278] A recent National Institute of Occupational Safety and Health (NIOSH) study of garment workers also found increased risk of death due to leukemia among workers exposed to formaldehyde.[279] 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.[280] Recently, the IARC re-classified formaldehyde as a human carcinogen (Group 1).[281]

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.[282] [283]

iv. 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.[284] 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

---

[262] Aksoy, M. (1989). Hematotoxicity and carcinogenicity of benzene. Environ. Health Perspect. 82: 193–197.

[263] Goldstein, B.D. (1988). Benzene toxicity. Occupational medicine. State of the Art Reviews. 3: 541–554.

[264] 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.

[265] U.S. EPA (2002) Toxicological Review of Benzene (Noncancer Effects). Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington DC. This material is available electronically at *http://www.epa.gov/iris/subst/0276.htm.*

[266] 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.

[267] 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.

[268] Lan, Qing, Zhang, L., Li, G., Vermeulen, R., et al. (2004) Hematotoxically in Workers Exposed to Low Levels of Benzene. Science 306: 1774–1776.

[269] 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.

[270] 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.*

[271] 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.*

[272] International Agency for Research on Cancer (IARC) (1999) Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 71, Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide and Volume 97 (in preparation), World Health Organization, Lyon, France.

[273] 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.*

[274] 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.

[275] 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.

[276] Hauptmann, M.; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Blair, A. 2003. Mortality from lymphohematopeotic malignancies among workers in formaldehyde industries. Journal of the National Cancer Institute 95: 1615–1623.

[277] 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.

[278] 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.

[279] Pinkerton, L. E. 2004. Mortality among a cohort of garment workers exposed to formaldehyde: an update. Occup. Environ. Med. 61: 193–200.

[280] 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.

[281] International Agency for Research on Cancer (IARC). 2006. Formaldehyde, 2–Butoxyethanol and 1-tert-Butoxypropan-2-ol. Volume 88. (in preparation), World Health Organization, Lyon, France.

[282] 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://www.atsdr.cdc.gov/toxprofiles/tp111.html.*

[283] 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.

[284] U.S. EPA. 1991. Integrated Risk Information System File of Acetaldehyde. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0290.htm.*

the IARC.[285] [286] 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.[287] In short-term (4 week) rat studies, degeneration of olfactory epithelium was observed at various concentration levels of acetaldehyde exposure.[288] [289] 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.[290] The agency is currently conducting a reassessment of the health hazards from inhalation exposure to acetaldehyde.

v. Acrolein

Acrolein is extremely acrid and irritating to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation, mucus hypersecretion and congestion. Levels considerably lower than 1 ppm (2.3 mg/m^3) elicit subjective complaints of eye and nasal irritation and a decrease in the respiratory rate.[291] [292] Lesions to the lungs and upper respiratory tract of rats, rabbits, and hamsters have been observed after subchronic exposure to acrolein. Based on animal data, 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. This was demonstrated in mice with allergic airway-disease by comparison to non-diseased mice in a study of the acute respiratory irritant effects of acrolein.[293] 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.[294]

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 acrolein in humans and the animal data provided inadequate evidence of carcinogenicity.[295] The IARC determined in 1995 that acrolein was not classifiable as to its carcinogenicity in humans.[296]

vi. Polycyclic Organic Matter (POM)

POM is generally defined as a large class of organic compounds which have multiple benzene rings and a boiling point greater than 100 degrees Celsius. Many of the compounds included in the class of compounds known as POM are classified by EPA as probable human carcinogens based on animal data. One of these compounds, naphthalene, is discussed separately below. Polycyclic aromatic hydrocarbons (PAHs) are a subset of POM that contain only hydrogen and carbon atoms. A number of PAHs are known or suspected carcinogens. Recent studies have found that maternal exposures to PAHs (a subclass of POM) 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.[297] [298] EPA has not yet evaluated these recent studies.

vii. 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.[299] The draft reassessment completed external peer review.[300] 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. Once EPA evaluates public and peer reviewer comments, the document will be revised. 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.[301] 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.[302] Naphthalene also causes a number of chronic non-cancer effects in animals, including

[285] 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.*

[286] International Agency for Research on Cancer (IARC). 1999. Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemical to Humans, Vol. 71. Lyon, France.

[287] U.S. EPA. 1991. Integrated Risk Information System File of Acetaldehyde. This material is available electronically at *http://www.epa.gov/iris/subst/0290.htm.*

[288] 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.

[289] 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.

[290] 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.

[291] Weber-Tschopp, A; Fischer, T; Gierer, R; et al. (1977) Experimentelle reizwirkungen von Acrolein auf den Menschen. Int Arch Occup Environ Hlth 40(2):117–130. In German

[292] Sim, VM; Pattle, RE. (1957) Effect of possible smog irritants on human subjects. J Am Med Assoc 165(15):1908–1913.

[293] Morris JB, Symanowicz PT, Olsen JE, 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.

[294] Sim VM, Pattle RE. Effect of possible smog irritants on human subjects JAMA165: 1980–2010, 1957.

[295] 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.*

[296] International Agency for Research on Cancer (IARC). 1995. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 63, Dry cleaning, some chlorinated solvents and other industrial chemicals, World Health Organization, Lyon, France.

[297] 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.

[298] 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.

[299] 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/0436.htm.*

[300] 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.*

[301] 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.*

[302] International Agency for Research on Cancer (IARC). (2002). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans. Vol. 82. Lyon, France.

abnormal cell changes and growth in respiratory and nasal tissues.[303]

viii. Other Air Toxics

In addition to the compounds described above, other compounds in gaseous hydrocarbon and PM emissions from vehicles will be affected by this proposed action. Mobile source air toxic compounds that would potentially be impacted include ethylbenzene, polycyclic organic matter, propionaldehyde, toluene, and xylene. Information regarding the health effects of these compounds can be found in EPA's IRIS database.[304]

4. Environmental Effects of Non-GHG Pollutants

a. Visibility

Visibility can be defined as the degree to which the atmosphere is transparent to visible light. Airborne particles degrade visibility by scattering and absorbing light. Visibility is important because it has direct significance to people's enjoyment of daily activities in all parts of the country. Individuals value good visibility for the well-being it provides them directly, where they live and work and in places where they enjoy recreational opportunities. Visibility is also highly valued in significant natural areas such as national parks and wilderness areas and special emphasis is given to protecting visibility in these areas. For more information on visibility, *see* the final 2004 PM AQCD as well as the 2005 PM Staff Paper.[305 306]

EPA is pursuing a two-part strategy to address visibility. First, to address the welfare effects of PM on visibility, EPA has set secondary $PM_{2.5}$ standards which act in conjunction with the establishment of a regional haze program. In setting this secondary standard, EPA has concluded that $PM_{2.5}$ causes adverse effects on visibility in various locations, depending on PM concentrations and factors such as chemical composition and average relative humidity. Second, section 169 of the Clean Air Act provides additional authority to address existing visibility impairment and prevent future visibility impairment in the 156 national parks, forests and wilderness areas categorized as mandatory class I *Federal* areas (62 FR 38680–81, July 18, 1997).[307] In July 1999, the regional haze rule (64 FR 35714) was put in place to protect the visibility in mandatory class I *Federal* areas. Visibility can be said to be impaired in both $PM_{2.5}$ nonattainment areas and mandatory class I *Federal* areas.

b. 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 AQCD presents more detailed information on ozone effects on vegetation and ecosystems.

c. 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.*, POM, 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.[308]

Adverse impacts on water quality can occur when atmospheric contaminants deposit to the water surface or when material deposited on the land enters a water body through runoff. Potential impacts of atmospheric deposition to water bodies 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 toxins may lead to the human ingestion of contaminated fish, human ingestion of contaminated 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.[309 310 311 312 313]

[303] 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.*

[304] U.S. EPA Integrated Risk Information System (IRIS) database is available at: *www.epa.gov/iris.*

[305] U.S. EPA. (2004). *Air Quality Criteria for Particulate Matter (AQCD).* Volume I Document No. EPA600/P–99/002aF and Volume II Document No. EPA600/P–99/002bF. Washington, DC: U.S. Environmental Protection Agency. Retrieved on March 18, 2009 from *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=87903.*

[306] U.S. EPA. (2005). *Review of the National Ambient Air Quality Standard for Particulate Matter: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper.* EPA–452/R–05–005. Washington, DC: U.S. Environmental Protection Agency.

[307] These areas are defined in section 162 of the Act 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.

[308] 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. This document is available in Docket EPA–HQ–OAR–2003–0190.

[309] U.S. EPA (2004) National Coastal Condition Report II. Office of Research and Development/Office of Water. EPA–620/R–03/002. This document is available in Docket EPA–HQ–OAR–2003–0190.

[310] Gao, Y., E.D. Nelson, M.P. Field, *et al.* 2002. Characterization of atmospheric trace elements on $PM_{2.5}$ particulate matter over the New York-New Jersey harbor estuary. *Atmos. Environ.* 36: 1077–1086.

[311] Kim, G., N. Hussain, J.R. Scudlark, and T.M. Church. 2000. Factors influencing the atmospheric

Continued

Atmospheric deposition of nitrogen and sulfur contributes to acidification, altering biogeochemistry and affecting animal and plant life in terrestrial and aquatic ecosystems across the U.S. 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 causes ecosystem nutrient enrichment leading to eutrophication that alters biogeochemical cycles. Excess nitrogen also leads to the loss of nitrogen sensitive lichen species as they are outcompeted by invasive grasses as well as altering the biodiversity of terrestrial ecosystems, such as grasslands and meadows. For a broader explanation of the topics treated here, refer to the description in Chapter 7 of the DRIA.

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). The rate of metal corrosion depends on a number of factors, including the deposition rate and nature of the pollutant; the influence of the metal protective corrosion film; the amount of moisture present; variability in the electrochemical reactions; the presence and concentration of other surface electrolytes; and the orientation of the metal surface.

d. Environmental Effects of Air Toxics

Fuel combustion emissions contribute to ambient levels of pollutants that contribute to adverse effects on vegetation. Volatile organic compounds (VOCs), some of which are considered air toxics, have long been suspected to play a role in vegetation damage.[314] In laboratory experiments, a wide range of tolerance to VOCs has been observed.[315] 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.[316]

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.[317 318 319] 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.

5. Air Quality Impacts of Non-GHG Pollutants

a. Current Levels of $PM_{2.5}$, Ozone, CO and Air Toxics

This proposal may have impacts on levels of $PM_{2.5}$, ozone, CO and air toxics. Nationally, levels of $PM_{2.5}$, ozone, CO and air toxics are declining.[320 321] However, in 2005 EPA designated 39 nonattainment areas for the 1997 $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS) (70 FR 943, January 5, 2005). These areas are composed of 208 full or partial counties with a total population exceeding 88 million. The 1997 $PM_{2.5}$ NAAQS was recently revised and the 2006 24-hour $PM_{2.5}$ NAAQS became effective on December 18, 2006. The numbers above likely underestimate the number of counties that are not meeting the $PM_{2.5}$ NAAQS because the nonattainment areas associated with the more stringent 2006 24-hour $PM_{2.5}$ NAAQS have not yet been designated. Area designations for the 2006 24-hour $PM_{2.5}$ NAAQS are expected to be promulgated in 2009 and become effective 90 days after publication in the **Federal Register**.

In addition, the U.S. EPA has recently amended the ozone NAAQS (73 FR 16436, March 27, 2008). That final 2008 ozone NAAQS rule set forth revisions to the previous 1997 NAAQS for ozone to provide increased protection of public health and welfare. As of June 5, 2009, there are 55 areas designated as

depositional fluxes of stable Pb, 210Pb, and 7Be into Chesapeake Bay. *J. Atmos. Chem.* 36: 65–79.

[312] 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.

[313] 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.

[314] U.S. EPA. 1991. Effects of organic chemicals in the atmosphere on terrestrial plants. EPA/600/3–91/001.

[315] 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.

[316] 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.

[317] Viskari E-L. 2000. Epicuticular wax of Norway spruce needles as indicator of traffic pollutant deposition. Water, Air, and Soil Pollut. 121:327–337.

[318] Ugrekhelidze D, F Korte, G Kvesitadze. 1997. Uptake and transformation of benzene and toluene by plant leaves. Ecotox. Environ. Safety 37:24–29.

[319] Kammerbauer H, H Selinger, R Rommelt, A Ziegler-Jons, D Knoppik, B Hock. 1987. Toxic components of motor vehicle emissions for the spruce Pciea abies. Environ. Pollut. 48:235–243.

[320] U.S. EPA (2008) National Air Quality Status and Trends through 2007. Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA 454/R–08–006. *http://epa.gov/airtrends/2008/index.html.*

[321] U.S. EPA (2007) Final Regulatory Impact Analysis: Control of Hazardous Air Pollutants from Mobile Sources, Office of Transportation and Air Quality, Ann Arbor, MI, Publication No. EPA420–R–07–002. *http://www.epa.gov/otaq/toxics.htm.*

nonattainment for the 1997 8-hour ozone NAAQS, comprising 290 full or partial counties with a total population of approximately 132 million people. These numbers do not include the people living in areas where there is a future risk of failing to maintain or attain the 1997 8-hour ozone NAAQS. The numbers above likely underestimate the number of counties that are not meeting the ozone NAAQS because the nonattainment areas associated with the more stringent 2008 8-hour ozone NAAQS have not yet been designated.

The proposed vehicle standards may also impact levels of ambient CO, a criteria pollutant (see Table III.G–1 above for co-pollutant emission impacts). As of June 5, 2009 there are approximately 479,000 people living in a portion of Clark Co., NV which is currently the only area in the country that is designated as nonattainment for CO.[322]

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.[323] 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.[324]

b. Impacts of Proposed Standards on Future Ambient $PM_{2.5}$, Ozone, CO and Air Toxics

Full-scale photochemical air quality modeling is necessary to accurately project levels of $PM_{2.5}$, ozone, CO and air toxics. For the final rule, a national-scale air quality modeling analysis will be performed to analyze the impacts of the vehicle 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.

Section III.G.1 of the preamble presents projections of the changes in criteria pollutant and air toxics emissions due to the proposed vehicle standards; the basis for those estimates is set out in Chapter 5 of the DRIA. 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 vehicle standards, EPA expects that there will be an improvement in ambient air quality, pending a more comprehensive analysis for the final rule.

For the final rule, 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 U.S.).[325] [326] [327] 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.[328] The CMAQ model (version 4.6) was peer-reviewed in February of 2007 for EPA as reported in ''Third Peer Review of CMAQ Model,'' and the EPA Office of Research and Development (ORD) peer review report which includes version 4.7 is currently being finalized.[329]

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 CMAQ version (version 4.7), which was officially released by EPA's Office of Research and Development (ORD) in December 2008 and reflects updates to earlier versions in a number of areas to improve the underlying science. These include (1) enhanced secondary organic aerosol (SOA) mechanism to include chemistry of isoprene, sesquiterpene, and aged in-cloud biogenic SOA in addition to terpene; (2) improved vertical convective mixing; (3) improved heterogeneous reaction involving nitrate formation; and (4) an updated gas-phase chemistry mechanism, Carbon Bond 05 (CB05), with extensions to model explicit concentrations of air toxic species as well as chlorine and mercury. This mechanism, CB05-toxics, also computes concentrations of species that are involved in aqueous chemistry and that are precursors to aerosols.

H. What Are the Estimated Cost, Economic, and Other Impacts of the Proposal?

In this section, EPA presents the costs and impacts of EPA's proposed GHG program. It is important to note that NHTSA's CAFE standards and EPA's GHG standards will both be in effect, and each will lead to increases in average fuel economy and CO_2 emissions reductions. The two agencies' standards comprise the National Program, and this discussion of costs and benefits of EPA's GHG standard does not change the fact that both the CAFE and GHG standards, jointly, are the source of the benefits and costs of the National Program.

This section outlines the basis for assessing the benefits and costs of these standards and provides estimates of these costs and benefits. Some of these effects are private, meaning that they affect consumers and producers directly in their sales, purchases, and use of vehicles. These private effects include the costs of the technology, fuel savings, and the benefits of additional driving and reduced refueling. Other costs and benefits affect people outside the markets for vehicles and their use; these effects are termed external costs, because they affect people external to the market. The external effects include the climate impacts, the effects on non-GHG pollutants, and the effects on traffic, accidents, and noise due to additional driving. The sum of the private and external benefits and costs is the net social benefits of the program. There is some debate about the role of private benefits in assessing the benefits and costs of the program: If consumers have full information and perfect foresight in their vehicle purchase decisions, it is possible that they have

[322] Carbon Monoxide Nonattainment Area Summary: *http://www.epa.gov/air/oaqps/greenbk/cnsum.html.*

[323] U.S. Environmental Protection Agency (2007). Control of Hazardous Air Pollutants from Mobile Sources; Final Rule. 72 FR 8434, February 26, 2007.

[324] U.S. Environmental Protection Agency (2007). Control of Hazardous Air Pollutants from Mobile Sources; Final Rule. 72 FR 8434, February 26, 2007.

[325] U.S. Environmental Protection Agency, Byun, D.W., and Ching, J.K.S., Eds, 1999. Science algorithms of EPA Models-3 Community Multiscale Air Quality (CMAQ modeling system, EPA/600/R–99/030, Office of Research and Development).

[326] 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.

[327] 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.

[328] 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.

[329] Aiyyer, A., Cohan, D., Russell, A., Stockwell, W., Tanrikulu, S., Vizuete, W., Wilczak, J., 2007. Final Report: Third Peer Review of the CMAQ Model. p. 23.

already considered these benefits in their vehicle purchase decisions. If so, then the inclusion of private benefits in the net benefits calculation may be inappropriate. If these conditions do not hold, then the private benefits may be a part of the net benefits. Section III.H.1 discusses this issue more fully.

EPA's proposed program costs consist of the vehicle program costs (costs of complying with the vehicle CO_2 standards, taking into account FFV credits through 2015, the temporary lead-time alternative allowance standard program (TLAASP), full car/truck trading, and the A/C credit program), along with the fuel savings associated with reduced fuel usage resulting from the proposed program. These proposed program costs also include external costs associated with noise, congestion, accidents, time spent refueling vehicles, and energy security impacts. EPA also presents the cost-effectiveness of the proposed standards and our analysis of the expected economy-wide impacts. The projected monetized benefits of reducing GHG emissions and co-pollutant health and environmental impacts are also presented. EPA also presents our estimates of the impact on vehicle miles traveled and the impacts associated with those miles as well as other societal impacts of the proposed program, including energy security impacts.

The total monetized benefits (excluding fuel savings) under the proposed program are projected to be $21 to $54 billion in 2030, assuming a 3 percent discount rate and depending on the value used for the social cost of carbon. The costs of the proposed program in 2030 are estimated to be approximately $18 billion for new vehicle technology less $90 billion in savings realized by consumers through fewer fuel expenditures (calculated using pre-tax fuel prices).

EPA has undertaken an analysis of the economy-wide impacts of the proposed GHG tailpipe standards as an exploratory exercise that EPA believes could provide additional insights into the potential impacts of the proposal.[330] These results were not a factor regarding the appropriateness of the proposed GHG tailpipe standards. It is important to note that the results of this modeling exercise are dependent on the assumptions associated with how consumers will respond to increases in higher vehicle costs and improved vehicle fuel economy as a result of the proposal. Section III.H.1 discusses the underlying distinctions and implications of the role of consumer response in economic impacts.

Further information on these and other aspects of the economic impacts of our proposed rule are summarized in the following sections and are presented in more detail in the DRIA for this rulemaking. EPA requests comment on all aspects of the cost, savings, and benefits analysis presented here and in the DRIA. EPA also requests comment on the inputs used in these analyses as described in the Draft Joint TSD.

1. Conceptual Framework for Evaluating Consumer Impacts

For this proposed rule, EPA projects significant private gains to consumers in three major areas: (1) Reductions in spending on fuel, (2) time saved due to less refueling, and (3) welfare gains from additional driving that results from the rebound effect. In combination, these private savings, mostly from fuel savings, appear to outweigh by a large margin the costs of the program, even without accounting for externalities.

Admittedly, these findings pose a conundrum. On the one hand, consumers are expected to gain significantly from the proposed rules, as the increased cost of fuel efficient cars appears to be far smaller than the fuel savings (assuming modest discount rates). Yet fuel efficient cars are currently offered for sale, and consumers' purchasing decisions may suggest a preference for lower fuel economy than the proposed rule mandates. Assuming full information and perfect foresight, standard economic theory suggests that the private gains to consumers, large as they are, must therefore be accompanied by a consumer welfare loss. This calculation assumes that consumers accurately predict all the benefits they will get from a new vehicle, even if they underestimated fuel savings at the time of purchase. Even if there is some such loss, EPA believes that under realistic assumptions, the private gains from the proposed rule, together with the social gains (in the form of reduction of externalities), significantly outweigh the costs. But EPA seeks comments on the underlying issue.

The central conundrum has been referred to as the Energy Paradox in this setting (and in several others).[331] In short, the problem is that consumers appear not to purchase products that are in their economic self-interest. There are strong theoretical reasons why this might be so.[332] Consumers might be myopic and hence undervalue the long-term; they might lack information or a full appreciation of information even when it is presented; they might be especially averse to the short-term losses associated with energy efficient products (the behavioral phenomenon of ''loss aversion''); even if consumers have relevant knowledge, the benefits of energy efficient vehicles might not be sufficiently salient to them at the time of purchase. A great deal of work in behavioral economics identifies factors of this sort, which help account for the Energy Paradox.[333] This point holds in the context of fuel savings (the main focus here), but it applies equally to the other private benefits, including reductions in refueling time and additional driving.[334]

Considerable research suggests that the Energy Paradox is real and significant due to consumers' inability to value future fuel savings appropriately. For example, Sanstad and Howarth (1994) argue that consumers optimize behavior without full information by resorting to imprecise but convenient rules of thumb. Larrick and Soll (2008) find evidence that consumers do not understand how to translate changes in miles-per-gallon into fuel savings (a concern that EPA is continuing to attempt to address).[335] If these arguments are valid, then there will be significant gains to consumers of the government mandating additional fuel economy.

The evidence from consumer vehicle choice models indicates a huge range of estimates for consumers' willingness to pay for additional fuel economy. Because consumer surplus estimates from consumer vehicle choice models depend critically on this value, EPA would consider any consumer surplus estimates of the effect of our rule from such models to be unreliable. In addition, the predictive ability of consumer vehicle choice models may be limited. While vehicle choice models

[330] *See* Memorandum to Docket, ''Economy-Wide Impacts of Proposed Greenhouse Gas Tailpipe Standards,'' September 14, 2009 (Docket EPA–HQ–OAR–2009–0472).

[331] Jaffe, A.B., & Stavins, R.N. (1994). The Energy Paradox and the Diffusion of Conservation Technology. Resource and Energy Economics, 16(2), 91–122.

[332] For an overview, *see id.*

[333] *Id.*; Thaler, Richard. Quasi-Rational Economics. New York: Russell Sage, 1993.

[334] For example, it might be maintained that at the time of purchase, consumers take full account of the time potentially saved by fuel-efficient cars, but it might also be questioned whether they have adequate information to do so, or whether that factor is sufficiently salient to play the proper role in purchasing decisions.

[335] Sanstad, A., and R. Howarth (1994). '' 'Normal' Markets, Market Imperfections, and Energy Efficiency.'' Energy Policy 22(10): 811–818; Larrick, R.P., and J.B. Soll (2008). ''The MPG illusion.'' *Science* 320: 1593–1594.

are based on sales of existing vehicles, vehicle models are likely to change, both independently and in response to this proposed rule; the models may not predict well in response to these changes. Instead, EPA compares the value of the fuel savings associated with this rule with the increase in technology costs. EPA will continue its efforts to review the literature, but, given the known difficulties, EPA has not conducted an analysis using these models for this proposal.

Consumer vehicle choice models (referred to as ''market shift'' models by NHTSA in Section IV.C.4.c) are a tool that attempts to estimate how consumers decide what vehicles they buy. The models typically take into consideration both household characteristics (such as income, family size, and age) and vehicle characteristics (including a vehicle's power, price, and fuel economy). These models are often used to examine how a consumer's vehicle purchase decision is affected by a change in vehicle or personal characteristics. Although these models focus on the consumer, some have also linked consumer choice models with information on vehicle technologies and costs, to estimate an integrated system of consumer and auto maker response.

The outputs from consumer vehicle choice models typically include the market shares of each category of vehicle in the model. In addition, consumer vehicle choice models are often used to estimate the effect of market or regulatory changes on consumer surplus. Consumer surplus is the benefit that a consumer gets over and above the market price paid for the good. For instance, if a consumer is willing to pay up to $30,000 for a car but is able to negotiate a price of $25,000, the $5,000 difference is consumer surplus. Information on consumer surplus can be used in benefit-cost analysis to measure whether consumers are likely to consider themselves better or worse off due to the changes.

Consumer vehicle choice modeling has not previously been applied in *Federal* regulatory analysis of fuel economy, and EPA has not used a consumer vehicle choice model in its analysis of the effects of this proposed rule. EPA has not done so, to this point, due to concern over the wide variation in the methods and results of existing models, as well as some of the limitations of existing applications of consumer choice modeling. Our preliminary review of the literature indicates that these models vary in a number of dimensions, including data sources used, modeling methods, vehicle characteristics included in the analysis, and the research questions for which they were designed. These dimensions are likely to affect the models' results and their interpretation. In addition, their ability to incorporate major changes in the vehicle fleet appears unproven.

One problem for this rule is the variation in the value that consumers place on fuel economy in their vehicle purchase decisions. A number of consumer vehicle choice models make the assumption that auto producers provide as much fuel economy in their vehicles as consumers are willing to purchase, and consumers are satisfied with the current combinations of vehicle fuel economy and price in the marketplace.[336] If this assumption is true, then consumers will not benefit from required improvements in fuel economy, even if the fuel savings that they receive exceed the additional costs from the fuel-saving technology. Other vehicle choice models, in contrast, find that consumers are willing to pay more for additional fuel economy than the costs to auto producers of installing that technology.[337] If this result is true, then both consumers and producers would benefit from increased fuel economy. This result leaves open the question why auto producers do not follow the market incentive to provide more fuel economy, and why consumers do not seek out more fuel-efficient vehicles.

Whether consumers and producers will benefit from improved fuel economy depends on the value of improved fuel economy to consumers. There may be a difference between the fuel savings that consumers would receive from improved fuel economy, and the amount that consumers would be willing to spend on a vehicle to get improved fuel economy. A 1988 review of consumers' willingness to pay for improved fuel economy found estimates that varied by more than an order of magnitude: for a $1 per year reduction in vehicle operating costs, consumers would be willing to spend between $0.74 and $25.97 in increased vehicle price.[338] For comparison, the present value of saving $1 per year on fuel for 15 years at a 3% discount rate is $11.94, while a 7% discount rate produces a present value of $8.78. Thus, this study finds that consumers may be willing to pay either far too much or far too little for the fuel savings they will receive.

Although EPA has not found an updated survey of these values, a few examples suggest that the existing consumer vehicle choice models still demonstrate wide variation in estimates of how much people are willing to pay for fuel savings. For instance, Espey and Nair (2005) and McManus (2006) find that consumers are willing to pay around $600 for one additional mile per gallon.[339] In contrast, Gramlich (2008) finds that consumers' willingness to pay for an increase from 25 mpg to 30 mpg varies between $4,100 (for luxury cars when gasoline costs $2/gallon) to $20,560 (for SUVs when gasoline costs $3.50/gallon).[340]

As noted, lack of information is one possible reason for the variation. Consumers face difficulty in predicting the fuel savings that they are likely to get from a vehicle, for a number of reasons. For instance, the calculation of fuel savings is complex, and consumers

[336] E.g., Kleit, Andrew N. (2004). ''Impacts of Long-Range Increases in the Fuel Economy (CAFE) Standard.'' Economic Inquiry 42(2): 279–294 (Docket EPA–HQ–OAR–2009–0472); Austin, David, and Terry Dinan (2005). ''Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increased Gasoline Taxes.'' Journal of Environmental Economics and Management 50: 562–582 (Docket EPA–HQ–OAR–2009–0472); Klier, Thomas, and Joshua Linn (2008). ''New Vehicle Characteristics and the Cost of the Corporate Average Fuel Economy Standard,'' working paper. *http://www.chicagofed.org/publications/workingpapers/wp2008_13.pdf* (Docket EPA–HQ–OAR–2009–0472); Jacobsen, Mark. ''Evaluating U.S. Fuel Economy Standards In a Model with Producer and Household Heterogeneity,'' *http://www.econ.ucsd.edu/~m3jacobs/Jacobsen_CAFE.pdf*, accessed 5/11/09 (Docket EPA–HQ–OAR–2009–0472).

[337] E.g., Gramlich, Jacob (2008). ''Gas Prices and Endogenous Product Selection in the U.S. Automobile Industry,'' *http://www.econ.yale.edu/seminars/apmicro/am08/gramlich-081216.pdf*, accessed 5/11/09 (Docket EPA–HQ–OAR–2009–0472); McManus, Walter M. (2007). ''The Impact of Attribute-Based Corporate Average Fuel Economy (CAFE) Standards: Preliminary Findings.'' University of Michigan Transportation Research Institute paper UMTRI–2007–31 (Docket EPA–HQ–OAR–2009–0472); McManus, W. and R. Kleinbaum (2009). ''Fixing Detroit: How Far, How Fast, How Fuel Efficient.'' Working Paper, Transportation Research Institute, University of Michigan (Docket EPA–HQ–OAR–2009–0472).

[338] Greene, David L., and Jin-Tan Liu (1988). ''Automotive Fuel Economy Improvements and Consumers' Surplus.'' Transportation Research Part A 22A(3): 203–218 (Docket EPA–HQ–OAR–2009–0472). The study actually calculated the willingness to pay for reduced vehicle operating costs, of which vehicle fuel economy is a major component.

[339] Espey, Molly, and Santosh Nair (2005). ''Automobile Fuel Economy: What is it Worth?'' Contemporary Economic Policy 23(3): 317–323 (Docket EPA–HQ–OAR–2009–0472); McManus, Walter M. (2006). ''Can Proactive Fuel Economy Strategies Help Automakers Mitigate Fuel-Price Risks?'' University of Michigan Transportation Research Institute (Docket EPA–HQ–OAR–2009–0472).

[340] Gramlich, Jacob (2008). ''Gas Prices and Endogenous Product Selection in the U.S. Automobile Industry,'' *http://www.econ.yale.edu/seminars/apmicro/am08/gramlich-081216.pdf*, accessed 5/11/09 (Docket EPA–HQ–OAR–2009–0472).

may not make it correctly.[341] In addition, future fuel price (a major component of fuel savings) is highly uncertain. Consumer fuel savings also vary across individuals, who travel different amounts and have different driving styles. Studies regularly show that fuel economy plays a role in consumers' vehicle purchases, but modeling that role may still be in development.[342]

If there is a difference between fuel savings and consumers' willingness to pay for fuel savings, the next question is, which is the appropriate measure of consumer benefit? Fuel savings measure the actual monetary value that consumers will receive after purchasing a vehicle; the willingness to pay for fuel economy measures the value that, before a purchase, consumers place on additional fuel economy. As noted, there are a number of reasons that consumers may incorrectly estimate the benefits that they get from improved fuel economy, including risk or loss aversion, poor ability to estimate savings, and a lack of salience of fuel economy savings.

Considerable evidence suggests that consumers discount future benefits more than the government when evaluating energy efficiency gains. The Energy Information Agency (1996) has used discount rates as high as 111 percent for water heaters and 120 percent for electric clothes dryers.[343] In the transportation sector, evidence also points to high private discount rates: Kubik (2006) conducts a representative survey that finds consumers are impatient or myopic (*e.g.,* use a high discount rate) with regard to vehicle fuel savings.[344] On average, consumers indicated that fuel savings would have to pay back the additional cost in only 2.9 years to persuade them to buy a higher fuel-economy vehicle. EPA also incorporate a relatively short ''payback period'' into OMEGA to evaluate and order technologies that can be used to increase fuel economy, assuming that buyers value the resulting fuel savings over the first five years of a new vehicle's lifetime. This assumption is based on the current average term of consumer loans to finance the purchase of new vehicles. That said, there is no consensus in the literature on what the private discount rate is or should be in this context.

One possibility is that the discounting framework may not be a good model for consumer decision-making and for determining consumer welfare regarding fuel economy. Buying a vehicle involves trading off among dozens of vehicle characteristics, including price, vehicle class, safety, performance, and even audio systems and cupholders. Fuel economy is only one of these attributes, and its role in consumer vehicle purchase decisions is not well understood (see DRIA Section 8.1.2 for further discussion). As noted above, if consumers do not fully consider fuel economy at the time of vehicle purchase, then the fuel savings from this rule provide a realized benefit to consumers after purchase. There are two distinct ideas at work here: one is that efficiency improvements change the nature of the cost of the car, requiring higher up-front vehicle costs while enabling lower long-run fuel costs; the other is that while consumers may benefit from the lower long-run fuel costs, they may also experience some loss in welfare on account of the possible change in vehicle mix.

A second problem with use of consumer vehicle choice models, as they now stand, is that they are even less reliable in the face of significant changes otherwise occurring in fleet composition. One attempt to analyze the effect of the oil shock of 1973 on consumer vehicle choice found that, after two years, the particular model did not predict well due to changes in the vehicle fleet.[345] It is likely that, in the next few years, many of the vehicles that will be offered for sale will change. In coming years, new vehicles will be developed, and existing vehicles will be redesigned. For instance, over the next few years, new vehicles that have both high fuel economy and high safety factors, in combinations that consumers have not previously been offered, are likely to appear in the market. Models based on the existing vehicle fleet may not do well in predicting consumers' choices among the new vehicles offered. Given that consumer vehicle choice models appear to be less effective in predicting vehicle choices when the vehicles are likely to change, EPA is reluctant to use the models for this proposed rulemaking.

In sum, the estimates of consumer surplus from consumer vehicle choice models depend heavily on the value to consumers of improved fuel economy, a value for which estimates are highly varied. In addition, the predictive ability of consumer vehicle choice models may be limited as consumers face new vehicle choices that they previously did not have.

Nonetheless, because there are potential advantages to using consumer vehicle choice models if these difficulties can be addressed, EPA plans to continue our investigation and evaluation of consumer vehicle choice models. This effort includes further review of existing consumer vehicle choice models and the estimates of consumers' willingness to pay for increased fuel economy. In addition, EPA is developing capacity to examine the factors that may affect the results of consumer vehicle choice models, and to explore their impact on analysis of regulatory scenarios.

A detailed discussion of the state of the art of consumer choice modeling is provided in the DRIA. For this rulemaking, EPA is not able to estimate the consumer welfare loss which may accompany the actual fuel savings from the proposal, and so any such loss must remain unquantified. EPA seeks comments on how to assess these difficult questions in the future.

2. Costs Associated With the Vehicle Program

In this section EPA presents our estimate of the costs associated with the proposed vehicle program. The presentation here summarizes the costs associated with the new vehicle technology expected to be added to meet the proposed GHG standards, including hardware costs to comply with the proposed A/C credit program. The analysis summarized here provides our estimate of incremental costs on a per vehicle basis and on an annual total basis.

The presentation here summarizes the outputs of the OMEGA model that was discussed in some detail in Section III.D of this preamble. For details behind the analysis such as the OMEGA model inputs and the estimates of costs associated with individual technologies, the reader is directed to Chapters 1 and 2 of the DRIA, and Chapter 3 of the Draft Joint TSD. For more detail on the

[341] Turrentine, T. and K. Kurani (2007). ''Car Buyers and Fuel Economy?'' Energy Policy 35: 1213–1223 (Docket EPA–HQ–OAR–2009–0472); Larrick, R.P., and J.B. Soll (2008). ''The MPG illusion.'' *Science* 320: 1593–1594 (Docket EPA–HQ–OAR–2009–0472).

[342] Busse, Meghan R., Christopher R. Knittel, and Florian Zettelmeyer (2009). ''Pain at the Pump: How Gasoline Prices Affect Automobile Purchasing in New and Used Markets,'' Working paper (accessed 6/30/09), available at *http://www.econ.ucdavis.edu/faculty/knittel/papers/gaspaper_latest.pdf* (Docket EPA–HQ–OAR–2009–0472).

[343] Energy Information Administration, U.S. Department of Energy (1996). Issues in Midterm Analysis and Forecasting 1996, DOE/EIA–0607(96), Washington, DC., *http://www.osti.gov/bridge/purl.cover.jsp?purl=/366567-BvCFp0/webviewable/*, accessed 7/7/09.

[344] Kubik, M. (2006). Consumer Views on Transportation and Energy. Second Edition. Technical Report: National Renewable Energy Laboratory.

[345] Berry, Steven, James Levinsohn, and Ariel Pakes (July 1995). ''Automobile Prices in Market Equilibrium,'' Econometrica 63(4): 841–940 (Docket EPA–HQ–OAR–2009–0472).

outputs of the OMEGA model and the overall vehicle program costs summarized here, the reader is directed to Chapters 4 and 7 of the DRIA.

With respect to the cost estimates for vehicle technologies, EPA notes that, because these estimates relate to technologies which are in most cases already available, these cost estimates are technically robust. EPA notes further that, in all instances, its estimates are within the range of estimates in the most widely-utilized sources and studies. In that way, EPA believes that we have been conservative in estimating the vehicle hardware costs associated with this proposal.

With respect to the aggregate cost estimations presented in Section III.H.2.b, EPA notes that there are a number of areas where the results of our analysis may be conservative and, in general, EPA believes we have directionally overestimated the costs of compliance with these proposed standards, especially in not accounting for the full range of credit opportunities available to manufacturers. For example, some cost saving programs are considered in our analysis, such as full car/truck trading, while others are not, such as cross-manufacturer trading and advanced technology credits.

a. Vehicle Compliance Costs Associated With the Proposed CO_2 Standards

For the technology and vehicle package costs associated with adding new CO_2-reducing technology to vehicles, EPA began with EPA's 2008 Staff Report and NHTSA's 2011 CAFE FRM both of which presented costs generated using existing literature, meetings with manufacturers and parts suppliers, and meetings with other experts in the field of automotive cost estimation.[346] EPA has updated some of those technology costs with new information from our contract with FEV, through further discussion with NHTSA, and by converting from 2006 dollars to 2007 dollars using the GDP price deflator. The estimated costs presented here represent the incremental costs associated with this proposal relative to what the future vehicle fleet would be expected to look like absent this proposed rule. A more detailed description of the factors considered in our reference case is presented in Section III.D.

The estimates of vehicle compliance costs cover the years of implementation of the program—2012 through 2016. EPA has also estimated compliance costs for the years following implementation so that we can shed light on the long term—2022 and later—cost impacts of the proposal.[347] EPA used the year 2022 here because our 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. Some of the individual technology cost estimates are presented in brief in Section III.D, and account for both the direct and indirect costs incurred in the automobile manufacturing and dealer industries (for a complete presentation of technology costs, please refer to Chapter 3 of the Draft Joint TSD). To account for the indirect costs, EPA has applied an indirect cost markup (ICM) factor to all of our direct costs to arrive at the estimated technology cost.[348] The ICM factors used range from 1.11 to 1.64 in the short-term (2012 through 2021), depending on the complexity of the given technology, to account for differences in the levels of R&D, tooling, and other indirect costs that would be incurred. Once the program has been fully implemented, some of the indirect costs would no longer be attributable to these proposed standards and, as such, a lower ICM factor is applied to direct costs in years following full implementation. The ICM factors used range from 1.07 to 1.39 in the long-term (2022 and later) depending on the complexity of the given technology.[349] Note that the short-term ICMs are used in the 2012 through 2016 years of implementation and continue through 2021. EPA does this since the proposed standards are still being implemented during the 2012 through 2016 model years. Therefore, EPA considers the five year period following full implementation also to be short-term.

The argument has been made that the ICM approach may be more appropriate for regulatory cost estimation than the more traditional retail price equivalent, or RPE, markup. The RPE is based on the historical relationship between direct costs and consumer prices; it is intended to reflect the average markup over time required to sustain the industry as a viable operation. Unlike the RPE approach, the ICM focuses more narrowly on the changes that are required in direct response to regulation-induced vehicle design changes which may not directly influence all of the indirect costs that are incurred in the normal course of business. For example, an RPE markup captures all indirect costs including costs such as the retirement benefits of retired employees. However, the retirement benefits for retired employees are not expected to change as a result of a new GHG regulation and, therefore, those indirect costs should not increase in relation to newly added hardware in response to a regulation. So, under the ICM approach, if a newly added piece of technology has an incremental direct cost of $1, its direct plus indirect costs should not be $1 multiplied by an RPE markup of say 1.5, or $1.50, but rather something less since the manufacturer is not paying more for retired-employee retirement benefits as a direct result of adding the new piece of technology. Further, as noted above, the indirect cost multiplier can be adjusted for different levels of technological complexity. For example, a move to low rolling resistance tires is less complex than converting a gasoline vehicle to a plug-in hybrid. Therefore, the incremental indirect costs for the tires should be lower in magnitude than those for the plug-in hybrid. For the analysis underlying these proposed standards, the agencies have based our estimates on the ICM approach, but EPA notes that discussion continues about the use of the RPE approach and the ICM approach for safety and environmental regulations. We discuss our ICM factors and the complexity levels used in our analysis in more detail in Chapter 3 of the Draft Joint TSD and EPA requests comment on the approach described there as well as the general concepts of both the ICM and RPE approaches.

EPA has also considered the impacts of manufacturer learning on the technology cost estimates. Consistent with past EPA rulemakings, EPA has estimated that some costs would decline by 20 percent with each of the first two doublings of production beginning with the first year of implementation. These

[346] ''EPA Staff Technical Report: Cost and Effectiveness Estimates of Technologies Used to Reduce Light-duty Vehicle Carbon Dioxide Emissions,'' EPA 420–R–08–008; NHTSA 2011 CAFE FRM is at 74 FR 14196; both documents are contained in Docket EPA–HQ–OAR–2009–0472.

[347] Note that the assumption made here is that the standards proposed would continue to apply for years beyond 2016 so that new vehicles sold in model years 2017 and later would continue to incur costs as a result of this rule. Those costs are estimated to get lower in 2022 because some of the indirect costs attributable to this proposal in the years prior to 2022 would be eliminated in 2022 and later.

[348] Alex Rogozhin et al., *Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers*. Prepared for EPA by RTI International and Transportation Research Institute, University of Michigan. EPA–420–R–09–003, February 2009 (Docket EPA–HQ–OAR–2009–0472).

[349] Gloria Helfand and Todd Sherwood, ''Documentation of the Development of Indirect Cost Multipliers for Three Automotive Technologies,'' Office of Transportation and Air Quality, USEPA, August 2009 (Docket EPA–HQ–OAR–2009–0472).

volume-based cost declines—which EPA calls ''volume'' based learning—take place after manufacturers have had the opportunity to find ways to improve upon their manufacturing processes or otherwise manufacture these technologies in a more efficient way. After two 20 percent cost reduction steps, the cost reduction learning curve flattens out considerably as only minor improvements in manufacturing techniques and efficiencies remain to be had. By then, costs decline roughly three percent per year as manufacturers and suppliers continually strive to reduce costs. These time-based cost declines—which EPA calls ''time'' based learning—take place at a rate of three percent per year. EPA has considered learning impacts 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. EPA has considered volume-based learning for only a handful of technologies that EPA considers to be new or emerging technologies such as the hybrids and electric vehicles. For most technologies, EPA has considered them to be more established given their current use in the fleet and, hence, we have applied the lower time based learning. We have more discussion of our learning approach and the technologies to which we have applied which type of learning in the Draft Joint TSD.

The technology cost estimates discussed in Section III.D and detailed in Chapter 3 of the Draft Joint TSD are used to build up package cost estimates which are then used as inputs to the OMEGA model. EPA discusses our packages and package costs in Chapter 1 of the DRIA. The model determines what level of CO_2 improvement is required considering the reference case for each manufacturer's fleet. The vehicle compliance costs are the outputs of the model and take into account FFV credits through 2015, TLAASP, full car/truck trading, and the A/C credit program. Table III.H.2–1 presents the fleet average incremental vehicle compliance costs for this proposal. As the table indicates, 2012–2016 costs increase every year as the standards become more stringent. Costs per car and per truck then remain stable through 2021 while cost per vehicle (car/truck combined) decline slightly as the fleet mix trends slowly to increasing car sales. In 2022, costs per car and per truck decline as the long-term ICM kicks in because some indirect costs are no longer considered attributable to the proposed program. Costs per car and per truck remain constant thereafter while the cost per vehicle declines slightly as the fleet continues to trend toward cars. By 2030, projections of fleet mix changes become static and the cost per vehicle remains constant. EPA has a more detailed presentation of vehicle compliance costs on a manufacturer by manufacturer basis in the DRIA.

TABLE III.H.2–1—INDUSTRY AVERAGE VEHICLE COMPLIANCE COSTS ASSOCIATED WITH THE PROPOSED TAILPIPE CO_2 STANDARDS

[$/vehicle in 2007 dollars]

Calendar year	$/car	$/truck	$/vehicle (car & truck combined)
2012	374	358	368
2013	531	539	534
2014	663	682	670
2015	813	886	838
2016	968	1,213	1,050
2017	968	1,213	1,047
2018	968	1,213	1,044
2019	968	1,213	1,042
2020	968	1,213	1,040
2021	968	1,213	1,039
2022	890	1,116	955
2030	890	1,116	953
2040	890	1,116	953
2050	890	1,116	953

b. Annual Costs of the Proposed Vehicle Program

The costs presented here represent the incremental costs for newly added technology to comply with the proposed program. Together with the projected increases in car and light-truck sales, the increases in per-vehicle average costs shown in Table III.H.2–1 above result in the total annual costs reported in Table III.H.2–2 below. Note that the costs presented in Table III.H.2–2 do not include the savings that would occur as a result of the improvements to fuel consumption. Those impacts are presented in Section III.H.4.

TABLE III.H.2–2—QUANTIFIED ANNUAL COSTS ASSOCIATED WITH THE PROPOSED VEHICLE PROGRAM

[$Millions of 2007 dollars]

Year	Quantified annual costs
2012	$5,400
2013	$8,400
2014	$10,900
2015	$13,900
2016	$17,500
2020	$18,000
2030	$17,900
2040	$19,300
2050	$20,900
NPV, 3%	$390,000
NPV, 7%	$216,600

3. Cost per Ton of Emissions Reduced

EPA has calculated the cost per ton of GHG (CO_2-equivalent, or CO_2e) reductions associated with this proposal using the above costs and the emissions reductions described in Section III.F. More detail on the costs, emission reductions, and the cost per ton can be found in the DRIA and Draft Joint TSD. EPA has calculated the cost per metric ton of GHG emissions reductions 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. Note that EPA has not included the savings associated with reduced fuel consumption, nor any of the other benefits of this proposal in the cost per ton calculations. If EPA were to include fuel savings in the cost estimates, the cost per ton would be less than $0, since the estimated value of fuel savings outweighs these costs. With regard to the proposed CH_4 and N_2O standards, since these standards would be emissions caps designed to ensure manufacturers do not backslide from current levels, EPA has not estimated costs associated with the standards (since the standards would not require any change from current practices nor does EPA estimate they would result in emissions reductions).

The results for CO_2e costs per ton under the proposed vehicle program are shown in Table III.H.3–1.

TABLE III.H.3–1—ANNUAL COST PER METRIC TON OF CO_2e REDUCED, IN $2007 DOLLARS

Year	Cost [a] ($millions)	CO_2e Reduced (million metric tons)	Cost per ton
2020	$18,000	170	$110
2030	17,900	320	60
2040	19,300	420	50
2050	20,900	520	40

[a] Costs here include vehicle compliance costs and do not include any fuel savings (discussed in Section III.H.4) or other benefits of this proposal (discussed in Sections III.H.6 through III.H 10).

4. Reduction in Fuel Consumption and Its Impacts

a. What Are the Projected Changes in Fuel Consumption?

The proposed CO_2 standards would result in significant improvements in the fuel efficiency of affected vehicles. Drivers of those vehicles would see corresponding savings associated with reduced fuel expenditures. EPA has estimated the impacts on fuel consumption for both the proposed tailpipe CO_2 standards and the proposed A/C credit program. To do this, fuel consumption is calculated using both current CO_2 emission levels and the proposed CO_2 standards. The difference between these estimates represents the net savings from the proposed CO_2 standards. Note that the total number of miles that vehicles are driven each year is different under each of the control case scenarios than in the reference case due to the ''rebound effect,'' which is discussed in Section III.H.4.c.

The expected impacts on fuel consumption are shown in Table III.H.4–1. The gallons shown in the tables reflect impacts from the proposed CO_2 standards, including the proposed A/C credit program, and include increased consumption resulting from the rebound effect.

TABLE III.H.4–1—FUEL CONSUMPTION IMPACTS OF THE PROPOSED VEHICLE STANDARDS AND A/C CREDIT PROGRAMS

[Million gallons]

Year	Total
2012	530
2013	1,320
2014	2,410
2015	3,910
2016	5,930
2020	13,350
2030	26,180
2040	33,930
2050	42,570

b. What Are the Fuel Savings to the Consumer?

Using the fuel consumption estimates presented in Section III.H.4.a, EPA can calculate the monetized fuel savings associated with the proposed CO_2 standards. To do this, we multiply reduced fuel consumption in each year by the corresponding estimated average fuel price in that year, using the reference case taken from the AEO 2009.[350] AEO is the government consensus estimate used by NHTSA and many other government agencies to estimate the projected price of fuel. EPA has included all fuel taxes in these estimates since these are the prices paid by consumers. As such, the savings shown reflect savings to the consumer. These results are shown in Table III.H.4–2. Note that EPA presents the monetized fuel savings using pre-tax fuel prices in Section III.H.10. The fuel savings based on pre-tax fuel prices reflect the societal savings in contrast to the consumer savings presented in Table III.H.4–2. Also in Section III.H.10, EPA presents the benefit-cost of the proposal and, for that reason, present the fuel impacts as negative costs of the program while here EPA presents them as positive savings.

TABLE III.H.4–2—ESTIMATED FUEL CONSUMPTION SAVINGS TO THE CONSUMER [a]

[Millions of 2007 dollars]

Calendar year	Total
2012	$1,400
2013	3,800
2014	7,200
2015	12,400
2016	19,400
2020	48,400
2030	100,000
2040	136,800
2050	181,000
NPV, 3%	1,850,200
NPV, 7%	826,900

[a] Fuel consumption savings calculated using taxed fuel prices. Fuel consumption impacts using pre-tax fuel prices are presented in Section III.H.10 as negative costs of the vehicle program

As shown in Table III.H.4–2, EPA is projecting that consumers would realize very large fuel savings as a result of the standards contained in this proposal. There are several ways to view this value. Some, as demonstrated below in Section III.H.5, view these fuel savings as a reduction in the cost of owning a vehicle, whose full benefits consumers realize. This approach assumes that, regardless how consumers in fact make their decisions on how much fuel economy to purchase, they will gain these fuel savings. Another view says that consumers do not necessarily value fuel savings as equal to the results of this calculation. Instead, consumers may either undervalue or overvalue fuel economy relative to these savings, based

[350] Energy Information Administration, Supplemental tables to the Annual Energy Outlook 2009, Updated Reference Case with American Recovery and Reinvestment Act. Available *http://www.eia.doe.gov/oiaf/aeo/supplement/stimulus/regionalarra.html.* April 2009.

on their personal preferences. This issue is discussed further in Section III.H.5 and in Chapter 8 of the DRIA.

c. VMT Rebound Effect

The fuel economy rebound effect refers to the fraction of fuel savings expected to result from an increase in vehicle fuel economy—particularly one required by higher fuel efficiency standards—that is offset by additional vehicle use. The increase in vehicle use occurs because higher fuel economy reduces the fuel cost of driving, which is typically the largest single component of the monetary cost of operating a vehicle, and vehicle owners respond to this reduction in operating costs by driving slightly more.

For this proposal, EPA is using an estimate of 10% for the rebound effect. This value is based on the most recent time period analyzed in the Small and Van Dender 2007 paper,[351] and falls within the range of the larger body of historical work on the rebound effect.[352] Recent work by David Greene on the rebound effect for light-duty vehicles in the U.S. further supports the hypothesis that the rebound effect is decreasing over time.[353] If we were to use a dynamic estimate of the future rebound effect, our analysis shows that the rebound effect could be in the range of 5% or lower.[354] The rebound effect is also discussed in Section II.F of the preamble; the TSD, Section 4.2.5, reviews the relevant literature and discusses in more depth the reasoning for the rebound values used here.

EPA also invites comments on other alternatives for estimating the rebound effect. As one illustration, variation in the price per gallon of gasoline directly affects the per-mile cost of driving, and drivers may respond just as they would to a change in the cost of driving resulting from a change in fuel economy, by varying the number of miles they drive. Because vehicles' fuel economy is fixed in the short run, variation in the number of miles driven in response to changes in fuel prices will be reflected in changes in gasoline consumption. Under the assumption that drivers respond similarly to changes in the cost of driving whether they are caused by variation in fuel prices or fuel economy, the short-run price elasticity of demand for gasoline—which measures the sensitivity of gasoline consumption to changes in its price per gallon—may provide some indication about the magnitude of the rebound effect itself. EPA invites comment on the extent to which the short run elasticity of demand for gasoline with respect to its price can provide useful information about the size of the rebound effect. Specifically, we seek comment on whether it would be appropriate to use the price elasticity of demand for gasoline, or other alternative approaches, to guide the choice of a value for the rebound effect.

5. Impacts on U.S. Vehicle Sales and Payback Period

a. Vehicle Sales Impacts

The methodology EPA used for estimating the impact on vehicle sales is relatively straightforward, but makes a number of simplifying assumptions. According to the literature, the price elasticity of demand for vehicles is commonly estimated to be −1.0.[355] In other words, a one percent increase in the price of a vehicle would be expected to decrease sales by one percent, holding all other factors constant. For our estimates, EPA calculated the effect of an increase in vehicle costs due to the proposed standards and assume that consumers will face the full increase in costs, not an actual (estimated) change in vehicle price. (The estimated increases in vehicle cost due to the rule are discussed in Section III.H.2) This is a conservative methodology, since an increase in cost may not pass fully into an increase in market price in an oligopolistic industry such as the automotive sector.[356] EPA also notes that we have not used these estimated sales impacts in the OMEGA Model.

Although EPA uses the one percent price elasticity of demand for vehicles as the basis for our vehicle sales impact estimates, we assumed that the consumer would take into account both the higher vehicle purchasing costs as well as some of the fuel savings benefits when deciding whether to purchase a new vehicle. Therefore, the incremental cost increase of a new vehicle would be offset by reduced fuel expenditures over a certain period of time (*i.e.,* the ''payback period''). For the purposes of this rulemaking, EPA used a five-year payback period, which is consistent with the length of a typical new light-duty vehicle loan.[357] This approach may not accurately reflect the role of fuel savings in consumers' purchase decisions, as the discussion in Section III.H.1 suggests. If consumers consider fuel savings in a different fashion than modeled here, then this approach will not accurately reflect the impact of this rule on vehicle sales.

This increase in costs has other effects on consumers as well: If vehicle prices increase, consumers will face higher insurance costs and sales tax, and additional finance costs if the vehicle is bought on credit. In addition, the resale value of the vehicles will increase. EPA estimates that, with corrections for these factors, the effect on consumer expenditures of the cost of the new technology should be 0.932 times the cost of the technology at a 3% discount rate, and 0.892 times the cost of the technology at a 7% discount rate. The details of this calculation are in the DRIA, Chapter 8.l.

Once the cost estimates are adjusted for these additional factors, the fuel cost savings associated with the rule, discussed in Section III.H.4, are subtracted to get the net effect on consumer expenditures for a new vehicle. With the assumed elasticity of demand of −1, the percent change in this ''effective price,'' estimated as the adjusted increase in cost, is equal to the negative of the percent change in vehicle purchases. The net effect of this calculation is in Table III.H.5–1 and Table III.H.5–2.

[351] Small, K. and K. Van Dender, 2007a. ''Fuel Efficiency and Motor Vehicle Travel: The Declining Rebound Effect'', The Energy Journal, vol. 28, no. 1, pp. 25–51 (Docket EPA–HQ–OAR–2009–0472).

[352] Sorrell, S. and J. Dimitropoulos, 2007. ''UKERC Review of Evidence for the Rebound Effect, Technical Report 2: Econometric Studies'', UKERC/WP/TPA/2007/010, UK Energy Research Centre, London, October (Docket EPA–HQ–OAR–2009–0472).

[353] Report by Kenneth A. Small of University of California at Irvine to EPA, ''The Rebound Effect from Fuel Efficiency Standards: Measurement and Projection to 2030'', June 12, 2009 (Docket EPA–HQ–OAR–2009–0472).

[354] Report by David Greene of Oak Ridge National Laboratory to EPA, ''Rebound 2007: Analysis of National Light-Duty Vehicle Travel Statistics,'' March 24, 2009 (Docket EPA–HQ–OAR–2009–0472). Note, this report has been submitted for peer review. Completion of the peer review process is expected prior to the final rule.

[355] Kleit A.N., 1990. ''The Effect of Annual Changes in Automobile Fuel Economy Standards.'' Journal of Regulatory Economics 2: 151–172 (Docket EPA–HQ–OAR–2009–0472); McCarthy, Patrick S., 1996. ''Market Price and Income Elasticities of New Vehicle Demands.'' Review of Economics and Statistics 78: 543–547 (Docket EPA–HQ–OAR–2009–0472); Goldberg, Pinelopi K., 1998. ''The Effects of the Corporate Average Fuel Efficiency Standards in the U.S.,'' *Journal of Industrial Economics* 46(1): 1–33 (Docket EPA–HQ–OAR–2009–0472).

[356] *See*, for instance, Gron, Ann, and Deborah Swenson, 2000. ''Cost Pass-Through in the U.S. Automobile Market,'' Review of Economics and Statistics 82: 316–324 (Docket EPA–HQ–OAR–2009–0472).

[357] There is not a consensus in the literature on how consumers consider fuel economy in their vehicle purchases. Results are inconsistent, possibly due to fuel economy not being a major focus of many of the studies. Espey, Molly, and Santosh Nair (1995, ''Automobile Fuel Economy: What Is It Worth?'' Contemporary Economic Policy 23: 317–323, (Docket EPA–HQ–OAR–2009–0472) find that their results are consistent with consumers using the lifetime of the vehicle, not just the first five years, in their fuel economy purchase decisions. This result suggests that the five-year time horizon used here may be an underestimate.

The estimates provided in Table III.H.5–1 and Table III.H.5–2 are meant to be illustrative rather than a definitive prediction. When viewed at the industry-wide level, they give a general indication of the potential impact on vehicle sales. As shown below, the overall impact is positive and growing over time for both cars and trucks, because the estimated value of fuel savings exceeds the costs of meeting the higher standards. If, however, consumers do not take fuel savings and other costs into account as modeled here when they purchase vehicles, the results presented here may not reflect actual impacts on vehicle sales.

TABLE III.H.5–1—VEHICLE SALES IMPACTS USING A 3% DISCOUNT RATE

	Change in car sales	Percent change	Change in truck sales	Percent change
2012	66,600	0.7	27,300	0.5
2013	93,300	0.9	161,300	2.8
2014	134,400	1.3	254,400	4.4
2015	236,300	2.2	368,400	6.5
2016	375,400	3.4	519,000	9.4

Table III.H.5–1 shows the impacts on new vehicle sales using a 3% discount rate. The fuel savings are always higher than the technology costs. Although both cars and trucks show very small effects initially, over time vehicle sales become increasingly positive, as increased fuel prices make improved fuel economy more desirable. The increases in sales for trucks are larger than the increases for trucks (except in 2012) in both absolute numbers and percentage terms.

TABLE III.H.5–2—NEW VEHICLE SALES IMPACTS USING A 7% DISCOUNT RATE

	Change in car sales	Percent change	Change in truck sales	Percent change
2012	61,900	0.7	25,300	0.5
2013	86,600	0.9	60,000	1
2014	125,200	1.2	122,900	2.1
2015	221,400	2	198,100	3.5
2016	353,100	3.2	291,500	5.3

Table III.H.5–2 shows the impacts on new vehicle sales using a 7% interest rate. While a 7% interest rate shows slightly lower impacts than using a 3% discount rate, the results are qualitatively similar to those using a 3% discount rate. Sales increase for every year. For both cars and trucks, sales become increasingly positive over time, as higher fuel prices make improved fuel economy more valuable. The car market grows more than the truck market in absolute numbers, but less on a percentage basis.

The effect of this rule on the use and scrappage of older vehicles will be related to its effects on new vehicle prices, the fuel efficiency of new vehicle models, and the total sales of new vehicles. If the value of fuel savings resulting from improved fuel efficiency to the typical potential buyer of a new vehicle outweighs the average increase in new models' prices, sales of new vehicles will rise, while scrappage rates of used vehicles will increase slightly. This will cause the ''turnover'' of the vehicle fleet—that is, the retirement of used vehicles and their replacement by new models—to accelerate slightly, thus accentuating the anticipated effect of the rule on fleet-wide fuel consumption and CO_2 emissions. However, if potential buyers value future fuel savings resulting from the increased fuel efficiency of new models at less than the increase in their average selling price, sales of new vehicles will decline, as will the rate at which used vehicles are retired from service. This effect will slow the replacement of used vehicles by new models, and thus partly offset the anticipated effects of the proposed rules on fuel use and emissions.

Because the agencies are uncertain about how the value of projected fuel savings from the proposed rules to potential buyers will compare to their estimates of increases in new vehicle prices, we have not attempted to estimate explicitly the effects of the rule on scrappage of older vehicles and the turnover of the vehicle fleet. We seek comment on the methods that might be used to estimate the effect of the proposed rule on the scrappage and use of older vehicles as part of the analysis to be conducted for the final rule.

A detailed discussion of the vehicle sales impacts methodology is provided in the DRIA. EPA invites comments on this approach to estimating the vehicle sales impacts of this proposal.

b. Consumer Payback Period and Lifetime Savings on New Vehicle Purchases

Another factor of interest is the payback period on the purchase of a new vehicle that complies with the proposed 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 2016 MY vehicle is estimated to cost $1,050 more (on average, and relative to the reference case vehicle) due to the addition of new GHG reducing technology (*see* Section III.D.6 for details on this cost estimate). This new technology will result in lower fuel consumption and, therefore, savings in fuel expenditures (*see* Section III.F.1 for details on fuel savings). But how many months or years would pass before the fuel savings exceed the upfront cost of $1,050?

Table III.H.5–3 provides the answer to this question for a vehicle purchaser who pays for the new vehicle upfront in cash (we discuss later in this section the payback period for consumers who finance the new vehicle purchase with a loan). The table uses annual miles driven (vehicle miles traveled, or VMT) and survival rates consistent with the emission and benefits analyses presented in Chapter 4 of the draft joint TSD. The control case includes rebound VMT but the reference case does not, consistent with other parts of the analysis. Also included are fuel savings associated with A/C controls (in the control case only), but the expected A/C-related maintenance savings are not included. The likely A/C-related maintenance savings are discussed in Chapter 2 of EPA's draft RIA. Further, this analysis does not include other societal impacts such as the value of increased driving, or noise, congestion and accidents since the focus is meant to be on those factors consumers consider most while in the showroom considering a new car purchase. Car/truck fleet weighting is handled as described in Chapter 1 of the draft joint TSD. As can be seen in the table, it will take under 3 years (2 years and 8 months at a 3% discount rate, 2 years and 10 months at a 7% discount rate) for the cumulative discounted fuel savings to exceed the upfront increase in vehicle cost. More detail on this analysis can be found in Chapter 8 of EPA's draft RIA.

TABLE III.H.5–3—PAYBACK PERIOD ON A 2016 MY NEW VEHICLE PURCHASE VIA CASH

[2007 dollars]

Year of ownership	Increased vehicle cost [a]	Annual fuel savings [b]	Cumulative discounted fuel savings at 3%	Cumulative discounted fuel savings at 7%
1	$1,128	$443	$436	$428
2		444	860	829
3		443	1,272	1,203
4		434	1,663	1,546

[a] Increased cost of the proposed rule is $1,050; the value here includes nationwide average sales tax of 5.3% and increased insurance premiums of 1.98%; both of these percentages are discussed in Section 8.1.1 of EPA's draft RIA.
[b] Calculated using AEO 2009 reference case fuel price including taxes.

However, most people purchase a new vehicle using credit rather than paying cash up front. The typical car loan today is a five year, 60 month loan. As of August 24, 2009, the national average interest rate for a 5 year new car loan was 7.41 percent. If the increased vehicle cost is spread out over 5 years at 7.41 percent, the analysis would look like that shown in Table III.H.5–4. As can be seen in this table, the fuel savings immediately outweigh the increased payments on the car loan, amounting to $162 in discounted net savings (3% discount rate) saved in the first year and similar savings for the next two years before reduced VMT starts to cause the fuel savings to fall. Results are similar using a 7% discount rate. This means that for every month that the average owner is making a payment for the financing of the average new vehicle their monthly fuel savings would be greater than the increase in the loan payments. This amounts to a savings on the order of $9 to $14 per month throughout the duration of the 5 year loan. Note that in year six when the car loan is paid off, the net savings equal the fuel savings (as would be the case for the remaining years of ownership).

TABLE III.H.5–4—PAYBACK PERIOD ON A 2016 MY NEW VEHICLE PURCHASE VIA CREDIT

[2007 dollars]

Year of ownership	Increased vehicle cost [a]	Annual fuel savings [b]	Annual discounted net savings at 3%	Annual discounted net savings at 7%
1	$278	$443	$162	$159
2	278	444	158	150
3	278	443	153	139
4	278	434	141	123
5	278	423	127	107
6	0	403	343	278

[a] This uses the same increased cost as Table III.H.4–3 but spreads it out over 5 years assuming a 5 year car loan at 7.41 percent.
[b] Calculated using AEO 2009 reference case fuel price including taxes.

The lifetime fuel savings and net savings can also be calculated for those who purchase the vehicle using cash and for those who purchase the vehicle with credit. This calculation applies to the vehicle owner who retains the vehicle for its entire life and drives the vehicle each year at the rate equal to the national projected average. The results are shown in Table III.H.5–5. In either case, the present value of the lifetime net savings is greater than $3,200 at a 3% discount rate, or $2,400 at a 7% discount rate.

TABLE III.H.5–5—LIFETIME DISCOUNTED NET SAVINGS ON A 2016 MY NEW VEHICLE PURCHASE
[2007 dollars]

Purchase option	Increased discounted vehicle cost	Lifetime discounted fuel savings [b]	Lifetime discounted net savings
3% discount rate			
Cash	$1,128	$4,558	$3,446
Credit [a]	1,293	4,558	3,265
7% discount rate			
Cash	1,128	3,586	2,495
Credit [a]	1,180	3,586	2,406

[a] Assumes a 5 year loan at 7.41 percent.
[b] Fuel savings here were calculated using AEO 2009 reference case fuel price including taxes.

Note that throughout this consumer payback discussion, the average number of vehicle miles traveled per year has been used. Drivers who drive more miles than the average would incur fuel related savings more quickly and, therefore, the payback would come sooner. Drivers who drive fewer miles than the average would incur fuel related savings more slowly and, therefore, the payback would come later.

6. Benefits of Reducing GHG Emissions

a. Introduction

This proposal is designed to reduce greenhouse gas (GHG) emissions from light-duty vehicles. This section provides monetized estimates of some of the economic benefits of this proposal's projected GHG emissions reductions.[358] The total benefit estimates were calculated by multiplying a marginal dollar value (*i.e.,* cost per ton) of carbon emissions, also referred to as ''social cost of carbon'' (SCC), by the anticipated level of emissions reductions in tons. We request comment on the approach used to estimate the set of SCC values used for this coordinated proposal as well as the other options considered.

The estimates presented here are interim values. EPA and other agencies will continue to explore the underlying assumptions and issues.

As discussed below, the interim dollar estimates of the SCC represent a partial accounting of climate change impacts. The quantitative account presented here is accompanied by a qualitative appraisal of climate-related impacts presented elsewhere in this proposal. For example, Section III.F.2 of the preamble presents a summary of the impacts and risks of climate change projected in the absence of actions to mitigate GHG emissions. Section III.F.2 is based on EPA documents that synthesize major findings from the best available scientific assessments of the scientific literature that have gone through rigorous and transparent peer review, including the major assessment reports of both the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Climate Change Science Program.[359]

The rest of this preamble section will provide the basis for the interim SCC values, and the estimates of the total climate-related benefits of the proposed rule that follow from these interim values.

b. Derivation of Interim Social Cost of Carbon Values

The ''social cost of carbon'' (SCC) is intended to be a monetary measure of the incremental damage resulting from carbon dioxide (CO_2) emissions, including (but not limited to) net agricultural productivity loss, human health effects, property damages from sea level rise, and changes in ecosystem services. Any effort to quantify and to monetize the consequences associated with climate change will raise serious questions of science, economics, and ethics. But with full regard for the limits of both quantification and monetization, the SCC can be used to provide an estimate of the social benefits of reductions in GHG emissions.

For at least three reasons, any particular figure will be contestable. First, scientific and economic knowledge about the impacts of climate change continues to grow. With new and better information about relevant questions, including the cost, burdens, and possibility of adaptation, current estimates will inevitably change over time. Second, some of the likely and potential damages from climate change—for example, the loss of endangered species—are generally not included in current SCC estimates. These omissions may turn out to be significant, in the sense that they may mean that the best current estimates are too low. As noted by the IPCC Fourth Assessment Report, ''It is *very likely* that globally aggregated figures underestimate the damage costs because they cannot include many non-quantifiable impacts.'' [360] Third, when economic efficiency criteria, under specific assumptions, are juxtaposed with ethical considerations, the outcome may be controversial.[361] These ethical considerations, including those involving the treatment of future generations, should and will also play a role in judgments about the SCC (*see* in particular the discussion of the discount rate, below).

To date, SCC estimates presented in recent regulatory documents have varied within and among agencies, including DOT, DOE, and EPA. For example, a regulation proposed by DOT in 2008 assumed a value of $7 per metric ton CO_2 (2006$) for 2011 emission reductions (with a range of $0–14 for sensitivity analysis; see EPA Docket, EPA–HQ–OAR–2009–0472).[362]

[358] The marginal and total benefit estimates presented in this section are limited to the impacts that can be monetized. Section III.F.2 of this preamble discusses the physical impacts of climate change, some of which are not monetized and are therefore omitted from the monetized benefits discussed here.

[359] U.S. Environmental Protection Agency, ''Advance Notice of Proposed Rulemaking for Greenhouse Gases Under the Clean Air Act, Technical Support Document on Benefits of Reducing GHG Emissions,'' June 2008. *See www.regulations.gov* and search for ID ''EPA–HQ–OAR–2008–0138–0078.''

[360] IPCC WGII. 2007. *Climate Change 2007—Impacts, Adaptation and Vulnerability Contribution of Working Group II to the Fourth Assessment Report of the IPCC. See* EPA Docket, EPA–HQ–OAR–2009–0472.

[361] *See, e.g.,* Discounting and Intergenerational Equity (Paul Portney and John P. Weyant eds. 1999).

[362] For the purposes of this discussion, we present all values of the SCC as the cost per metric

Continued

A regulation proposed by DOE in 2009 used a range of \$0–\$20 (2007\$). Both of these ranges were designed to reflect the value of damages to the United States resulting from carbon emissions, or the ''domestic'' SCC. In the final MY2011 CAFE EIS, DOT used both a domestic SCC value of \$2/tCO_2 and a global SCC value of \$33/tCO_2 (with sensitivity analysis at \$80/tCO_2) (in 2006 dollars for 2007 emissions), increasing at 2.4% per year thereafter. The final MY2011 CAFE rule also presented a range from \$2 to \$80/tCO_2 (see EPA Docket, EPA–HQ–OAR–2009–0472, for the MY2011 EIS and final rule). EPA's Advance Notice of Proposed Rulemaking for Greenhouse Gases discussed the benefits of reducing GHG emissions and identified what it described as ''very preliminary'' SCC estimates ''subject to revision'' that spanned three orders of magnitude. EPA's global mean values were \$68 and \$40/tCO_2 for discount rates of 2% and 3% respectively (in 2006 real dollars for 2007 emissions).[363]

The current Administration has worked to develop a transparent methodology for selecting a set of interim SCC estimates to use in regulatory analyses until a more comprehensive characterization of the SCC is developed. This discussion proposes a set of values for the interim social cost of carbon resulting from this methodology. It should be emphasized that the analysis here is preliminary. This proposed joint rulemaking presents SCC estimates that reflect the Administration's current understanding of the relevant literature and will be used for the short-term while an interagency group develops a more comprehensive characterization of the distribution of SCC values for future economic and regulatory analyses. The interim values should not be viewed as an expectation about the results of the longer-term process. The Administration is seeking comment in this proposed rule on all of the scientific, economic, and ethical issues before establishing improved estimates for use in future rulemakings.

The outcomes of the Administration's process to develop interim values are judgments in favor of (a) global rather than domestic values, (b) an annual growth rate of 3%, and (c) interim global SCC estimates for 2007 (in 2007 dollars) of \$56, \$34, \$20, \$10, and \$5 per ton of CO_2. The proposed figures are based on the following judgments.

i. Global and Domestic Measures

Because of the distinctive nature of the climate change problem, we present both a global SCC and a fraction of that value that represents impacts that may occur within the borders of the U.S. alone, or a ''domestic'' SCC, but fix our attention on the global measure. This approach represents a departure from past practices, which relied, for the most part, on domestic measures. As a matter of law, both global and domestic values are permissible; the relevant statutory provisions are ambiguous and allow selection of either measure.[364]

It is true that under OMB guidance, analysis from the domestic perspective is required, while analysis from the international perspective is optional. The domestic decisions of one nation are not typically based on a judgment about the effects of those decisions on other nations. But the climate change problem is highly unusual in the sense that it involves (a) a global public good in which (b) the emissions of one nation may inflict significant damages on other nations and (c) the United States is actively engaged in promoting an international agreement to reduce worldwide emissions.

In these circumstances, we believe that the global measure is preferred. Use of a global measure reflects the reality of the problem and is consistent with the continuing efforts of the United States to ensure that emissions reductions occur in many nations.

Domestic SCC values are also presented. The development of a domestic SCC is greatly complicated by the relatively few region- or country-specific estimates of the SCC in the literature. One potential source of estimates comes from EPA's ANPR Benefits TSD, using the Climate Framework for Uncertainty, Negotiation and Distribution (FUND) model.[365] The resulting estimates suggest that the ratio of domestic to global benefits varies with key parameter assumptions. With a 3% discount rate, for example, the U.S. benefit is about 6% of the global benefit of GHG reductions for the ''central'' (mean) FUND results, while, for the corresponding ''high'' estimates associated with a higher climate sensitivity and lower global economic growth, the U.S. benefit is less than 4% of the global benefit. With a 2% discount rate, the U.S. share is about 2–5% of the global estimate. Comments are requested on whether the share of U.S. SCC is correlated with the discount rate.

Based on this available evidence, an interim domestic SCC value equal to 6% of the global damages is proposed. This figure is around the middle of the range of available estimates cited above. It is recognized that the 6% figure is approximate and highly speculative. Alternative approaches will be explored before establishing improved values for future rulemakings. However, it should be noted that it is difficult to apportion global benefits to different regions. For example, impacts outside the U.S. border can have significant welfare implications for U.S. populations (*e.g.* tourism, disaster relief) and if not included, these omissions will lead to an underestimation of the ''domestic'' SCC. We request comment on this issue.

ii. Filtering Existing Analyses

There are numerous SCC estimates in the existing literature, and it is reasonable to make use of those estimates in order to produce a figure for current use. A starting point is provided by the meta-analysis in Richard Tol, 2008.[366] With that starting point, the Administration proposes to ''filter'' existing SCC estimates by using those that (1) are derived from peer-reviewed studies; (2) do not weight the monetized damages to one country more than those in other countries; (3) use a ''business as usual'' climate scenario; and (4) are based on the most recent published version of each of the three major integrated assessment models (IAMs): FUND, Policy Analysis for the Greenhouse Effect (PAGE), and DICE.

Proposal (1) is based on the view that those studies that have been subject to peer review are more likely to be reliable than those that have not. Proposal (2) avoids treating the citizens of one nation (or different citizens within the U.S.) differently on the basis

ton of CO_2 emissions. Some discussions of the SCC in the literature use an alternative presentation of a dollar per metric ton of carbon. The standard adjustment factor is 3.67, which means, for example, that a SCC of \$10 per ton of CO_2 would be equivalent to a cost of \$36.70 for a ton of carbon emitted. Unless otherwise indicated, a ''ton'' refers to a metric ton.

[363] 73 FR 44416 (July 30, 2008). EPA, ''Advance Notice of Proposed Rulemaking for Greenhouse Gases Under the Clean Air Act, Technical Support Document on Benefits of Reducing GHG Emissions,'' June 2008. *www.regulations.gov.* Search for ID ''EPA–HQ–OAR–2008–0318–0078.

[364] It is true that *Federal* statutes are presumed not to have extraterritorial effect, in part to ensure that the laws of the United States respect the interests of foreign sovereigns. But use of a global measure for the SCC does not give extraterritorial effect to *Federal* law and hence does not intrude on such interests.

[365] 73 FR 44416 (July 30, 2008). EPA, ''Advance Notice of Proposed Rulemaking for Greenhouse Gases Under the Clean Air Act, Technical Support Document on Benefits of Reducing GHG Emissions,'' June 2008. *www.regulations.gov.* Search for ID ''EPA–HQ–OAR–2008–0318–0078.

[366] Richard Tol, The Social Cost of Carbon: Trends, Outliers, and Catastrophes, Economics: The Open-Access, Open-Assessment E-Journal, Vol. 2, 2008–25. *http://www.economics-ejournal.org/economics/journalarticles/2008-25* (2008). *See* also EPA Docket, EPA–HQ–OAR–2009–0472.

of income considerations, which some may find controversial and in any event would significantly complicate that analysis. In addition, that approach is consistent with the potential compensation tests of Kaldor (1939) and Hicks (1940), which form the conceptual foundations of benefit-cost analysis and use unweighted sums of willingness to pay. Finally, this is the approach used in rulemakings across a variety of settings and consequently keeps USG policy consistent across contexts.

Proposal (3) stems from the judgment that as a general rule, the proper way to assess a policy decision is by comparing the implementation of the policy against a counterfactual state where the policy is not implemented. In addition, our expectation is that most policies to be evaluated using these interim SCC estimates will constitute sufficiently small changes to the larger economy to make it safe to assume that the marginal benefits of emissions reductions will not change between the baseline and policy scenarios.

Proposal (4) is based on four complementary judgments. First, the FUND, PAGE, and DICE models now stand as the most comprehensive and reliable efforts to measure the economic damages from climate change. Second, the latest versions of the three IAMs are likely to reflect the most recent evidence and learning, and hence they are presumed to be superior to those that preceded them.[367]

Third, any effort to choose among them, or to reject one in favor of the others, would be difficult to defend at the present time. In the absence of a clear reason to choose among them, it is reasonable to base the SCC on all of them. Fourth, in light of the uncertainties associated with the SCC, a range of values is more representative and the additional information offered by different models should be taken into account.

iii. Use a Model-Weighted Average of the Estimates at Each Discount Rate

We have just noted that at this time, a strong reason to prefer any of the three major IAMs (FUND, PAGE, and DICE) over the others has not been identified. To address the concern that certain models not be given unequal weight relative to the others, the estimates are based on an equal weighting of the means of the estimates from each of the models. Among estimates that remain after applying the filter, we begin by taking the average of all estimates within a model. The estimated SCC is then calculated as the average of the three model-specific averages. This approach is used to ensure that models with a greater number of published results do not exert unequal weight on the interim SCC estimates.

It should be noted, however, that the resulting set of SCC estimates does not provide information about variability among or within models except in so far as they have different discounting assumptions. Comment is sought on whether model-weighting averaging of published estimates is appropriate for developing interim SCC estimates.

iv. Apply a 3% Annual Growth Rate to the Chosen SCC Values

SCC is expected to increase over time, because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed as the magnitude of climate change increases. Indeed, an implied growth rate in the SCC can be produced by most of the models that estimate economic damages caused by increased GHG emissions in future years. But neither the rate itself nor the information necessary to derive its implied value is commonly reported. In light of the limited amount of debate thus far about the appropriate growth rate of the SCC, applying a rate of 3% per year seems appropriate at this stage. This value is consistent with the range recommended by IPCC (2007) and close to the latest published estimate (Hope 2008) (see EPA Docket, EPA–HQ–OAR–2009–0472, for both citations).

(1) Discount Rates

For estimation of the benefits associated with the mitigation of climate change, one of the most complex issues involves the appropriate discount rate. OMB's current guidance offers a detailed discussion of the relevant issues and calls for discount rates of 3% and 7%. It also permits a sensitivity analysis with low rates (1–3%) for intergenerational problems: ''If your rule will have important intergenerational benefits or costs you might consider a further sensitivity analysis using a lower but positive discount rate in addition to calculating net benefits using discount rates of 3 and 7 percent.'' [368]

The choice of a discount rate, especially over long periods of time, raises highly contested and exceedingly difficult questions of science, economics, philosophy, and law. See, *e.g.*, William Nordhaus, The Challenge of Global Warming (2008); Nicholas Stern, The Economics of Climate Change (2008); Discounting and Intergenerational Equity (Paul Portney and John Weyant eds. 1999), in the EPA Docket, EPA–HQ–OAR–2009–0472. Under imaginable assumptions, decisions based on cost-benefit analysis with high discount rates might harm future generations—at least if investments are not made for the benefit of those generations. *See* Robert Lind, Analysis for Intergenerational Discounting, id. at 173, 176–177 (1999), in the EPA Docket, EPA–HQ–OAR–2009–0472. It is not clear that future generations would be willing to trade environmental quality for consumption at the same rate as the current generations. It is also possible that the use of low discount rates for particular projects might itself harm future generations, by diverting resources from private or public sector investments with higher rates of return for future generations. In the context of climate change, questions of intergenerational equity are especially important.

Because of the substantial length of time in which CO_2 and other GHG emissions reside in the atmosphere, choosing a high discount rate could result in irreversible changes in CO_2 concentrations, and possibly irreversible climate changes (unless substantial reductions in short-lived climate forcing emissions are achieved). Even if these changes are reversible, delaying mitigation efforts could result in substantially higher costs of stabilizing CO_2 concentrations. On the other hand, using too low a discount rate in benefit-cost analysis may suggest some potentially economically unwarranted investments in mitigation. It is also possible that the use of low discount rates for particular projects might itself harm future generations, by ensuring that resources are not used in a way that would greatly benefit them. We invite comment on the methods used to select discount rates for application in deriving SCC values, and in particular, application of the Newell and Pizer work on uncertainty in discount rates in developing the SCC used in evaluating the climate-related benefits of this proposal. Comments are requested on the use of the rates discussed in this preamble and on alternative rates. We

[367] However, it is acknowledged that the most recently published results do not necessarily repeat prior modeling exercises with an updated model, so valuable information may be lost, for instance, estimates of the SCC using specific climate sensitivities or economic scenarios. In addition, although some older model versions were used to produce estimates between 1996 and 2001, there have been no significant modeling paradigm changes since 1996.

[368] *See* OMB Circular A–4, pp. 35–36, citing Portney and Weyant, eds. (1999), Discounting and Intergenerational Equity, Resources for the Future, Washington, DC. *See* EPA Docket, EPA–HQ–OAR–2009–0472.

also invite comment on how to best address the ethical and policy concerns in the context of selecting the appropriate discount rate.

Reasonable arguments support the use of a 3% discount rate. First, that rate is among the two figures suggested by OMB guidance, and hence it fits with existing national policy. Second, it is standard to base the discount rate on the compensation that people receive for delaying consumption, and the 3% is close to the risk-free rate of return, proxied by the return on long term inflation-adjusted U.S. Treasury Bonds, as of this writing. Although these rates are currently closer to 2.5%, the use of 3% provides an adjustment for the liquidity premium that is reflected in these bonds' returns. However, this approach does not adjust for the significantly longer time horizon associated with climate change impacts. It could also be argued that the discount rate should be lower than 3% if the benefits of climate mitigation policies tend to be higher than expected in time periods when the returns to investments in rest of the economy are lower than normal.

At the same time, others would argue that a 5% discount rate can be supported. The argument relies on several assumptions. First, this rate can be justified by reference to the level of compensation for delaying consumption, because it fits with market behavior with respect to *individuals'* willingness to trade-off consumption across periods as measured by the estimated post-tax average real returns to risky private investments (*e.g.*, the S&P 500). In the climate setting, the 5% discount rate may be preferable to the riskless rate because the benefits to mitigation are not known with certainty. In principal, the correct discount rate would reflect the variance in payoff from climate mitigation policy and the correlation between the payoffs of the policy and the broader economy.[369]

Second, 5%, and not 3%, is roughly consistent with estimates implied by inputs to the theoretically derived Ramsey equation presented below, which specifies the optimal time path for consumption. That equation specifies the optimal discount rate as the sum of two components. The first term (the product of the elasticity of the marginal utility of consumption and the growth rate of consumption) reflects the fact that consumption in the future is likely to be higher than consumption today, so diminishing marginal utility implies that the same monetary damage will cause a smaller reduction of utility in the future. Standard estimates of this term from the economics literature are in the range of 3%–5%.[370] The second component reflects the possibility that a lower weight should be placed on utility in the future, to account for social impatience or extinction risk, which is specified by a pure rate of time preference (PRTP). A common estimate of the PRTP is 2%, though some observers believe that a principle of intergenerational equity suggests that the PRTP should be close to zero. It follows that discount rate of 5% is near the middle of the range of values that are able to be derived from the Ramsey equation.[371]

It is recognized that the arguments above—for use of market behavior and the Ramsey equation—face objections in the context of climate change, and of course there are alternative approaches. In light of climate change, it is possible that consumption in the future will not be higher than consumption today, and if so, the Ramsey equation will suggest a lower figure. The historical evidence is consistent with rising consumption over time.[372]

Some critics contend that using observed interest rates for inter-generational decisions imposes current preferences on future generations. For intergenerational equity, they argue that the discount rate should be below market rates to correct for market distortions and inefficiencies in intergenerational transfers of wealth (which are presumed to compensate future generations for damage), and to treat generations equitably based on ethical principles (*see* Broome 2008 in the EPA Docket, EPA–HQ–OAR–2009–0472).[373]

Additionally, some analyses attempt to deal with uncertainty with respect to interest rates over time. We explore below how this might be done.[374]

(2) Proposed Interim Estimates

The application of the methodology outlined above yields interim estimates of the SCC that are reported in Table III.H.6–1. These estimates are reported separately using 3% and 5% discount rates. The cells are empty in rows 10 and 11, because these studies did not report estimates of the SCC at a 3% discount rate. The model-weighted means are reported in the final or summary row; they are \$34 per tCO_2 at a 3% discount rate and \$5 per tCO_2 with a 5% discount rate.

[369] Specifically, if the benefits of the policy are highly correlated with the returns from the broader economy, then the market rate should be used to discount the benefits. If the benefits are uncorrelated with the broader economy the long term government bond rate should be applied. Furthermore, if the benefits are negatively correlated with the broader economy, a rate less than that on long term government bonds should be used (Lind, 1982 pp. 89–90).

[370] For example, *see:* Arrow KJ, Cline WR, Maler K–G, Munasinghe M, Squitieri R, Stiglitz JE. 1996. Intertemporal equity, discounting, and economic efficiency. Chapter 4 in Economic and Social Dimensions of Climate Change: Contribution of Working Group III to the Second Assessment Report, Summary for Policy Makers. Cambridge: Cambridge University Press; Dasgupta P. 2008. Discounting climate change. Journal of Risk and Uncertainty 37:141–169; Hoel M, Sterner T. 2007. Discounting and relative prices. Climatic Change 84:265–280; Nordhaus WD. 2008. A Question of Balance: Weighing the Options on Global Warming Policies. New Haven, CT: Yale University Press; Stern N. 2008. The economics of climate change. The American Economic Review 98(2):1–37. *See* EPA Docket, EPA–HQ–OAR–2009–0472.

[371] Sterner and Persson (2008) note that a consistent treatment of the marginal utility of consumption would require that if higher discount rates are justified by the diminishing marginal utility of consumption, *e.g.*, a dollar of damages is worth less to future generations because they have greater income, then so-called equity weights should be used to account for the higher value that countries with lower income would place on a dollar of damages relative to the U.S. This is a consistent and logical outcome of application of the Ramsey framework. Because the distribution of climate change related damages is expected to be skewed towards developing nations with lower incomes, this can have significant implications for estimates of total global SCC if the Ramsey framework is used to derive discount rates. *See* EPA Docket, EPA–HQ–OAR–2009–0472 for Sterner and Persson (2008).

[372] However, because climate change impacts may be outside the bounds of historical evidence, predictions about future growth in consumption based on past experience may be inaccurate.

[373] For relevant discussion, see Arrow, K.J., W.R. Cline, K–G Maler, M. Munasinghe, R. Squiteri, J.E.Stiglitz, 1996. ''Intertemporal equity, discounting and economic efficiency,'' in Climate Change 1995: Economic and Social Dimensions of Climate Change, Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change. *See* also Weitzman, M.L., 1999, in Portney P.R. and Weyant J.P. (eds.), Discounting and Intergenerational Equity, Resources for the Future, Washington, DC. *See* EPA Docket, EPA–HQ–OAR–2009–0472.

[374] Richard Newell and William Pizer, Discounting the distant future: how much do uncertain rates increase valuations? J. Environ. Econ. Manage. 46 (*2003*) 52–71. *See* EPA Docket, EPA–HQ–OAR–2009–0472.

TABLE III.H.6–1—GLOBAL SOCIAL COST OF CARBON (SCC) ESTIMATES ($/t$CO_2$ IN 2007 (2007$)), BASED ON 3% AND 5% DISCOUNT RATES [a]

	Model	Study [b]	Climate Scenario	3%	5%
1	FUND	Anthoff *et al.* 2009	FUND default	6	−1
2	FUND	Anthoff *et al.* 2009	SRES A1b	1	−1
3	FUND	Anthoff *et al.* 2009	SRES A2	9	−1
4	FUND	Link and Tol 2004	No THC	12	3
5	FUND	Link and Tol 2004	THC continues	12	2
6	FUND	Guo et al. 2006	Constant PRTP	5	−1
7	FUND	Guo et al. 2006	Gollier discount 1	14	0
8	FUND	Guo et al. 2006	Gollier discount 2	7	−1
			FUND Mean	8.47	0
9	PAGE	Wahba & Hope 2006	A2-scen	59	7
10	PAGE	Hope 2006			7
11	DICE	Nordhaus 2008			8
Summary			Model-weighted Mean	34	5

[a] The sample includes all peer reviewed, non-equity-weighted estimates included in Tol (2008), Nordhaus (2008), Hope (2008), and Anthoff *et al.* (2009), that are based on the most recent published version of FUND, PAGE, or DICE and use business-as-usual climate scenarios.[375] [376] All values are based on the best available information from the underlying studies about the base year and year dollars, rather than the Tol (2008) assumption that all estimates included in his review are 1995 values in 1995$. All values were updated to 2007 using a 3% annual growth rate in the SCC, and adjusted for inflation using GDP deflator.

[b] *See* EPA Docket, EPA–HQ–OAR–2009–0472, for each study.

In this proposal, benefits of reducing GHG emissions have been estimated using global SCC values of $34 and $5 as these represent the estimates associated with the 3% and 5% discount rates, respectively.[377] The 3% and 5% estimates have independent appeal and at this time a clear preference for one over the other is not warranted. Thus, we have also included—and centered our current attention on—the average of the estimates associated with these discount rates, which is $20. (Based on the $20 global value, the approximate domestic fraction of these benefits would be $1.20 per ton of CO_2 assuming that domestic benefits are 6% of the global benefits.)

The distinctions between sets of estimates generated using different discount rates are due only in part to discount rate differences, because the models and parameters used to generate the estimates in the sets associated with different discount rates also vary.

It is true that there is uncertainty about interest rates over long time horizons. Recognizing that point, Newell and Pizer (2003) have made a careful effort to adjust for that uncertainty (*see* EPA Docket, EPA–HQ–OAR–2009–0472). The Newell-Pizer approach models discount rate uncertainty as something that evolves over time.[378] This is a different way to model discount rate uncertainty than the approach outlined above, which assumes there is a single discount rate with equal probability of 3% and 5%. Since Newell and Pizer (2003) is a relatively recent contribution to the literature, estimates based on this method are included with the aim of soliciting comment.

Table III.H.6–2 reports on the application of the Newell-Pizer adjustments. The precise numbers depend on the assumptions about the data generating process that governs interest rates. Columns (1a) and (1b) assume that ''random walk'' model best describes the data and uses 3% and 5% discount rates, respectively. Columns (2a) and (2b) repeat this, except that it assumes a ''mean-reverting'' process. While the empirical evidence does not rule out a mean-reverting model, Newell and Pizer find stronger empirical support for the random walk model. EPA solicits comment on these and other models for representing the variation in interest rates over time.

[375] Most of the estimates in Table 1 rely on climate scenarios developed by the Intergovernmental Panel on Climate Change (IPCC). The IPCC published a new set of scenarios in 2000 for use in the Third Assessment Report (Special Report on Emissions Scenarios—SRES). The SRES scenarios define four narrative storylines: A1, A2, B1 and B2, describing the relationships between the forces driving greenhouse gas and aerosol emissions and their evolution during the 21st century for large world regions and globally. Each storyline represents different demographic, social, economic, technological, and environmental developments that diverge in increasingly irreversible ways. The storylines are summarized in the SRES report (Nakicenovic *et al.,* 2000; *see* also *http://sedac.ciesin.columbia.edu/ddc/sres/*) (*see* EPA Docket, EPA–HQ–OAR–2009–0472). Although they were intended to represent BAU scenarios, at this point in time the B1 and B2 storylines are widely viewed as representing policy cases rather than business-as-usual projections, estimates derived from these scenarios to be less appropriate for use in benefit-cost analysis. They are therefore excluded.

[376] Guo *et al.* (2006) report estimates based on two Gollier discounting schemes. The Gollier discounting assumes complex specifications about individual utility functions and risk preferences. After various conditions are satisfied, declining social discount rates emerge. Gollier Discounting Scheme 1 employs a certainty-equivalent social rate of time preference (SRTP) derived by assuming the regional growth rate is equally likely to be 1% above or below the original forecast growth rate. Gollier Discounting Scheme 2 calculates a certainty-equivalent social rate of time preference (SRTP) using five possible growth rates, and applies the new SRTP instead of the original. Hope (2008) conducts Monte Carlo analysis on the PRTP component of the discount rate. The PRTP is modeled as a triangular distribution with a min value of 1%/yr, a most likely value of 2%/yr, and a max value of 3%/yr. *See* EPA Docket, EPA–HQ–OAR–2009–0472 for the studies.

[377] It should be noted that reported discount rates may not be consistently derived across models or specific applications of models: While the discount rate may be identical, it may reflect different assumptions about the individual components of the Ramsey equation identified earlier.

[378] In contrast, an alternative approach based on Weitzman (2001) would assume that there is a constant discount rate that is uncertain and represented by a probability distribution. The Newell and Pizer, and Weitzman approaches are relatively recent contributions and we invite comment on the advantages and disadvantages of each. *See* EPA Docket, EPA–HQ–OAR–2009–0472.

TABLE III.H.6–2—GLOBAL SOCIAL COST OF CARBON (SCC) ESTIMATES ($ PER METRIC TON CO_2 IN 2007 (2007$)) [a], USING NEWELL & PIZER (2003) ADJUSTMENT FOR FUTURE DISCOUNT RATE UNCERTAINTY [b]

	Model	Study [c]	Climate scenario	Random-walk model		Mean-reverting model	
				3% (1a)	5% (1b)	3% (2a)	5% (2b)
1	FUND	Anthoff *et al.* 2009	FUND default	10	0	7	−1
2	FUND	Anthoff *et al.* 2009	SRES A1b	2	0	1	−1
3	FUND	Anthoff *et al.* 2009	SRES A2	15	0	10	−1
4	FUND	Link and Tol 2004	No THC	21	6	13	4
5	FUND	Link and Tol 2004	THC continues	21	4	13	2
6	FUND	Guo et al. 2006	Constant PRTP	9	0	6	−1
7	FUND	Guo et al. 2006	Gollier discount 1	14	0	14	0
8	FUND	Guo et al. 2006	Gollier discount 2	7	−1	7	−1
			FUND Mean	12	1	9	0
9	PAGE	Wahba & Hope 2006	A2-scen	100	13	65	8
10	PAGE	Hope 2006			13		8
11	DICE	Nordhaus 2008			15		9
Summary			Model-weighted Mean	56	10	37	6

[a] The sample includes all peer reviewed, non-equity-weighted estimates included in Tol (2008), Nordhaus (2008), Hope (2008), and Anthoff et al. (2009), that are based on the most recent published version of FUND, PAGE, or DICE and use business-as-usual climate scenarios. All values are based on the best available information from the underlying studies about the base year and year dollars, rather than the Tol (2008) assumption that all estimates included in his review are 1995 values in 1995$. All values were updated to 2007 using a 3% annual growth rate in the SCC, and adjusted for inflation using GDP deflator. *See* the Notes to Table III.H.6–1 for further details.

[b] Assumes a starting discount rate of 3% or 5%. Newell and Pizer (2003) based adjustment factors are not applied to estimates from Guo et al. (2006) that use a different approach to account for discount rate uncertainty (rows 7–8).

Note that the correction factor from Newell and Pizer is based on the DICE model. The proper adjustment may differ for other integrated assessment models that produce different time schedules of marginal damages. We would expect this difference to be minor.

[c] *See* EPA Docket, EPA–HQ–OAR–2009–0472, for each study.

The resulting estimates of the social cost of carbon are necessarily greater. When the adjustments from the random walk model are applied, the estimates of the social cost of carbon are $10 and $56 per ton of CO_2, with the 5% and 3% discount rates, respectively. The application of the mean-reverting adjustment yields estimates of $6 and $37. Relying on the random walk model, analyses are also conducted with the value of the SCC set at $10 and $56.

(3) Caveats

There are at least four caveats to the approach outlined above.

First, and as noted, the existing IAMs do not currently individually account for and assign value to all of the important physical and other impacts of climate change that are recognized in the climate change literature.[379] The impacts of climate change are expected to be widespread, diverse, and heterogeneous. In addition, the exact magnitude of these impacts is uncertain, because of the inherent randomness in the Earth's atmospheric processes, the U.S. and global economies, and the behaviors of current and future populations. To this extent, as emphasized by the IPCC, SCC estimates are ''very likely'' underestimated.[380] In addition, the SCC approach also likely underestimates the value of GHG reductions because the marginal values apply only to CO_2 emissions, which have different impacts than non-CO_2 emissions because of variances in atmospheric lifetimes and radiative forcing.[381] Although it is likely that our capability to quantify and monetize impacts will improve with time, it is also likely that even in future applications, a number of potentially significant benefits categories will remain unmonetized. In order to capture the benefits of mitigation these non-monetized benefits should be discussed along with monetized benefits based on the SCC.

Second, in the opposite direction, it is unlikely that the damage estimates adequately account for the directed technological change that climate change will cause. In particular, climate change will increase the return on investment to develop technologies that allow individuals to cope with climate change. For example, it is likely that scientists will develop crops that are better able to withstand high temperatures. In this respect, the current estimates may overstate the likely quantified damages, though the costs associated with the investments in adaptive technologies must also be considered (technologies must also be included in the calculations, as the benefits should reflect net welfare changes to society).

Third, there has been considerable recent discussion of the risk of catastrophic impacts and of how best to account for worst-case scenarios. Recent work by Weitzman (2009) specifies some conditions under which the possibility of catastrophe would undermine the use of IAMs and conventional cost-benefit analysis.[382] This research requires further exploration before its generality is known and the proper way to incorporate it into regulatory reviews is understood. We also request comments on approaches for measuring the premium associated with reductions in

[379] Examples of impacts that are difficult to monetize, and have generally not been included in SCC estimates, include risks from extreme weather (death, disease, agricultural damage, and other economic damage from droughts, floods and wildfires) and possible long-term catastrophic events, such as collapse of the West Antarctic ice sheet or the release of large amounts of methane from melting permafrost.

[380] IPCC WGII. 2007. *Climate Change 2007—Impacts, Adaptation and Vulnerability Contribution of Working Group II to the Fourth Assessment Report of the IPCC.* See EPA Docket, EPA–HQ–OAR–2009–0472.

[381] Radiative forcing is the change in the balance between solar radiation entering the atmosphere and the Earth's radiation going out. On average, a positive radiative forcing tends to warm the surface of the Earth while negative forcing tends to cool the surface. Greenhouse gases have a positive radiative forcing because they absorb and emit heat. *See http://www.epa.gov/climatechange/science/recentac.html* for more general information about GHGs and climate science. *See* EPA Docket, EPA–HQ–OAR–2009–0472.

[382] Weitzman, Martin, 2009. On Modeling and Interpreting the Economics of Catastrophic Climate Change. Review of Economics and Statistics 9(1): 1–19. *See* EPA Docket, EPA–HQ–OAR–2009–0472.

climate-related risks such as catastrophic events.

Fourth, it is also worth noting that the SCC estimates are only relevant for incremental policies relative to the projected baselines, which capture business-as-usual scenarios. To evaluate non-marginal changes, such as might occur if the U.S. acts in tandem with other nations, it might be necessary to go beyond the simple expedient of using the SCC along the BAU path. This approach would require explicitly calculating the total benefits in a move from the BAU scenario to the policy scenario, without imposing the restriction that the marginal benefit remains constant over this range.

(4) Other options

The Administration considered other interim SCC options in addition to the approach described above; we request comment on each of them. One alternative option was to bring in SCC estimates in studies published after 1995, rather than limiting the estimates to those in studies relying on the most recent published version of each of the three major integrated assessment models: PAGE, FUND, and DICE. Although some older model versions (and old versions of other models) were used to produce estimates between 1996 and 2001, it appears that there have been no significant modeling paradigm changes since 1996.

Another option was to select a range of SCC values for separate discount rates. For example, sensitivity analysis could be conducted at the lowest and highest SCC values reported in the filtered set of estimates for each discount rate considered. If considering SCC estimates from studies published after 1995 and a discount rate of 2 percent, this option would result in a range of SCC values of \$5/t-CO_2 to \$260/t-CO_2 (2007 emissions in 2007 dollars); at a 3 percent discount rate, the range would be \$0 to \$58/t-CO_2.

Finally, we considered the possibility that different assumptions under the Ramsey framework, such as placing approximately equal weight on the welfare of current and future generations, would imply a lower discount rate, such as 2%. The Newell and Pizer (2003) method applied to recent long-term risk free rates would likewise be approximately consistent with a certainty equivalent rate of 2%.[383]

(5) Ongoing SCC Development

As noted, this is an emphatically interim SCC value. The judgments described here will be subject to further scrutiny and exploration.

c. Application of Interim SCC Estimates to GHG Emissions Reductions From This Proposed Rule

The strategy underlying these joint proposals—to coordinate *Federal* efforts to reduce GHGs—warrants consideration when assessing the benefits. To be sure, while no single rule or action can independently achieve the deep worldwide emissions reductions necessary to halt and reverse the growth of GHGs. But the combined effects of multiple strategies to reduce GHG emissions domestically and abroad could make a major difference in the climate change impacts experienced by future generations.[384]

The projected net GHG emissions reductions associated with the proposal reflect an incremental change to projected total global emissions. Therefore, as shown in Section III.F.3, the projected global climate signal will be small but discernible—an incrementally lower projected distribution of global mean surface temperatures.

Given that the climate response is projected to be a marginal change relative to the baseline climate, we estimate the marginal value of changes in climate change impacts over time and use this value to measure the monetized marginal benefits of the GHG emissions reductions projected for this proposal.

Accordingly, EPA and NHTSA have used the set of interim, global SCC values described above to estimate the benefits of these coordinated proposals. The interim SCC values, which reflect the Administration's interim interpretation of the current literature, are \$5 (based on a 5% discount rate), \$10 (5% using Newell-Pizer adjustment), \$20 (average SCC value from the average SCC estimates based on 5% and 3%), \$34 (3%), and \$56 (3% using Newell-Pizer adjustment), in 2007 dollars, and are based on a CO_2 emissions change of 1 metric ton in 2007. Table III.H.6–3 presents the interim SCC values in other years in 2007 dollars. These values are presented as one of many considerations that will inform the Administration's action on this proposed rule.

TABLE III.H.6–3—INTERIM SCC SCHEDULE

Discount rate assumption	Interim SCC schedule (2007\$) [a]					
	2007	2015	2020	2030	2040	2050
5%	\$5	\$7	\$8	\$10	\$14	\$18
5% (Newell-Pizer) [b]	10	13	15	20	27	37
Average SCC Values from 3% and 5%	20	25	29	39	52	70
3%	34	43	50	67	90	120
3% (Newell-Pizer) [b]	56	72	83	110	150	200

[a] The SCC values are dollar-year and emissions-year specific. These values are presented in 2007\$, for individual year of emissions. To determine values for years not presented in the table, use a 3% growth rate. SCC values represent only a partial accounting for climate impacts.
[b] SCC values are adjusted based on Newell and Pizer (2003) to account to future uncertainty in discount rates. See EPA Docket, EPA–HQ–OAR–2009–0472.

Tables III.H.6–4 to III.H.6–6 provide the annual benefits for each year impacted by the proposed rule. As discussed above, marginal benefits of GHG reductions are projected to grow over time. The tables below summarize the total benefits for the lifetime of the rule, which are calculated by using the five interim SCC values.

Total monetized benefits in each specific year are calculated by

[383] Specifically, Newell and Pizer (2003) found that modeling of uncertainty in economic growth causes the effective discount rate to decline over time. When starting at a 4% discount rate, the effective discount rate is 2% at 100 years and 1% at 200 years. *See* EPA Docket, EPA–HQ–OAR–2009–0472.

[384] The Supreme Court recognized in *Massachusetts* v. *EPA* that a single action will not on its own achieve all needed GHG reductions, noting that ''[a]gencies, like legislatures, do not generally resolve massive problems in one fell regulatory swoop.'' *See Massachusetts* v. *EPA*, 549 U.S. at 524 (2007). *See* EPA Docket, EPA–HQ–OAR–2009–0472.

multiplying the marginal benefits estimates per metric ton of CO_2 (the SCC) from Table III.H.6–3 by the reductions in CO_2 for that year. Table III.H.6–5 approximates the total monetized benefits for non-CO_2 GHGs by multiplying the SCC value by the reductions in non-CO_2 GHGs for that year. Marginal benefit estimates per metric ton of non-CO_2 GHGs are currently unavailable, but work is on-going to monetize benefits related to the mitigation of other non-CO_2 GHGs. Inclusion of these benefits is planned for the final rule.

TABLE III.H.6–4—MONETIZED GHG BENEFITS OF VEHICLE PROGRAM, CO_2 EMISSIONS

[Million 2007$]

Year	Emissions reduction (million metric tons)	Discount rate				
		3%	3% (Newell-Pizer)	Average SCC from 3% and 5%	5%	5% (Newell-Pizer)
2015	43.2	$1,900	$3,100	$1,100	$280	$560
2020	146	7,300	12,000	4,200	1,100	2,200
2030	289	19,000	32,000	11,000	2,900	5,900
2040	375	34,000	56,000	19,000	5,100	10,000
2050	470	57,000	95,000	33,000	8,600	17,000

TABLE III.H.6–5—MONETIZED GHG BENEFITS OF VEHICLE PROGRAM, NON-CO_2 EMISSIONS IN CO_2-EQUIVALENTS

[Million 2007$]

Year	Emissions reduction (million metric tons)	Discount rate				
		3%	3% (Newell-Pizer)	Average SCC from 3% and 5%	5%	5% (Newell-Pizer)
2015	5.86	$250	$400	$150	$38	$76
2020	17.7	880	1,500	510	130	270
2030	35.3	2,400	3,900	1,400	360	700
2040	42.7	3,800	6,400	2,200	580	1,200
2050	48.2	5,800	9,700	3,400	880	1,800

TABLE III.H.6–6—MONETIZED GHG BENEFITS OF VEHICLE PROGRAM, TOTAL CO_2 AND NON-CO_2 EMISSIONS IN CO_2-EQUIVALENTS

[Million 2007$] [a]

Year	Emissions reduction (million metric tons)	Discount rate				
		3%	3% (Newell-Pizer)	Average SCC from 3% and 5%	5%	5% (Newell-Pizer)
2015	49.1	$2,100	$3,500	$1,200	$320	$640
2020	165	8,200	14,000	4,700	1,200	2,500
2030	325	22,000	36,000	12,000	3,300	6,600
2040	417	38,000	63,000	22,000	5,700	11,000
2050	518	63,000	100,000	36,000	9,500	19,000

[a] Numbers may not add exactly from Tables III.H.6–4 and III.H.6–5 due to rounding.

7. Non-Greenhouse Gas Health and Environmental Impacts

This section presents EPA's analysis of the non-GHG health and environmental impacts that can be expected to occur as a result of the proposed light-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, 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, EPA is using PM-related benefits-per-ton values as an interim approach to estimating the PM-related benefits of the proposal. EPA also provides a complete characterization of the health and environmental impacts that will be quantified and monetized for the final rulemaking.

This section is split into two sub-sections: the first presents the PM-related benefits-per-ton values used to monetize the PM-related co-benefits associated with the proposal; the second explains what PM- and ozone-related health and environmental impacts EPA will quantify and monetize in the analysis for the final rule. EPA bases its analyses on peer-reviewed studies of air quality and health and welfare effects and peer-reviewed studies of the monetary values of public health and welfare improvements, and is generally consistent with benefits analyses performed for the analysis of the final Ozone National Ambient Air Quality Standard (NAAQS) and the final PM NAAQS analysis, as well as the recent Portland Cement National Emissions Standards for Hazardous Air Pollutants (NESHAP) RIA (U.S. EPA, 2009a), and NO_2 NAAQS (U.S.≤ EPA, 2009b).[385] [386] [387] [388]

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 III.G for more information about the air toxics emissions impacts associated with the proposed standards.

a. Economic Value of Reductions in Criteria Pollutants

As described in Section III.G, the proposed standards would reduce emissions of several criteria and toxic pollutants and precursors. In this analysis, EPA estimates the economic value of the human health benefits associated with reducing $PM_{2.5}$ exposure. Due to analytical limitations, this analysis does not estimate benefits related to other criteria pollutants (such as ozone, NO_2 or SO_2) or toxics pollutants, nor does it monetize all of the potential health and welfare effects associated with $PM_{2.5}$.

This analysis uses a ''benefit-per-ton'' method to estimate a selected suite of $PM_{2.5}$-related health benefits described below. These $PM_{2.5}$ benefit-per-ton estimates provide the total monetized human health benefits (the sum of premature mortality and premature morbidity) of reducing one ton of directly emitted $PM_{2.5}$, or its precursors (such as NO_X, SO_X, and VOCs), from a specified source. Ideally, the human health benefits would be estimated based on changes in ambient $PM_{2.5}$ as determined by full-scale air quality modeling. However, this modeling was not possible in the timeframe for this proposal.

The dollar-per-ton estimates used in this analysis are provided in Table III.H.7–1. In the summary of costs and benefits, Section III.H.10 of this preamble, EPA presents the monetized value of PM-related improvements associated with the proposal.

TABLE III.H.7–1—BENEFITS-PER-TON VALUES (2007$) DERIVED USING THE ACS COHORT STUDY FOR PM-RELATED PREMATURE MORTALITY (POPE ET AL., 2002) [a] AND A 3% DISCOUNT RATE [b]

Year [c]	All sources [d]		Stationary (non-EGU) sources		Mobile sources	
	SO_X	VOC	NO_X	Direct $PM_{2.5}$	NO_X	Direct $PM_{2.5}$
2015	$28,000	$1,200	$4,700	$220,000	$4,900	$270,000
2020	31,000	1,300	5,100	240,000	5,300	290,000
2030	36,000	1,500	6,100	280,000	6,400	350,000
2040	43,000	1,800	7,200	330,000	7,600	420,000

[a] The benefit-per-ton estimates presented in this table are based on an estimate of premature mortality derived from the ACS study (Pope et al., 2002). If the benefit-per-ton estimates were based on the Six Cities study (Laden et al., 2006), the values would be approximately 145% (nearly two-and-a-half times) larger.

[b] The benefit-per-ton estimates presented in this table assume a 3% discount rate in the valuation of premature mortality to account for a twenty-year segmented cessation lag. If a 7% discount rate had been used, the values would be approximately 9% lower.

[c] Benefit-per-ton values were estimated for the years 2015, 2020, and 2030. For 2040, EPA and NHTSA extrapolated exponentially based on the growth between 2020 and 2030.

[d] Note that the benefit-per-ton value for SO_X is based on the value for Stationary (Non-EGU) sources; no SO_X value was estimated for mobile sources. The benefit-per-ton value for VOCs was estimated across all sources.

The benefit per-ton technique has been used in previous analyses, including EPA's recent Ozone National Ambient Air Quality Standards (NAAQS) RIA (U.S. EPA, 2008a),[389] Portland Cement National Emissions Standards for Hazardous Air Pollutants (NESHAP) RIA (U.S. EPA, 2009a),[390] and NO_2 NAAQS (U.S. EPA, 2009b).[391]

[385] 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.

[386] 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.

[387] U.S. Environmental Protection Agency (U.S. EPA). 2009a. 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*.

[388] U.S. Environmental Protection Agency (U.S. EPA). 2009b. Proposed 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/proposedno2ria.pdf*.

[389] U.S. Environmental Protection Agency (U.S. EPA). 2008a. Regulatory Impact Analysis, 2008 National Ambient Air Quality Standards for Ground-level Ozone, Chapter 6. Office of Air Quality Planning and Standards, Research Triangle Park, NC. March. Available at *http://www.epa.gov/ttn/ecas/regdata/RIAs/6-ozoneriachapter6.pdf*.

[390] U.S. Environmental Protection Agency (U.S. EPA). 2009a. 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*.

[391] U.S. Environmental Protection Agency (U.S. EPA). 2009b. Proposed 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/proposedno2ria.pdf*.

Table III.H.7–2 shows the quantified and unquantified $PM_{2.5}$-related co-benefits captured in those benefit-per-ton estimates.

TABLE III.H.7–2—HUMAN HEALTH AND WELFARE EFFECTS OF $PM_{2.5}$

Pollutant/effect	Quantified and monetized in primary estimates	Unquantified effects changes in
$PM_{2.5}$	Adult premature mortality Bronchitis: chronic and acute Hospital admissions: respiratory and cardiovascular Emergency room visits for asthma Nonfatal heart attacks (myocardial infarction) Lower and upper respiratory illness Minor restricted-activity days Work loss days Asthma exacerbations (asthmatic population) Infant mortality	Subchronic bronchitis cases Low birth weight Pulmonary function Chronic respiratory diseases other than chronic bronchitis Non-asthma respiratory emergency room visits Visibility Household soiling

Consistent with the NO_2 NAAQS,[392] the benefits estimates utilize the concentration-response functions as reported in the epidemiology literature. To calculate the total monetized impacts associated with quantified health impacts, EPA applies values derived from a number of sources. For premature mortality, EPA applies a value of a statistical life (VSL) derived from the mortality valuation literature. For certain health impacts, such as 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.

Readers interested in reviewing the complete methodology for creating the benefit-per-ton estimates used in this analysis can consult the Technical Support Document (TSD) [393] accompanying the recent final ozone NAAQS RIA (U.S. EPA, 2008a). Readers can also refer to Fann et al. (2009) [394] for a detailed description of the benefit-per-ton methodology.[395] A more detailed description of the benefit-per-ton estimates is also provided in the Draft Joint TSD that accompanies this rulemaking.

As described in the documentation for the benefit per-ton estimates cited above, national per-ton estimates were developed for selected pollutant/source category combinations. The per-ton values calculated therefore apply only to tons reduced from those specific pollutant/source combinations (*e.g.,* NO_2 emitted from mobile sources; direct PM emitted from stationary sources). Our estimate of $PM_{2.5}$ benefits is therefore based on the total direct $PM_{2.5}$ and PM-related precursor emissions controlled by sector and multiplied by each per-ton value.

The benefit-per-ton estimates are subject to a number of assumptions and uncertainties.

- They do not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors that might lead to an overestimate or underestimate of the actual benefits of controlling fine particulates. EPA will conduct full-scale air quality modeling for the final rulemaking in an effort to capture this variability.
- This analysis assumes that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because $PM_{2.5}$ produced via transported precursors emitted from stationary sources may differ significantly from direct $PM_{2.5}$ released from diesel engines and other industrial sources, but no clear scientific grounds exist for supporting differential effects estimates by particle type.
- This analysis assumes that the health impact function for fine particles is linear within the range of ambient concentrations under consideration. Thus, the estimates include health benefits from reducing fine particles in areas with varied concentrations of $PM_{2.5}$, including both regions that are in attainment with fine particle standard and those that do not meet the standard down to the lowest modeled concentrations.
- There are several health benefits categories that EPA was unable to quantify due to limitations associated with using benefits-per-ton estimates, several of which could be substantial. Because the NO_X and VOC emission reductions associated with this proposal are also precursors to ozone, reductions in NO_X and VOC would also reduce ozone formation and the health effects associated with ozone exposure. Unfortunately, benefits-per-ton estimates do not exist due to issues associated with the complexity of the atmospheric air chemistry and nonlinearities associated with ozone formation. The PM-related benefits-per-ton estimates also do not include any human welfare or ecological benefits. Please refer to Chapter 7.3 of the RIA that accompanies this proposal for a description of the quantification and monetization of health impact for the FRM and a description of the unquantified co-pollutant benefits associated with this rulemaking.
- There are many uncertainties associated with the health impact functions used in this modeling effort. These include: Within-study variability (the precision with which a given study estimates the relationship between air quality changes and health effects); across-study variation (different published studies of the same pollutant/

[392] Although we summarize the main issues in this chapter, we encourage interested readers to see benefits chapter of the NO_2 NAAQS for a more detailed description of recent changes to the PM benefits presentation and preference for the no-threshold model.

[393] U.S. Environmental Protection Agency (U.S. EPA). 2008b. Technical Support Document: Calculating Benefit Per-Ton estimates, Ozone NAAQS Docket #EPA–HQ–OAR–2007–0225–0284. Office of Air Quality Planning and Standards, Research Triangle Park, NC. March. Available on the Internet at *http://www.regulations.gov*.

[394] Fann, N. *et al.* (2009). The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution. Air Qual Atmos Health. Published online: 09 June, 2009.

[395] The values included in this report are different from those presented in the article cited above. Benefits methods change to reflect new information and evaluation of the science. Since publication of the June 2009 article, EPA has made two significant changes to its benefits methods: (1) We no longer assume that a threshold exists in PM-related models of health impacts; and (2) We have revised the Value of a Statistical Life to equal $6.3 million (year 2000$), up from an estimate of $5.5 million (year 2000$) used in the June 2009 report. Please refer to the following Web site for updates to the dollar-per-ton estimates: *http://www.epa.gov/air/benmap/bpt.html.*

health effect relationship typically do not report identical findings and in some instances the differences are substantial); the application of concentration-response functions nationwide (does not account for any relationship between region and health effect, to the extent that such a relationship exists); extrapolation of impact functions across population (we assumed that certain health impact functions applied to age ranges broader than that considered in the original epidemiological study); and various uncertainties in the concentration-response function, including causality and thresholds. These uncertainties may under- or over-estimate benefits.

• EPA has investigated methods to characterize uncertainty in the relationship between $PM_{2.5}$ exposure and premature mortality. EPA's final $PM_{2.5}$ NAAQS analysis provides a more complete picture about the overall uncertainty in $PM_{2.5}$ benefits estimates. For more information, please consult the $PM_{2.5}$ NAAQS RIA (Table 5.5).

• The benefit-per-ton estimates used in this analysis incorporate projections of key variables, including atmospheric conditions, source level emissions, population, health baselines and incomes, technology. These projections introduce some uncertainties to the benefit per ton estimates.

• As described above, using the benefit-per-ton value derived from the ACS study (Pope *et al.,* 2002) alone provides an incomplete characterization of $PM_{2.5}$ benefits. When placed in the context of the Expert Elicitation results, this estimate falls toward the lower end of the distribution. By contrast, the estimated $PM_{2.5}$ benefits using the coefficient reported by Laden in that author's reanalysis of the Harvard Six Cities cohort fall toward the upper end of the Expert Elicitation distribution results.

As mentioned above, emissions changes and benefits-per-ton estimates alone are not a good indication of local or regional air quality and health impacts, as there may be localized impacts associated with the proposed rulemaking. Additionally, the atmospheric chemistry related to ambient concentrations of $PM_{2.5}$, ozone and air toxics is very complex. Full-scale photochemical modeling is therefore necessary to provide the needed spatial and temporal detail to more completely and accurately estimate the changes in ambient levels of these pollutants and their associated health and welfare impacts. As discussed above, timing and resource constraints precluded from conducting a full-scale photochemical air quality modeling analysis in time for the NPRM. For the final rule, however, 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. The benefits analysis plan for the final rulemaking is discussed in the next section.

b. Human Health and Environmental Benefits for the Final Rule

i. Human Health and Environmental Impacts

To model the ozone and PM air quality benefits of the final rule, EPA will use the Community Multiscale Air Quality (CMAQ) model (*see* Section III.G.5.b 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).[396] 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 7.3 in the DRIA 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 light-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.

ii. Monetized Impacts

To calculate the total monetized impacts associated with quantified health impacts, EPA applies values derived from a number of sources. For premature mortality, EPA applies a value of a statistical life (VSL) derived from the mortality valuation literature. For certain health impacts, such as 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 7.3 in the DRIA that accompanies this proposal presents the monetary values EPA will apply to changes in the incidence of health and welfare effects associated with reductions in non-GHG pollutants that will occur when these GHG control strategies are finalized.

iii. Other Unquantified Health and Environmental Impacts

In addition to the co-pollutant health and environmental impacts EPA will quantify for the analysis of the final standard, there are a number of other health and human welfare endpoints that EPA will not be able to quantify or monetize because of current limitations in the methods or available data. These impacts are associated with emissions of air toxics (including benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, and ethanol), ambient ozone, and ambient $PM_{2.5}$ exposures. Chapter 7.3 of the DRIA lists these unquantified health and environmental impacts.

While there will be impacts associated with air toxic pollutant emission changes that result from the final standard, EPA will not attempt to monetize those impacts. This is primarily because currently available tools and methods to assess air toxics risk from mobile sources at the national scale are not adequate for extrapolation to incidence estimations or benefits assessment. The best suite of tools and methods currently available for assessment at the national scale are those used in the National-Scale Air Toxics Assessment (NATA). The EPA Science Advisory Board specifically commented in their review of the 1996 NATA that these tools were not yet ready for use in a national-scale benefits analysis, because they did not consider the full distribution of exposure and risk, or address sub-chronic health effects.[397] 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.[398]

[396] Information on BenMAP, including downloads of the software, can be found at *http://www.epa.gov/ttn/ecas/benmodels.html.*

[397] 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.*

[398] 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

Continued

8. Energy Security Impacts

This proposal to reduce GHG emissions in light-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 associated with a potential disruption in supply or a spike in cost of a particular energy source. This reduction in risk is a measure of improved U.S. energy security. This section summarizes our estimate of the monetary value of the energy security benefits of the proposed GHG vehicle standards against the reference case by estimating the impact of the expanded use of lower-GHG vehicle technologies on U.S. oil imports and avoided U.S. oil import expenditures. Additional discussion of this issue can be found in Chapter 5.1 of EPA's RIA and Section 4.2.8 of the TSD.

a. Implications of Reduced Petroleum Use on U.S. Imports

In 2008, U.S. petroleum import expenditures represented 21% of total U.S. imports of all goods and services.[399] In 2008, the U.S. imported 66% of the petroleum it consumed, and the transportation sector accounted for 70% of total U.S. petroleum consumption. This compares to approximately 37% of petroleum from imports and 55% consumption of petroleum in the transportation sector in 1975.[400] It is clear that petroleum imports have a significant impact on the U.S. economy. Requiring lower-GHG vehicle technology in the U.S. is expected to lower U.S. petroleum imports.

b. Energy Security Implications

In order to understand the energy security implications of reducing U.S. petroleum imports, EPA has 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 provide 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 recent study is included as part of the docket for this rulemaking.[401 402]

When conducting this recent analysis, ORNL considered the economic cost of importing petroleum into the U.S. The economic cost of importing petroleum into the U.S. 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 OPEC market power (*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 U.S. (*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 difficult.

For this proposal, ORNL further updated the energy security premium by incorporating the most recent oil price forecast in the in the Energy Information Administration's 2009 Annual Energy Outlook into its model. In order for the energy security premium estimated to be used in EPA's OMEGA model, ORNL developed energy security estimates for a number of different years; please refer to Table III.H.8–1 for this information for years 2015, 2020, 2030 and 2040,[403] as well as a breakdown of the components of the energy security premium for each of these years. The components of the energy security premium and their values are discussed in detail in the TSD, Chapter 4.2.8.

TABLE III.H.8–1—ENERGY SECURITY PREMIUM IN 2015, 2020, 2030 AND 2040 (2007$/BARREL)

Year (range)	Monopsony	Macroeconomic disruption/ adjustment costs	Total mid-point
2015	$11.79 ($4.26–$21.37)	$6.70 ($3.11–$10.67)	$18.49 ($9.80–$28.08)
2020	$12.31 ($4.46–$22.53)	$7.62 ($3.77–$12.46)	$19.94 ($10.58–$30.47)
2030	$10.57 ($3.84–$18.94)	$8.12 ($3.90–$13.04)	$18.69 ($10.52–$27.89)
2040	$10.57 ($3.84–$18.94)	$8.12 ($3.90–$13.04)	$18.69 ($10.52–$27.89)

The literature on the energy security for the last two decades has routinely combined the monopsony and the macroeconomic disruption components when calculating the total value of the energy security premium. However, in the context of using a global value for the Social Cost of Carbon (SCC) the question arises: How should the energy security premium be used when some benefits from the proposed rule, such as the benefits of reducing greenhouse gas emissions, are calculated at a global level? Monopsony benefits represent avoided payments by the U.S. to oil producers in foreign countries that result from a decrease in the world oil price as the U.S. decreases its consumption of imported oil. Although there is clearly a benefit to the U.S. when considered from the domestic perspective, the decrease in price due to decreased demand in the U.S. also represents a loss of income to oil-producing countries. Given the redistributive nature of this effect, do the negative effects on other countries ''net out'' the positive impacts to the U.S.? If this is the case, then, the monopsony portion of the energy security premium should be excluded from the net benefits calculation for the rule.

Based on this reasoning, EPA's estimates of net benefits for this proposal exclude the portion of energy

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.

[399] Source: U.S. Bureau of Economic Analysis, U.S. International Transactions Accounts Data, as shown on June 24, 2009.

[400] 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.

[401] 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–2009–0472)

[402] 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–2009–0472).

[403] AEO 2009 forecasts energy market trends and values only to 2030. The energy security premium estimates post-2030 were assumed to be the 2030 estimate.

security benefits stemming from the U.S. exercising its monopsony power in oil markets. Thus, EPA only includes the macroeconomic disruption/adjustment cost portion of the energy security premium.

EPA invites comments on whether, when the global value for greenhouse gas reduction benefits is used, it may still be appropriate to include the monopsony benefits in net benefits calculation for the proposed rule. From one perspective, the global SCC is used in these calculations, not because the global net benefits of the rule are being computed (they are not), but rather because in the context of a global public good, the global marginal benefit is the correct domestic benefit against which domestic costs are to be compared. Similarly, energy security is inherently a domestic benefit. Thus, should the two benefits, if they are both viewed from this domestic perspective, be counted in the net benefits estimates for this rulemaking and more generally what are the overall implications of this approach to justifying regulation? If the monopsony benefits were included in this case, they could be significant.

Total annual energy security benefits are derived from the estimated reductions in U.S. imports of finished petroleum products and crude oil using only the macroeconomic disruption/adjustment portion of the energy security premium. These values are shown in Table III.H.8–2.[404] The reduced oil estimates were derived from the OMEGA model, as explained in Section VI of this preamble. EPA used the same assumption that NHTSA used in its Corporate Average Fuel Economy and CAFE Reform for MY 2008–2011 Light Trucks proposal, which assumed each gallon of fuel saved reduces total U.S. imports of crude oil or refined products by 0.95 gallons.[405]

TABLE III.H.8–2—TOTAL ANNUAL ENERGY SECURITY BENEFITS USING ONLY THE MACROECONOMIC DISRUPTION/ADJUSTMENT COMPONENT OF THE ENERGY SECURITY PREMIUM IN 2015, 2020, 2030 AND 2040

[Billions of 2007$]

Year	Benefits
2015	$0.59
2020	2.30
2030	4.81
2040	6.23

9. Other Impacts

There are other impacts associated with the proposed CO_2 emissions standards and associated reduced fuel consumption that vary with miles driven. Lower fuel consumption would, presumably, result in fewer trips to the filling station to refuel and, thus, time saved. The rebound effect, discussed in detail in Section III.H.4.c, produces additional benefits to vehicle owners in the form of consumer surplus from the increase in vehicle-miles driven, but may also increase the societal costs associated with traffic congestion, motor vehicle crashes, and noise. These effects are likely to be relatively small in comparison to the value of fuel saved as a result of the proposed standards, but they are nevertheless important to include. Table III.H.9–1 summarizes the other economic impacts. Please refer to Preamble Section II.F and the Draft Joint TSD that accompanies this proposal for more information about these impacts and how EPA and NHTSA use them in their analyses.

TABLE III.H.9–1—ESTIMATED ECONOMIC EXTERNALITIES ASSOCIATED WITH THE PROPOSED LIGHT-DUTY VEHICLE GHG PROGRAM

[Millions of 2007 dollars]

Economic externalities	2020	2030	2040	2050	NPV, 3%	NPV, 7%
Value of Less Frequent Refueling	$2,500	$4,900	$6,400	$8,000	$89,600	$41,000
Value of Increased Driving [a]	4,900	10,000	13,600	18,000	184,700	82,700
Accidents, Noise, Congestion	−2,400	−4,900	−6,300	−7,900	−88,200	−40,200
Annual Quantified Benefits	5,000	10,000	13,700	18,100	186,100	83,500

[a] Calculated using post-tax fuel prices.

10. Summary of Costs and Benefits

In this section EPA presents a summary of costs, benefits, and net benefits of the proposal. EPA presents fuel consumption impacts as negative costs of the vehicle program.

Table III.H.10–1 shows the estimated annual societal costs of the vehicle 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 a 3 percent and a seven percent discount rate. In this table, fuel savings are calculated using pre-tax fuel prices and are presented as negative costs associated with the vehicle program (rather than positive savings).

Consumers are expected to receive the fuel savings presented here. The cost estimates for the fuel-saving technology are based on the assumptions that, to comply with the rule, no vehicle attributes will change except fuel economy and technology cost; that consumers will consider reduced fuel costs as a substitute for increased purchase price; and that consumers will not change the vehicles that they purchase. Instead, automakers are likely to redesign vehicles as part of their compliance strategies. If so, the redesigns may make the vehicles either less or more attractive to consumers. In

[404] Estimated reductions in U.S. imports of finished petroleum products and crude oil are 95% of 88 million barrels (MMB) in 2015, 302 MMB in 2020, 592 MMB in 2030, and 767 MMB in 2040.

[405] Preliminary Regulatory Impacts Analysis, April 2008. Based on a detailed analysis of differences in fuel consumption, petroleum imports, and imports of refined petroleum products among the Reference Case, High Economic Growth, and Low Economic Growth Scenarios presented in the Energy Information Administration's Annual Energy Outlook 2007, NHTSA estimated that approximately 50 percent of the reduction in fuel consumption 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 is anticipated to reduce total U.S. imports of crude petroleum or refined fuel by 0.95 gallons.

addition, consumers may choose to purchase different vehicles than they would in the absence of this rule. These changes may affect the satisfaction that consumers receive from their vehicles. Because of the unsettled state of the modeling of consumer choices (discussed in Section III.H.1 and in DRIA Section 8.1.2), this analysis does not measure these effects. To the extent that consumer satisfaction with vehicles may decline due to changes in vehicles other than fuel economy, or that consumers may take some of these fuel savings into account when they purchase their vehicles, the fuel savings may overstate the benefits of improved fuel economy to consumers.

TABLE III.H.10–1—ESTIMATED SOCIETAL COSTS OF THE LIGHT-DUTY VEHICLE GHG PROGRAM

[Millions of 2007 dollars]

Social costs	2020	2030	2040	2050	NPV, 3%	NPV, 7%
Vehicle Compliance Costs	$18,000	$17,900	$19,300	$20,900	$390,000	$216,600
Fuel Savings [a]	−43,100	−90,400	−125,000	−167,000	−1,677,600	−746,100
Quantified Annual Costs	−25,100	−72,500	−105,700	−146,100	−1,287,600	−529,500

[a] Calculated using pre-tax fuel prices.

Table III.H.10–2 presents estimated annual societal 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 a 3 percent and a 7 percent discount rate. The table shows the benefits of reduced GHG emissions—and consequently the annual quantified benefits (*i.e.,* total benefits)—for each of five interim SCC values considered by EPA. As discussed in Section III.H.6, there is a very high probability (*very likely* according to the IPCC) that the benefit estimates from GHG reductions are underestimates. One of the primary reasons is that models used to calculate SCC values do not include information about impacts that have not been quantified.

In addition, the total GHG reduction benefits presented below likely underestimate the value of GHG reductions because they were calculated using the marginal values for CO_2 emissions. The impacts of non-CO_2 emissions vary from those of CO_2 emissions because of differences in atmospheric lifetimes and radiative forcing.[406] As a result, the marginal benefit values of non-CO_2 GHG reductions and their growth rates over time will not be the same as the marginal benefits measured on a CO_2-equivalent scale.[407] Marginal benefit estimates per metric ton of non-CO_2 GHGs are currently unavailable, but work is on-going to monetize benefits related to the mitigation of other non-CO_2 GHGs.

TABLE III.H.10–2—ESTIMATED SOCIETAL BENEFITS ASSOCIATED WITH THE PROPOSED LIGHT-DUTY VEHICLE GHG PROGRAM

[Millions of 2007 dollars]

Benefits	2020	2030	2040	2050	NPV, 3%	NPV, 7%
Reduced GHG Emissions at each assumed SCC value						
SCC 5%	$1,200	$3,300	$5,700	$9,500	$69,200	$28,600
SCC 5% Newell-Pizer	2,500	6,600	11,000	19,000	138,400	57,100
SCC from 3% and 5%	4,700	12,000	22,000	36,000	263,000	108,500
SCC 3%	8,200	22,000	38,000	63,000	456,900	188,500
SCC 3% Newell-Pizer	14,000	36,000	63,000	100,000	761,400	314,200
$PM_{2.5}$ Related Benefits [a b c]	1,400	3,000	4,600	6,700	59,800	26,300
Energy Security Impacts (price shock)	2,300	4,800	6,200	7,800	85,800	38,800
Reduced Refueling	2,500	4,900	6,400	8,000	89,600	41,000
Value of Increased Driving [d]	4,900	10,000	13,600	18,000	184,700	82,700
Accidents, Noise, Congestion	−2,400	−4,900	−6,300	−7,900	−88,200	−40,200
Quantified Annual Benefits at each assumed SCC value						
SCC 5%	$9,900	$21,100	$30,200	$42,100	$400,900	$177,200
SCC 5% Newell-Pizer	11,200	24,400	35,500	51,600	470,100	205,700
SCC from 3% and 5%	13,400	29,800	46,500	68,600	594,700	257,100
SCC 3%	16,900	39,800	62,500	95,600	788,600	337,100
SCC 3% Newell-Pizer	22,700	53,800	87,500	132,600	1,093,100	462,800

[a] Note that the co-pollutant impacts associated with the standards presented here do not include the full complement of endpoints that, if quantified and monetized, would change the total monetized estimate of rule-related impacts. Instead, the co-pollutant benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in $PM_{2.5}$ exposure. Ideally, human health and environmental benefits would be based on changes in ambient $PM_{2.5}$ and ozone as determined by full-scale air quality modeling. However, EPA was unable to conduct a full-scale air quality modeling analysis in time for the proposal. We intend to more fully capture the co-pollutant benefits for the analysis of the final standards.

[406] Radiative forcing is the change in the balance between solar radiation entering the atmosphere and the Earth's radiation going out. On average, a positive radiative forcing tends to warm the surface of the Earth while negative forcing tends to cool the surface. Greenhouse gases have a positive radiative forcing because they absorb and emit heat. *See http://www.epa.gov/climatechange/science/recentac.html* for more general information about GHGs and climate science.

[407] *See* IPCC WGII, 2007 for discussion about implications of different marginal impacts among the GHGs.

[b] The $PM_{2.5}$-related benefits (derived from benefit-per-ton values) presented in this table are based on an estimate of premature mortality derived from the ACS study (Pope *et al.*, 2002). If the benefit-per-ton estimates were based on the Six Cities study (Laden *et al.,* 2006), the values would be approximately 145% (nearly two-and-a-half times) larger.

[c] The $PM_{2.5}$-related benefits (derived from benefit-per-ton values) presented in this table assume a 3% discount rate in the valuation of premature mortality to account for a twenty-year segmented cessation lag. If a 7% discount rate had been used, the values would be approximately 9% lower.

[d] Calculated using pre-tax fuel prices.

Table III.H.10–3 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 a 3 percent and a 7 percent discount rate. The table includes the benefits of reduced GHG emissions—and consequently the annual net benefits—for each of five interim SCC values considered by EPA. As noted above, there is a very high probability (*very likely* according to the IPCC) that the benefit estimates from GHG reductions are underestimates because, in part, models used to calculate SCC values do not include information about impacts that have not been quantified.

TABLE III.H.10–3—QUANTIFIED NET BENEFITS ASSOCIATED WITH THE PROPOSED LIGHT-DUTY VEHICLE GHG PROGRAM [a] [b]

[Millions of 2007 dollars]

	2020	2030	2040	2050	NPV, 3%	NPV, 7%
Quantified Annual Costs	−$25,100	−$72,500	−$105,700	−$146,100	−$1,287,600	−$529,500
Quantified Annual Benefits at each assumed SCC value						
SCC 5%	$9,900	$21,100	$30,200	$42,100	$400,900	$177,200
SCC 5% Newell-Pizer	11,200	24,400	35,500	51,600	470,100	205,700
SCC from 3% and 5%	13,400	29,800	46,500	68,600	594,700	257,100
SCC 3%	16,900	39,800	62,500	95,600	788,600	337,100
SCC 3% Newell-Pizer	22,700	53,800	87,500	132,600	1,093,100	462,800
Quantified Net Benefits at each assumed SCC value						
SCC 5%	$35,000	$93,600	$135,900	$188,200	$1,688,500	$706,700
SCC 5% Newell-Pizer	36,300	96,900	141,200	197,700	1,757,700	735,200
SCC from 3% and 5%	38,500	102,300	152,200	214,700	1,882,300	786,600
SCC 3%	42,000	112,300	168,200	241,700	2,076,200	866,600
SCC 3% Newell-Pizer	47,800	126,300	193,200	278,700	2,380,700	992,300

[a] Note that the co-pollutant impacts associated with the standards presented here do not include the full complement of endpoints that, if quantified and monetized, would change the total monetized estimate of rule-related impacts. Instead, the co-pollutant benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in $PM_{2.5}$ exposure. Ideally, human health and environmental benefits would be based on changes in ambient $PM_{2.5}$ and ozone as determined by full-scale air quality modeling. However, EPA was unable to conduct a full-scale air quality modeling analysis in time for the proposal. We intend to more fully capture the co-pollutant benefits for the analysis of the final standards.

[b] Fuel impacts were calculated using pre-tax fuel prices.

EPA also conducted a separate analysis of the total benefits over the model year lifetimes of the 2012 through 2016 model year vehicles. In contrast to the calendar year analysis, the model year lifetime analysis shows the lifetime impacts of the program on each of these MY fleets over the course of its lifetime. Full details of the inputs to this analysis can be found in DRIA Chapter 5. The societal benefits of the full life of each of the five model years from 2012 through 2016 are shown in Tables III.H.10–4 and III.H.10–5 at both a 3 percent and a 7 percent discount rate, respectively. The net benefits are shown in Tables III.H.10–6 and III.H.10–7 for both a 3 percent and a 7 percent discount rate. Note that the quantified annual benefits shown in Table III.H.10–4 and Table III.H.10–5 include fuel savings as a positive benefit. As such, the quantified annual costs as shown in Table III.H.10–6 and Table III.H.10–7 do not include fuel savings since those are included as benefits. Also note that each of the Tables III.H.10–4 through Table III.H.10–7 include the benefits of reduced CO_2 emissions—and consequently the total benefits—for each of five interim SCC values considered by EPA. As noted above, there is a very high probability (*very likely* according to the IPCC) that the benefit estimates from GHG reductions are underestimates because, in part, models used to calculate SCC values do not include information about impacts that have not been quantified.

TABLE III.H.10–4—ESTIMATED SOCIETAL BENEFITS ASSOCIATED WITH THE PROPOSED LIGHT-DUTY VEHICLE GHG PROGRAM, MODEL YEAR ANALYSIS

[Millions of 2007 dollars; 3% discount rate]

Monetized values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Cost of Noise, Accident, Congestion ($)	−$900	−$1,400	−$1,900	−$2,800	−$3,900	−$11,000
Pretax Fuel Savings ($)	$15,600	$24,400	$34,800	$49,800	$68,500	$193,300
Energy Security (price shock) ($)	$400	$600	$900	$1,200	$1,600	$4,700
Change in no. of Refuelings (#)	500	700	1,000	1,300	1,800	5,300
Change in Refueling Time (hours)	0	100	100	100	200	400

TABLE III.H.10–4—ESTIMATED SOCIETAL BENEFITS ASSOCIATED WITH THE PROPOSED LIGHT-DUTY VEHICLE GHG PROGRAM, MODEL YEAR ANALYSIS—Continued

[Millions of 2007 dollars; 3% discount rate]

Monetized values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Value of Reduced Refueling Time ($)	$900	$1,400	$1,900	$2,700	$3,700	$10,500
Value of Additional Driving ($)	$2,000	$3,000	$4,100	$5,700	$7,900	$22,700
Value of $PM_{2.5}$-related Health Impacts ($) [a b c]	$600	$900	$1,200	$1,700	$2,200	$6,600
Social Cost of Carbon (SCC) at each assumed SCC value						
SCC 5%	$500	$700	$1,000	$1,400	$1,900	$5,600
SCC 5% Newell-Pizer	1,000	1,500	2,000	2,900	3,800	11,000
SCC from 3% and 5%	1,800	2,800	3,900	5,400	7,200	21,000
SCC 3%	3,200	4,800	6,700	9,400	13,000	37,000
SCC 3% Newell-Pizer	5,300	8,100	11,000	16,000	21,000	61,000
Total Benefits at each assumed SCC value						
SCC 5%	$19,100	$29,600	$42,000	$59,700	$81,900	$232,400
SCC 5% Newell-Pizer	19,600	30,400	43,000	61,200	83,800	237,800
SCC from 3% and 5%	20,400	31,700	44,900	63,700	87,200	247,800
SCC 3%	21,800	33,700	47,700	67,700	93,000	263,800
SCC 3% Newell-Pizer	23,900	37,000	52,000	74,300	101,000	287,800

[a] Note that the co-pollutant impacts associated with the standards presented here do not include the full complement of endpoints that, if quantified and monetized, would change the total monetized estimate of rule-related impacts. Instead, the co-pollutant benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in $PM_{2.5}$ exposure. Ideally, human health and environmental benefits would be based on changes in ambient $PM_{2.5}$ and ozone as determined by full-scale air quality modeling. However, EPA was unable to conduct a full-scale air quality modeling analysis in time for the proposal. We intend to more fully capture the co-pollutant benefits for the analysis of the final standards.

[b] The $PM_{2.5}$-related benefits (derived from benefit-per-ton values) presented in this table are based on an estimate of premature mortality derived from the ACS study (Pope *et al.,* 2002). If the benefit-per-ton estimates were based on the Six Cities study (Laden *et al.,* 2006), the values would be approximately 145% (nearly two-and-a-half times) larger.

[c] The $PM_{2.5}$-related benefits (derived from benefit-per-ton values) presented in this table assume a 3% discount rate in the valuation of premature mortality to account for a twenty-year segmented cessation lag. If a 7% discount rate had been used, the values would be approximately 9% lower.

TABLE III.H.10–5—ESTIMATED SOCIETAL BENEFITS ASSOCIATED WITH THE PROPOSED LIGHT-DUTY VEHICLE GHG PROGRAM, MODEL YEAR ANALYSIS

[Millions of 2007 dollars; 7% discount rate]

Monetized values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Cost of Noise, Accident, Congestion ($)	−$700	−$1,100	−$1,500	−$2,200	−$3,100	−$8,700
Pretax Fuel Savings ($)	$12,100	$19,000	$27,200	$39,000	$53,700	$150,900
Energy Security (price shock) ($)	$300	$500	$700	$900	$1,300	$3,700
Change in no. of Refuelings (#)	400	500	800	1,100	1,500	4,200
Change in Refueling Time (hours)	0	0	100	100	100	300
Value of Reduced Refueling Time ($)	$700	$1,100	$1,500	$2,100	$2,900	$8,300
Value of Additional Driving ($)	$1,500	$2,400	$3,200	$4,500	$6,300	$18,000
Value of $PM_{2.5}$-related Health Impacts ($) [a b c]	$500	$700	$1,000	$1,300	$1,800	$5,300
Social Cost of Carbon (SCC) at each assumed SCC value						
SCC 5%	$400	$500	$700	$1,000	$1,300	$3,900
SCC 5% Newell-Pizer	700	1,100	1,500	2,000	2,500	7,700
SCC from 3% and 5%	1,400	2,100	2,800	3,700	4,800	15,000
SCC 3%	2,400	3,600	4,800	6,500	8,300	26,000
SCC 3% Newell-Pizer	4,000	6,000	8,000	11,000	14,000	43,000
Total Benefits at each assumed SCC value						
SCC 5%	$14,800	$23,100	$32,800	$46,600	$64,200	$181,400
SCC 5% Newell-Pizer	15,100	23,700	33,600	47,600	65,400	185,200
SCC from 3% and 5%	15,800	24,700	34,900	49,300	67,700	192,500
SCC 3%	16,800	26,200	36,900	52,100	71,200	203,500
SCC 3% Newell-Pizer	18,400	28,600	40,100	56,600	76,900	220,500

[a] Note that the co-pollutant impacts associated with the standards presented here do not include the full complement of endpoints that, if quantified and monetized, would change the total monetized estimate of rule-related impacts. Instead, the co-pollutant benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in $PM_{2.5}$ exposure. Ideally, human health and environmental benefits would be based on changes in ambient $PM_{2.5}$ and ozone as determined by full-scale air quality modeling. However, EPA was unable to conduct a full-scale air quality modeling analysis in time for the proposal. We intend to more fully capture the co-pollutant benefits for the analysis of the final standards.

[b] The $PM_{2.5}$-related benefits (derived from benefit-per-ton values) presented in this table are based on an estimate of premature mortality derived from the ACS study (Pope *et al.,* 2002). If the benefit-per-ton estimates were based on the Six Cities study (Laden *et al.,* 2006), the values would be approximately 145% (nearly two-and-a-half times) larger.

[c] The $PM_{2.5}$-related benefits (derived from benefit-per-ton values) presented in this table assume a 3% discount rate in the valuation of premature mortality to account for a twenty-year segmented cessation lag. If a 7% discount rate had been used, the values would be approximately 9% lower.

TABLE III.H.10–6—QUANTIFIED NET BENEFITS ASSOCIATED WITH THE PROPOSED LIGHT-DUTY VEHICLE GHG PROGRAM, MODEL YEAR ANALYSIS [a]

[millions of 2007 dollars; 3% discount rate]

Monetized values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Quantified Annual Costs (excluding fuel savings) [b]	$5,400	$8,400	$10,900	$13,900	$17,500	$56,100
Quantified Annual Benefits at each assumed SCC value						
SCC 5%	$19,100	$29,600	$42,000	$59,700	$81,900	$232,400
SCC 5% Newell-Pizer	19,600	30,400	43,000	61,200	83,800	237,800
SCC from 3% and 5%	20,400	31,700	44,900	63,700	87,200	247,800
SCC 3%	21,800	33,700	47,700	67,700	93,000	263,800
SCC 3% Newell-Pizer	23,900	37,000	52,000	74,300	101,000	287,800
Quantified Net Benefits at each assumed SCC value						
SCC 5%	$13,700	$21,200	$31,100	$45,800	$64,400	$176,300
SCC 5% Newell-Pizer	14,200	22,000	32,100	47,300	66,300	181,700
SCC from 3% and 5%	15,000	23,300	34,000	49,800	69,700	191,700
SCC 3%	16,400	25,300	36,800	53,800	75,500	207,700
SCC 3% Newell-Pizer	18,500	28,600	41,100	60,400	83,500	231,700

[a] Note that the co-pollutant impacts associated with the standards presented here do not include the full complement of endpoints that, if quantified and monetized, would change the total monetized estimate of rule-related impacts. Instead, the co-pollutant benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in PM2.5 exposure. Ideally, human health and environmental benefits would be based on changes in ambient PM2.5 and ozone as determined by full-scale air quality modeling. However, EPA was unable to conduct a full-scale air quality modeling analysis in time for the proposal. We intend to more fully capture the co-pollutant benefits for the analysis of the final standards.

[b] Quantified annual costs as shown here are the increased costs for new vehicles in each given model year. Since those costs are assumed to occur in the given model year (*i.e.,* not over a several year time span), the discount rate does not affect the costs.

TABLE III.H.10–7—QUANTIFIED NET BENEFITS ASSOCIATED WITH THE PROPOSED LIGHT-DUTY VEHICLE GHG PROGRAM, MODEL YEAR ANALYSIS [a]

[millions of 2007 dollars; 7% Discount Rate]

Monetized values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Quantified Annual Costs (excluding fuel savings) [b]	$5,400	$8,400	$10,900	$13,900	$17,500	$56,100
Quantified Annual Benefits at each assumed SCC value						
SCC 5%	$14,800	$23,100	$32,800	$46,600	$64,200	$181,400
SCC 5% Newell-Pizer	15,100	23,700	33,600	47,600	65,400	185,200
SCC from 3% and 5%	15,800	24,700	34,900	49,300	67,700	192,500
SCC 3%	16,800	26,200	36,900	52,100	71,200	203,500
SCC 3% Newell-Pizer	18,400	28,600	40,100	56,600	76,900	220,500
Quantified Net Benefits at each assumed SCC value						
SCC 5%	$9,400	$14,700	$21,900	$32,700	$46,700	$125,300
SCC 5% Newell-Pizer	9,700	15,300	22,700	33,700	47,900	129,100
SCC from 3% and 5%	10,400	16,300	24,000	35,400	50,200	136,400
SCC 3%	11,400	17,800	26,000	38,200	53,700	147,400
SCC 3% Newell-Pizer	13,000	20,200	29,200	42,700	59,400	164,400

[a] Note that the co-pollutant impacts associated with the standards presented here do not include the full complement of endpoints that, if quantified and monetized, would change the total monetized estimate of rule-related impacts. Instead, the co-pollutant benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in PM2.5 exposure. Ideally, human health and environmental benefits would be based on changes in ambient PM2.5 and ozone as determined by full-scale air quality modeling. However, EPA was unable to conduct a full-scale air quality modeling analysis in time for the proposal. We intend to more fully capture the co-pollutant benefits for the analysis of the final standards.

[b] Quantified annual costs as shown here are the increased costs for new vehicles in each given model year. Since those costs are assumed to occur in the given model year (*i.e.,* not over a several year time span), the discount rate does not affect the costs.

I. Statutory and Executive Order Reviews

1. Executive Order 12866: Regulatory Planning and Review

Under section 3(f)(1) of Executive Order (EO) 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, EPA submitted this action to the Office of Management and Budget (OMB) for review under EO 12866 and any changes made in response to OMB recommendations have been documented in the docket for this action.

In addition, EPA 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 rulemaking and at the docket Internet address listed under **ADDRESSES** above.

2. Paperwork Reduction Act

The information collection requirements in this proposed rule have been submitted for approval to the Office of Management and Budget (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 0783.56.

The Agency proposes to collect information to ensure compliance with the provisions in this rule. This includes a variety of requirements for vehicle manufacturers. Section 208(a) of the Clean Air Act 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 Clean Air Act.

As shown in Table III.J.2–1, the total annual burden associated with this proposal is about 39,900 hours and $5 million, based on a projection of 33 respondents. The estimated burden for vehicle manufacturers is a total estimate for both new and existing 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 III.J.2–1 ESTIMATED BURDEN FOR REPORTING AND RECORDKEEPING REQUIREMENTS

Number of respondents	Annual burden hours	Annual costs
33	39,940	$5,001,000

An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9.

To comment on the Agency's need 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 rule, which includes this ICR, under Docket ID number EPA–HQ–OAR–2007–0491. Submit any comments related to the ICR for this proposed rule to EPA and OMB. *See* **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 September 28, 2009, a comment to OMB is best assured of having its full effect if OMB receives it by October 28, 2009. The final rule will respond to any OMB or public comments on the information collection requirements contained in this proposal.

3. Regulatory Flexibility Act

a. Overview

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of this rule on small entities, small entity is defined as: (1) A small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201 (see table below); (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

Table III.J.3–1 provides an overview of the primary SBA small business categories included in the light-duty vehicle sector:

TABLE III.J.3—1 PRIMARY SBA SMALL BUSINESS CATEGORIES IN THE LIGHT-DUTY VEHICLE SECTOR

Industry [a]	Defined as small entity by SBA if less than or equal to:	NAICS codes [b]
Light-duty vehicles:		
—Vehicle manufacturers (*including small volume manufacturers*).	1,000 employees	336111

TABLE III.J.3—1 PRIMARY SBA SMALL BUSINESS CATEGORIES IN THE LIGHT-DUTY VEHICLE SECTOR—Continued

Industry [a]	Defined as small entity by SBA if less than or equal to:	NAICS codes [b]
—Independent commercial importers	$7 million annual sales	811111, 811112, 811198
	$23 million annual sales	441120
	100 employees	423110, 424990
—Alternative fuel vehicle converters	750 employees	336312, 336322, 336399
	1,000 employees	335312
	$7 million annual sales	454312, 485310, 811198

Notes:
[a] Light-duty vehicle entities that qualify as small businesses would not be subject to this proposed rule. 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

EPA has not conducted a Regulatory Flexibility Analysis or a SBREFA SBAR Panel for the proposed rule because we are proposing to certify that the rule would not have a significant economic impact on a substantial number of small entities. EPA is 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 proposed rule, the extremely small 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). EPA would instead consider appropriate GHG standards for these entities as part of a future regulatory action. This includes small entities in three distinct categories of businesses for light-duty vehicles: Small volume manufacturers (SVMs), independent commercial importers (ICIs), and alternative fuel vehicle converters. Based on preliminary assessment, EPA has identified a total of about 47 vehicle businesses, about 13 entities (or 28 percent) that fit the Small Business Administration (SBA) criterion of a small business. There are about 2 SVMs, 8 ICIs, and 3 alternative fuel vehicle converters in the light-duty vehicle market which are small businesses (no major vehicle manufacturers meet the small-entity criteria as defined by SBA). EPA estimates that these small entities comprise about 0.03 percent of the total light-duty vehicle sales in the U.S. for the year 2007, and therefore the proposed deferment will have a negligible impact on the GHG emissions reductions from the proposed standards.

To ensure that EPA is aware of which companies would be deferred, EPA is proposing that such entities submit a declaration to EPA containing a detailed written description of how that manufacturer qualifies as a small entity under the provisions of 13 CFR 121.201. Small 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 light-duty vehicles and light-duty trucks, absent such a declaration, EPA would assume that the entity was subject to the greenhouse gas control requirements in this GHG proposal. The declaration would need to be submitted at time of vehicle emissions certification under the EPA Tier 2 program. EPA expects that the additional paperwork burden associated with completing and submitting a small entity declaration to gain deferral from the proposed GHG standards would be negligible and easily done in the context of other routine submittals to EPA. However, EPA has 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 III.I.2. Based on this, EPA is proposing to certify that the rule would not have a significant economic impact on a substantial number of small entities.

c. Conclusions

I therefore certify that this proposed rule will not have a significant economic impact on a substantial number of small entities. However, EPA recognizes that some small entities continue to be concerned about the potential impacts of the statutory imposition of PSD requirements that may occur given the various EPA rulemakings currently under consideration concerning greenhouse gas emissions. As explained in the preamble for the proposed PSD tailoring rule, EPA is using the discretion afforded to it under section 609(c) of the RFA to consult with OMB and SBA, with input from outreach to small entities, regarding the potential impacts of PSD regulatory requirements as that might occur as EPA considers regulations of GHGs. Concerns about the potential impacts of statutorily imposed PSD requirements on small entities will be the subject of deliberations in that consultation and outreach. Concerned small entities should direct any comments relating to potential adverse economic impacts on small entities from PSD requirements for GHG emissions to the docket for the PSD tailoring rule.

EPA continues to be interested in the potential impacts of the proposed rule on small entities and welcomes comments on issues related to such impacts.

4. 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, EPA 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 an EPA rule for which a written statement is needed, section 205 of the UMRA generally requires EPA 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 EPA to adopt an alternative other than the least costly, most cost-effective or least burdensome alternative if the Administrator publishes with the final rule an explanation why that alternative was not adopted.

Before EPA establishes any regulatory requirements that may significantly or uniquely affect small governments, including tribal governments, it 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 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 rule imposes no enforceable duty on any State, local or tribal governments. EPA has determined that this rule contains no regulatory requirements that might significantly or uniquely affect small governments. EPA has determined that this proposal contains a Federal mandate that may result in expenditures of $100 million or more for the private sector in any one year. EPA believes that the proposal represents the least costly, most cost-effective approach to achieve the statutory requirements of the rule. The costs and benefits associated with the proposal are discussed above and in the Draft Regulatory Impact Analysis, as required by the UMRA.

5. 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 rulemaking 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, EPA did consult with representatives of State governments in developing this action.

In the spirit of Executive Order 13132, and consistent with EPA policy to promote communications between EPA and State and local governments, EPA specifically solicits comment on this proposed action from State and local officials.

6. Executive Order 13175 (Consultation and Coordination With Indian Tribal Governments)

This proposed rule does not have tribal implications, as specified in Executive Order 13175 (65 FR 67249, November 9, 2000). This rule 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 rule. EPA specifically solicits additional comment on this proposed rule from tribal officials.

7. Executive Order 13045: ''Protection of Children From Environmental Health Risks and Safety Risks''

This action is subject to EO 13045 (62 FR 19885, April 23, 1997) because it is an economically significant regulatory action as defined by EO 12866, and EPA believes 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 proposed rule.[408] 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 has determined that severe heat waves are projected to intensify in magnitude, frequency, and duration over the portions of the U.S. 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 III.F). Children may receive benefits from reductions in GHG emissions because they are included in the segment of the population that is most vulnerable to hot 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 U.S. 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 proposed rule.

8. Executive Order 13211 (Energy Effects)

This rule 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 rule has a positive effect on energy supply and use. Because the GHG emission standards proposed today result in significant fuel savings, this rule encourages more efficient use of fuels. Therefore, we have concluded that this rule is not likely to have any adverse energy effects. Our energy effects analysis is described above in Section III.H.

9. 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 EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent

[408] U.S. EPA. (2009). Technical Support Document for Endangerment or Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act. Washington, DC: U.S. EPA. Retrieved on April 21, 2009 from *http://epa.gov/climatechange/endangerment/downloads/TSD_Endangerment.pdf.*

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 EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

For CO_2, N_2O, and CH_4 emissions, EPA is proposing to collect data over the same tests that are used for the CAFE program. This will minimize the amount of testing done by manufacturers, since manufacturers are already required to run these tests. For A/C credits, EPA is proposing to use a consensus methodology developed by the Society of Automotive Engineers (SAE) and also a new A/C idle test. EPA knows of no consensus standard available for the A/C idle test.

10. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order (EO) 12898 (59 FR 7629 (Feb. 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.

With respect to GHG emissions, EPA has determined that this proposed rule 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 proposed standards will affect climate change projections, and EPA has estimated reductions in projected global mean surface temperatures (Section III.F.3). 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. [409] Therefore, these 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 proposed rule.

J. Statutory Provisions and Legal Authority

Statutory authority for the vehicle controls proposed today is found in 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), 202 (d), 203–209, 216, and 301 of the Clean Air Act, 42 U.S.C. 7521 (a), 7521 (d), 7522, 7523, 7524, 7525, 7541, 7542, 7543, 7550, and 7601.

IV. NHTSA Proposal for Passenger Car and Light Truck CAFE Standards for MYs 2012–2016

A. Executive Overview of NHTSA Proposal

1. Introduction

The National Highway Traffic Safety Administration (NHTSA) is proposing to establish corporate average fuel economy standards for passenger automobiles (passenger cars) and nonpassenger automobiles (light trucks) for model years (MY) 2012–2016. Improving vehicle fuel economy has been long and widely recognized as one of the key ways of achieving energy independence, energy security, and a low carbon economy.[410] NHTSA's proposed standards will require passenger cars and light trucks to meet an estimated combined average of 34.1 mpg in MY 2016. This represents an average annual increase of 4.3 percent from the 27.3 mpg combined fuel economy level in MY 2011. NHTSA's proposal projects total fuel savings of approximately 61.6 billion gallons over the lifetimes of the vehicles sold in model years 2012–2016, with corresponding net societal benefits of approximately $201.7 billion.

The significance accorded improving fuel economy reflects several factors. Conserving energy, especially reducing the nation's dependence on petroleum, benefits the U.S. in several ways. Improving energy efficiency has benefits for economic growth and the environment, as well as other benefits, such as reducing pollution and improving security of energy supply. More specifically, reducing total petroleum use decreases our economy's vulnerability to oil price shocks. Reducing dependence on oil imports from regions with uncertain conditions enhances our energy security. Additionally, the emission of CO_2 from the tailpipes of cars and light trucks is one of the largest sources of U.S. CO_2 emissions.[411] Using vehicle technology to improve fuel economy, and thereby reducing tailpipe emissions of CO_2, is one of the three main measures of reducing those tailpipe emissions of CO_2.[412] The two other measures for

[409] U.S. EPA. (2009). Technical Support Document for Endangerment or Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act. Washington, DC: U.S. EPA. Retrieved on April 21, 2009 from *http://epa.gov/climatechange/endangerment/downloads/TSD_Endangerment.pdf.*

[410] Among the reports and studies noting this point are the following:

John Podesta, Todd Stern and Kim Batten, ''Capturing the Energy Opportunity; Creating a Low-Carbon Economy,'' Center for American Progress (November 2007), pp. 2, 6, 8, and 24–29, *available at: http://www.americanprogress.org/issues/2007/11/pdf/energy_chapter.pdf* (last accessed August 9, 2009).

Sarah Ladislaw, Kathryn Zyla, Jonathan Pershing, Frank Verrastro, Jenna Goodward, David Pumphrey, and Britt Staley, ''A Roadmap for a Secure, Low-Carbon Energy Economy; Balancing Energy Security and Climate Change,'' World Resources Institute and Center for Strategic and International Studies (January 2009), pp. 21–22; *available at: http://pdf.wri.org/secure_low_carbon_energy_economy_roadmap.pdf* (last accessed August 9, 2009).

Alliance to Save Energy et al., ''Reducing the Cost of Addressing Climate Change Through Energy Efficiency (2009), *available at: http://Aceee.org/energy/climate/leg.htm* (last accessed August 9, 2009).

John DeCicco and Freda Fung, ''Global Warming on the Road; The Climate Impact of America's Automobiles,'' Environmental Defense (2006) pp. iv-vii; *available at: http://www.edf.org/documents/5301_Globalwarmingontheroad.pdf* (last accessed August 9, 2009).

''Why is Fuel Economy Important?,'' a Web page maintained by the Department of Energy and Environmental Protection Agency, *available at http://www.fueleconomy.gov/feg/why.shtml* (last accessed August 9, 2009);

Robert Socolow, Roberta Hotinski, Jeffery B. Greenblatt, and Stephen Pacala, ''Solving the Climate Problem: Technologies Available to Curb CO_2 Emissions,'' *Environment,* volume 46, no. 10, 2004. Pages 8–19, *available at: http://www.princeton.edu/~cmi/resources/CMI_Resources_new_files/Environ_08-21a.pdf* (last accessed August 9, 2009).

[411] EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990—2006 (April 2008), pp. ES–4, ES–8, and 2–24. *Available at http://www.epa.gov/climatechange/emissions/usgginv_archive.html* (last accessed August 9, 2009).

[412] Podesta *et al.,* p. 25; Ladislaw *et al.* p. 21; DeCicco *et al.* p. vii; ''Reduce Climate Change,'' a Web page maintained by the Department of Energy and Environmental Protection Agency at *http://www.fueleconomy.gov/feg/climate.shtml* (last accessed August 9, 2009).

reducing the tailpipe emissions of CO_2 are switching to vehicle fuels with lower carbon content and changing driver behavior, *i.e.,* inducing people to drive less.

While NHTSA has been setting fuel economy standards since the 1970s, today's action represents the first-ever joint proposal by NHTSA with another agency, the Environmental Protection Agency. As discussed in Section I, NHTSA's proposed MYs 2012–2016 CAFE standards are part of a joint National Program, such that a large majority of the projected benefits are achieved jointly with EPA's GHG rule, described in detail above in Section III of this preamble. These proposed CAFE standards are consistent with the President's National Fuel Efficiency Policy announcement of May 19, 2009, which calls for harmonized rules for all automakers, instead of three overlapping and potentially inconsistent requirements from DOT, EPA, and the California Air Resources Board. And finally, the proposed CAFE standards and the analysis supporting them also respond to President's Obama's January 26 memorandum regarding the setting of CAFE standards for model years 2011 and beyond.

2. Role of Fuel Economy Improvements in Promoting Energy Independence, Energy Security, and a Low Carbon Economy

The need to reduce energy consumption is more crucial today than it was when EPCA was enacted in the mid-1970s. U.S. energy consumption has been outstripping U.S. energy production at an increasing rate. Net petroleum imports now account for approximately 57 percent of U.S. domestic petroleum consumption, and the share of U.S. oil consumption for transportation is approximately 71 percent.[413] Moreover, world crude oil production continues to be highly concentrated, exacerbating the risks of supply disruptions and their negative effects on both the U.S. and global economies.

Gasoline consumption in the U.S. has historically been relatively insensitive to fluctuations in both price and consumer income, and people in most parts of the country tend to view gasoline consumption as a non-discretionary expense. Thus, when gasoline's share in consumer expenditures rises, the public experiences fiscal distress. This fiscal distress can, in some cases, have macroeconomic consequences for the economy at large. Additionally, since U.S. oil production is only affected by fluctuations in prices over a period of years, any changes in petroleum consumption (as through increased fuel economy) largely flow into changes in the quantity of imports. Although petroleum imports only account for about 2 percent of GDP, they are large enough to create a discernible fiscal drag. As a consequence, however, measures that reduce petroleum consumption, such as fuel economy standards, will flow directly into the balance-of-payments account, and strengthen the domestic economy to some degree. And finally, U.S. foreign policy has been affected for decades by rising U.S. and world dependency of crude oil as the basis for modern transportation systems, although fuel economy standards have only an indirect and general impact on U.S. foreign policy.

The benefits of a low carbon economy are manifold. The U.S. transportation sector is a significant contributor to total U.S. and global anthropogenic emissions of greenhouse gases. Motor vehicles are the second largest greenhouse gas-emitting sector in the U.S., after electricity generation, and accounted for 24 percent of total U.S. greenhouse gas emissions in 2006. Concentrations of greenhouse gases are at unprecedented levels compared to the recent and distant past, which means that fuel economy improvements to reduce those emissions are a crucial step toward addressing the risks of global climate change. These risks are well documented in section III of this notice.

3. The National Program

NHTSA and EPA are each announcing proposed rules that have the effect of addressing the urgent and closely intertwined challenges of energy independence and security and global warming. These proposed rules call for a strong and coordinated *Federal* greenhouse gas and fuel economy program for passenger cars, light-duty-trucks, and medium-duty passenger vehicles (hereafter light-duty vehicles), referred to as the National Program. The proposed rules represent a coordinated program that can achieve substantial reductions of greenhouse gas (GHG) emissions and improvements in fuel economy from the light-duty vehicle part of the transportation sector, based on technology that will be commercially available and that can be incorporated at a reasonable cost. The agencies' proposals will also provide regulatory certainty and consistency for the automobile industry by setting harmonized national standards. They were developed and are designed in ways that recognize and accommodate the serious current economic situation faced by this industry.

This joint notice is consistent with the President's announcement on May 19, 2009 of a National Fuel Efficiency Policy that will reduce greenhouse gas emissions and improve fuel economy for all new cars and light-duty trucks sold in the United States,[414] and with the Notice of Upcoming Joint Rulemaking signed by DOT and EPA on that date.[415] This joint notice also responds to the President's January 26, 2009 memorandum on CAFE standards for model years 2011 and beyond, the details of which can be found in Section IV of this joint notice.

a. Building Blocks of the National Program

The National Program is both needed and possible because the relationship between improving fuel economy and reducing CO_2 tailpipe emissions is a very direct and close one. CO_2 is the natural by-product of the combustion of fuel in motor vehicle engines. The more fuel efficient a vehicle is, the less fuel it burns to travel a given distance. The less fuel it burns, the less CO_2 it emits in traveling that distance.[416] Since the amount of CO_2 emissions is essentially constant per gallon combusted of a given type of fuel, the amount of fuel consumption per mile is directly related to the amount of CO_2 emissions per mile. In the real world, there is a single pool of technologies for reducing fuel consumption and CO_2 emissions. Using those technologies in the way that minimizes fuel consumption also minimizes CO_2 emissions. While there are emission control technologies that can capture or destroy the pollutants (*e.g.,* carbon monoxide) that are produced by imperfect combustion of fuel, there is at present no such technology for CO_2. In fact, the only way at present to reduce tailpipe emissions of CO_2 is by reducing fuel consumption. The National Program thus has dual benefits: It conserves energy by improving fuel economy, as required of NHTSA by EPCA and EISA; in the process, it necessarily reduces tailpipe

[413] Energy Information Administration, Petroleum Basic Statistics, updated July 2009. *Available at http://www.eia.doe.gov/basics/quickoil.html* (last accessed August 9, 2009).

[414] President Obama Announces National Fuel Efficiency Policy, The White House, May 19, 2009.

[415] 74 FR 24007 (May 22, 2009).

[416] Panel on Policy Implications of Greenhouse Warming, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, ''Policy Implications of Greenhouse Warming: Mitigation, Adaptation, and the Science Base,'' National Academies Press, 1992, at 287.

CO_2 emissions consonant with EPA's purposes and responsibilities under the Clean Air Act.

i. DOT's CAFE Program

In 1975, Congress enacted the Energy Policy and Conservation Act (EPCA), mandating a regulatory program for motor vehicle fuel economy to meet the various facets of the need to conserve energy, including ones having energy independence and security, environmental and foreign policy implications. EPCA allocates the responsibility for implementing the program between NHTSA and EPA as follows:

• NHTSA sets Corporate Average Fuel Economy (CAFE) standards for passenger cars and light trucks.

• Because fuel economy performance is measured during emissions regulation testing, EPA establishes the procedures for testing, tests vehicles, collects and analyzes manufacturers' test data, and calculates the average fuel economy of each manufacturer's passenger cars and light trucks. EPA determines fuel economy by the simple expedient of measuring the amount of CO_2 emitted from the tailpipe, not by attempting to measure directly the amount of fuel consumed during a vehicle test, a difficult task to accomplish with precision. EPA then uses the carbon content of the test fuel[417] to calculate the amount of fuel that had to be consumed per mile in order to produce that amount of CO_2. Finally, EPA converts that fuel consumption figure into a miles-per-gallon figure.

• Based on EPA's calculation, NHTSA enforces the CAFE standards.

The CAFE standards and compliance testing cannot capture all of the real world CO_2 emissions, because EPCA requires EPA to use the 1975 passenger car test procedures under which vehicle air conditioners are not turned on during fuel economy testing.[418] CAFE standards also do not address the 5–8 percent of GHG emissions that are not CO_2, *i.e.,* nitrous oxide (N_2O), and methane (CH_4) as well as emissions of CO_2 and hydrofluorocarbons (HFCs) related to operation of the air conditioning system.

NHTSA has been setting CAFE standards pursuant to EPCA since the enactment of the statute. Fuel economy gains since 1975, due both to the standards and market factors, have resulted in saving billions of barrels of oil and avoiding billions of metric tons of CO_2 emissions. In December 2007, Congress enacted the Energy Independence and Securities Act (EISA), amending EPCA to require, among other things, attribute-based standards for passenger cars and light trucks. The most recent CAFE rulemaking action was the issuance of standards governing model years 2011 cars and trucks.

ii. EPA's Greenhouse Gas Program

On April 2, 2007, the U.S. Supreme Court issued its opinion in *Massachusetts* v. *EPA,*[419] a case involving a 2003 order of the Environmental Protection Agency (EPA) denying a petition for rulemaking to regulate greenhouse gas emissions from motor vehicles under the Clean Air Act.[420] The Court ruled that greenhouse gases are ''pollutants'' under the CAA and that the Act therefore authorizes EPA to regulate greenhouse gas emissions from motor vehicles if that agency makes the necessary findings and determinations under section 202 of the Act. The Court considered EPCA only briefly, stating that the two obligations may overlap, but there is no reason to think the two agencies cannot both administer their obligations and yet avoid inconsistency.

EPA has been working on appropriate responses that are consistent with the decision of the Supreme Court in *Massachusetts* v. *EPA.*[421] As part of those responses, in July 2008, EPA issued an Advance Notice of Proposed Rulemaking seeking comments on the impact of greenhouse gases on the environment and on ways to reduce greenhouse gas emissions from motor vehicles. EPA recently also proposed to find that emissions of GHGs from new motor vehicles and motor vehicle engines cause or contribute to air pollution that may reasonably be anticipated to endanger public health and welfare.[422]

iii. California Air Resources Board's Greenhouse Gas Program

In 2004, the California Air Resources Board approved standards for new light-duty vehicles, which regulate the emission of not only CO_2, but also other GHGs. Since then, thirteen States and the District of Columbia, comprising approximately 40 percent of the light-duty vehicle market, have adopted California's standards. These standards apply to model years 2009 through 2016 and require reductions in CO2 emissions for passenger cars and some light trucks of 323 g/mil in 2009 up to 205 g/mi in 2016, and 439 g/mi for light trucks in 2009 up to 332 g/mi in 2016. In 2008, EPA denied a request by California for a waiver of preemption under the CAA for its GHG emissions standards. However, consistent with another Presidential Memorandum of January 26, 2009, EPA reconsidered the prior denial of California's request.[423] EPA withdrew the prior denial and granted California's request for a waiver on June 30, 2009.[424] The granting of the waiver permits California's emission standards to come into effect notwithstanding the general preemption of State emission standards for new motor vehicles that otherwise applies under the Clean Air Act.

b. The President's Announcement of National Fuel Efficiency Policy (May 2009)

The issue of three separate regulatory frameworks and overlapping requirements for reducing fuel consumption and CO_2 emissions has been a subject of much controversy and legal disputes. On May 19, 2009 President Obama announced a National Fuel Efficiency Policy aimed at both increasing fuel economy and reducing greenhouse gas pollution for all new cars and trucks sold in the United States, while also providing a predictable regulatory framework for the automotive industry. The policy seeks to set harmonized *Federal* standards to regulate both fuel economy and greenhouse gas emissions while preserving the legal authorities of the Department of Transportation, the Environmental Protection Agency and the State of California. The program covers model year 2012 to model year 2016 and ultimately requires the equivalent of an average fuel economy of 35.5 mpg in 2016, if all CO_2 reduction were achieved through fuel economy improvements. Building on the MY 2011 standard that was set in March 2009, this represents an average of 5 percent increase in average fuel economy each year between 2012 and 2016.

In conjunction with the President's announcement, the Department of Transportation and the Environmental Protection Agency issued on May 19, 2009, a Notice of Upcoming Joint

[417] This is the method that EPA uses to determine compliance with NHTSA's CAFE standards.

[418] *See* 49 U.S.C. 32904(c).

[419] 127 S.Ct. 1438 (2007).

[420] 68 FR 52922 (Sept. 8, 2003).

[421] 549 U.S. 497 (2007). For further information on *Massachusetts* v. *EPA* see the July 30, 2008 Advance Notice of Proposed Rulemaking, ''Regulating Greenhouse Gas Emissions under the Clean Air Act'', 73 FR 44354 at 44397. There is a comprehensive discussion of the litigation's history, the Supreme Court's findings, and subsequent actions undertaken by the EPA from 2007–2008 in response to the Supreme Court remand.

[422] 74 FR 18886 (Apr. 24, 2009).

[423] 74 FR 7040 (Feb. 12, 2009).

[424] 74 FR 32744 (July 8, 2009).

Rulemaking to propose a strong and coordinated fuel economy and greenhouse gas National Program for Model Year (MY) 2012–2016 light duty vehicles. Consistent, harmonized, and streamlined requirements under that program hold out the promise of delivering environmental and energy benefits, cost savings, and administrative efficiencies on a nationwide basis that might not be available under a less coordinated approach. The proposed National Program makes it possible for the standards of two different *Federal* agencies and the standards of California and other States to act in a unified fashion in providing these benefits. Establishing a harmonized approach to regulating light-duty vehicle greenhouse gas (GHG) emissions and fuel economy is critically important given the interdependent goals of addressing climate change and ensuring energy independence and security. Additionally, establishing a harmonized approach may help to mitigate the cost to manufacturers of having to comply with multiple sets of *Federal* and State standards

4. Review of CAFE Standard Setting Methodology per the President's January 26, 2009 Memorandum on CAFE Standards for MYs 2011 and Beyond

On May 2, 2008, NHTSA published a Notice of Proposed Rulemaking entitled Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011–2015, 73 Fed. Reg. 24352. In mid-October, the agency completed and released a final environmental impact statement in anticipation of issuing standards for those years. Based on its consideration of the public comments and other available information, including information on the financial condition of the automotive industry, the agency adjusted its analysis and the standards and prepared a final rule for MYs 2011–2015. On November 14, the Office of Information and Regulatory Affairs (OIRA) of the Office of Management and Budget concluded review of the rule as consistent with the Order.[425] However, issuance of the final rule was held in abeyance. On January 7, 2009, the Department of Transportation announced that the final rule would not be issued, saying:

The Bush Administration will not finalize its rulemaking on Corporate Fuel Economy Standards. The recent financial difficulties of the automobile industry will require the next administration to conduct a thorough review of matters affecting the industry, including how to effectively implement the Energy Independence and Security Act of 2007 (EISA). The National Highway Traffic Safety Administration has done significant work that will position the next Transportation Secretary to finalize a rule before the April 1, 2009 deadline.[426]

a. Requests in the President's Memorandum

In light of the requirement to prescribe standards for MY 2011 by March 30, 2009 and in order to provide additional time to consider issues concerning the analysis used to determine the appropriate level of standards for MYs 2012 and beyond, the President issued a memorandum on January 26, 2009, requesting the Secretary of Transportation and Administrator[427] of the National Highway Traffic Safety Administration NHTSA to divide the rulemaking into two parts: (1) MY 2011 standards, and (2) standards for MY 2012 and beyond.

i. CAFE Standards for Model Year 2011

The request that the final rule establishing CAFE standards for MY 2011 passenger cars and light trucks be prescribed by March 30, 2009 was based on several factors. One was the requirement that the final rule regarding fuel economy standards for a given model year must be adopted at least 18 months before the beginning of that model year (49 U.S.C. 32902(g)(2)). The other was that the beginning of MY 2011 is considered for the purposes of CAFE standard setting to be October 1, 2010.

ii. CAFE Standards for Model Years 2012 and Beyond

The President requested that, before promulgating a final rule concerning the model years after model year 2011, NHTSA

[C]onsider the appropriate legal factors under the EISA, the comments filed in response to the Notice of Proposed Rulemaking, the relevant technological and scientific considerations, and to the extent feasible, the forthcoming report by the National Academy of Sciences mandated under section 107 of EISA.

In addition, the President requested that NHTSA consider whether any provisions regarding preemption are appropriate under applicable law and policy.

b. Implementing the President's Memorandum

In keeping with the President's remarks on January 26 for new national policies to address the closely intertwined issues of energy independence, energy security and climate change, and for the initiation of serious and sustained domestic and international action to address them, NHTSA has developed CAFE standards for MY 2012 and beyond after collecting new information, conducting a careful review of technical and economic inputs and assumptions, and standard setting methodology, and completing new analyses.

The goal of the review and re-evaluation was to ensure that the approach used for MY 2012 and thereafter would produce standards that contribute, to the maximum extent possible under EPCA/EISA, to meeting the energy and environmental challenges and goals outlined by the President. We have sought to craft our program with the goal of creating the maximum incentives for innovation, providing flexibility to the regulated parties, and meeting the goal of making substantial and continuing reductions in the consumption of fuel. To that end, we have made every effort to ensure that the CAFE program for MYs 2012–2016 is based on the best scientific, technical, and economic information available, and that such information was developed in close coordination with other *Federal* agencies and our stakeholders, including the States and the vehicle manufacturers.

We have also re-examined EPCA, as amended by EISA, to consider whether additional opportunities exist to improve the effectiveness of the CAFE program. For example, EPCA authorizes increasing the amount of civil penalties for violating the CAFE standards.[428] Further, if the test procedures used for light trucks were revised to provide for the operation of air conditioning during fuel economy testing, vehicle manufacturers would have a regulatory incentive to increase the efficiency and reduce the weight of air conditioning systems, thereby reducing both fuel

[425] Record of OIRA's action can be found at *http://www.reginfo.gov/public/do/eoHistReviewSearch* (last accessed August 9, 2009). To find the report on the clearance of the draft final rule, select ''Department of Transportation'' under ''Economically Significant Reviews Completed'' and select ''2008'' under ''Select Calendar Year.''

[426] The statement can be found at *http://www.dot.gov/affairs/dot0109.htm* (last accessed August 9, 2009).

[427] Currently, the National Highway Traffic Safety Administration does not have an Administrator. Ronald L. Medford is the Acting Deputy Administrator.

[428] Under 49 U.S.C. 32904(c), EPA must use the same procedures for passenger automobiles that the Administrator used for model year 1975 (weighted 55 percent urban cycle and 45 percent highway cycle), or procedures that give comparable results.

consumption and tailpipe emissions of CO_2.

With respect to the President's request that NHTSA consider the issue of preemption, NHTSA is deferring further consideration of the preemption issue. The agency believes that it is unnecessary to address the issue further at this time because of the consistent and coordinated *Federal* standards that would apply nationally under the proposed National Program.

The following paragraphs provide a summary addressing how NHTSA has complied with the President's requests in the January 26 memorandum. NHTSA has reviewed comments received on the MY 2011 rulemaking and revisited its assumptions and methodologies for purposes of developing the proposed MY 2012–2016 standards. For any given assumption or aspect of NHTSA's analysis, comments rarely converged on a single position—and for many issues, NHTSA received diametrically-opposed comments from different parties—which makes it challenging to resolve the concerns of all parties in a single stroke. However, NHTSA has taken a fresh look at all the issues as part of its joint process with EPA, changing some assumptions and methodologies and validating others. The agency is confident that the assumptions and analysis used to develop these proposed standards represent the best possible approach that is consistent with NHTSA's statutory requirements for setting the required fuel economy standards.

The paragraphs below describe generally how the agency has reviewed comments on different issues related to the setting of the standards, and how the agency has either revised or validated its approach for the MY 2012–2016 standards. Much more detail on how the agency addresses all of these issues is found below in the rest of NHTSA's section of this preamble, in the joint TSD, and in NHTSA's PRIA.

How stringent should the standards be? How quickly should they increase?

EPCA requires that NHTSA set its standards for each model year at the ''maximum feasible average fuel economy level that the Secretary decides the manufacturers can achieve in that model year'' considering four factors: technological feasibility, economic practicability, the effect of other standards of the Government on fuel economy, and the need of the nation to conserve energy. None of these factors is further defined in the statute, and ''maximum feasible average fuel economy level'' is itself defined, if at all, only by reference to those four factors and the Secretary's consideration of them.[429] In addition, the agency has the authority to and traditionally does consider other relevant factors, such as the effect of the CAFE standards on motor vehicle safety.

In the previous CAFE rulemaking, NHTSA proposed to set standards at the point at which societal net benefits were maximized, which drew a number of comments from both manufacturers and environmental and public interest groups. Manufacturers generally commented that standards should be lower than the ''maximizing net benefits'' alternative, due to lead time concerns and manufacturers' difficulties in raising capital. Environmental and consumer groups, as well as a number of State Attorneys General, commented that NHTSA should set standards above that point, with some arguing in favor of standards as high as those at the point at which total costs equaled total benefits. Commenters also emphasized that NHTSA should ensure that standards increased ratably, as required by EISA.

For this NPRM, NHTSA has analyzed the costs and benefits of the ''maximizing net benefits'' alternative and other alternatives, using inputs that diverge substantially from those used in the analyses in the previous rulemakings to establish attribute-based standards. But the agency has not sought to use ''maximizing net benefits'' as a governing principle to select the applicable fuel economy standard in this NPRM. NHTSA's balancing of the statutory factors in these difficult financial times leads it to make a different conclusion this time: NHTSA is proposing to set standards at 34.1 mpg in MY 2016, below the point at which net benefits are maximized, due to economic practicability concerns. The results of the alternatives analysis for the ''maximizing net benefits'' alternative and the ''total costs = total benefits'' alternative may be found in the DEIS and in the PRIA.

Additionally, because today's proposed standards cover five model years, as opposed to the single model year covered by the March final rule, NHTSA is better able in this rulemaking to confirm that the standards do, in fact, increase ratably, as required by EISA.

What attribute should NHTSA use to set the standards?

In the previous rulemaking, most commenters agreed with NHTSA's use of footprint as the vehicle attribute for setting CAFE standards. Some manufacturers commented that NHTSA should consider multiple attributes—for example, sports car manufacturers suggested a mix of footprint and horsepower, while truck manufacturers suggested a mix of footprint and towing, hauling, or off-road capability. Several members of Congress also supported the latter comment.

For this NPRM, NHTSA and EPA together reconsidered the appropriate attribute for setting CAFE and CO_2 standards, and conclude that footprint best provides the ability address safety concerns without creating undue risk that program benefits will be lost to induced mix shifting. More information about this decision may be found in Section IV.C.5 below, in the draft joint TSD, and in NHTSA's PRIA.

What data should NHTSA use to develop the baseline market forecast?

In the previous rulemaking, the proposed standards were based on data from only the seven largest manufacturers. Several small and limited-line manufacturers commented that either the passenger car standards should be based on the plans of all manufacturers subject to the standards, or some alternative form of standard should be set for them. Ultimately, NHTSA set the MY 2011 standards based on the plans of all manufacturers subject to the standards.

However, a number of commenters also called for NHTSA to cease using manufacturer's confidential product plans in any way for developing the standards. Because manufacturers request confidentiality when they submit their product plans to the agency out of competitive concerns, NHTSA is prohibited by regulation from releasing that information to the public. Thus, when NHTSA developed a baseline market forecast using information from the manufacturer's product plans, NHTSA could not release that forecast intact for public review.

For this NPRM, in response to these concerns, NHTSA and EPA are using a baseline market file developed almost entirely from publicly-available data. Relying on adjusted MY 2008 CAFE compliance data enables the agency to make the baseline public and helps to address transparency concerns. However, by virtue of *not* being based on product plans, some manufacturers' concerns that the baseline does not represent *their* particular intentions for MYs 2012–2016 may not be addressed. These issues are explained in more detail in Section IV.C.1 below, in the draft joint TSD, and in NHTSA's PRIA.

Did commenters agree with NHTSA's technology assumptions?

In the previous rulemaking, manufacturers generally commented that NHTSA had underestimated the costs of technologies and overestimated

[429] 49 U.S.C. 32902(a).

their effectiveness, and that the rate of diesel and hybrid application required by the standards was too high, too quickly. Environmental and consumer groups, and the States Attorneys General who commented, largely argued the opposite. Environmental and consumer groups and the States Attorneys General also commented that NHTSA should include downweighting in its analysis for vehicles under 5,000 lbs GVWR, while the Insurance Institute for Highway Safety (IIHS) argued that NHTSA's approach to restricting downweighting to only those vehicles was correct.

For this NPRM, NHTSA, with EPA, has revisited every one of its cost and effectiveness estimates for individual technologies. Many of the estimates used in the MY 2011 final rule have been validated, while some have changed, notably the estimates for turbocharging and downsizing, diesels, and hybrids. Overall, the individual technology costs are lower for purposes of this NPRM than in the MY 2011 final rule due to the Indirect Cost Markup methodology developed by EPA for this rulemaking, which results in a lower markup than the 1.5 Retail Price Equivalent (RPE) markup previously used. The considerable majority of estimates for individual technology effectiveness were validated; changes largely resulted from the redefinition of certain electrification-related technologies and mild hybrids.

Additionally, NHTSA is now applying downweighting/material substitution to vehicles below 5,000 lbs GVWR, albeit in a way that, we believe, mitigates the safety concerns to some extent. These issues are explained in more detail in Section IV.C.2 below, in the draft joint TSD, and in NHTSA's PRIA.

With regard to the President's request that NHTSA consider, ''to the extent feasible, the forthcoming report by the National Academy of Sciences mandated under section 107 of EISA,'' we note that it was not feasible to consider this report for purposes of this NPRM because it is not scheduled to be completed until Fall 2009. However, NHTSA intends to make it available in the rulemaking docket as soon as the agency receives it, and will consider it for the final rule.

Did commenters agree with NHTSA's economic assumptions?

In the previous rulemaking, NHTSA primarily received comments regarding four particular economic assumptions. Regarding fuel prices, many commenters supported NHTSA's use of the AEO 2008 Reference Case, while many commenters also argued, given high pump prices in summer 2008, that NHTSA should use at least the AEO High Price Case or possibly a higher estimate. Regarding the discount rate, some commenters supported NHTSA's use of 7 percent, while others argued that NHTSA should use no higher than 3 percent. Regarding the magnitude of the rebound effect, some commenters supported NHTSA's use of a 15 percent rebound effect, while some called for a higher number and some called for numbers as low as zero percent. And finally, for the social cost of carbon, some commenters supported NHTSA's use of a domestic value and stated that the value should be $7/ton or lower, while other commenters argued that NHTSA should use a global value much higher than $7/ton, although there was little consensus as to what precise number.

For this NPRM, NHTSA, with EPA, has revisited every one of its economic assumptions. Many of the assumptions used in the MY 2011 final rule have been validated, while some have changed. For fuel prices, NHTSA used the AEO High Price Case in the MY 2011 final rule, but stated that its decision was based on its expectation that the Reference Case would soon be revised to reflect higher estimates of future fuel prices. EIA did, in fact, revise the Reference Case upward in AEO 2009 to levels higher than the 2008 High Price Case, and NHTSA has therefore elected to use the Reference Case for this NPRM. For the discount rate, NHTSA is continuing to conduct and present the results of analyses using both a 3 percent and a 7 percent rate, as is EPA in its analysis. For the rebound effect, NHTSA took a fresh look at the recent literature and developed new estimates for the rebound effect, and has used a value of 10 percent in its analysis. And for the social cost of carbon, based on the results of an interagency effort to develop an estimate that can be used by all government agencies in rulemakings that affect climate change, NHTSA has conducted analyses for this NPRM using a range of values from $5 to $56/ton, representing global SCC values. These issues are explained in Section II above, in more detail in Section IV.C.3 below, in the joint TSD, and in NHTSA's PRIA.

Did commenters agree with NHTSA's analytical tools?

In the previous rulemaking, although some commenters generally supported NHTSA's use of the CAFE modeling system developed by DOT's Volpe National Transportation Systems Center (Volpe Center), other commenters expressed concerns regarding the modeling system, the ways in which the system was applied, and accessibility of the system and its inputs and outputs.

Technical concerns regarding the model itself centered on the fact that it does not apply a direct and explicit representation of the physical processes connecting the engineering characteristics of a given vehicle to that vehicle's fuel economy. As NHTSA explained in its March 2009 **Federal Register** notice establishing final MY 2011 CAFE standards, full vehicle simulation could useful in developing model inputs, but not, at least in the foreseeable future, in performing forward-looking analysis of the future fleet.[430] Having again reconsidered this issue, NHTSA again concludes that with proper care in developing model inputs, the Volpe model is as ''physics-based'' as is practical or necessary for CAFE analysis.

Some commenters also questioned the model's structural assumptions about manufacturers' compliance strategies. NHTSA has reconsidered this question with respect to the potential for systematic underestimation or overestimation of compliance costs. As a result, the Volpe model has been modified to account for manufacturers' ability to engage in ''multi-year planning,'' adding more technology than necessary for compliance in an early model year when a vehicle model is being redesigned in order to carry that technology forward and facilitate compliance in later model years. This major change to the Volpe model tends to produce greater costs (and benefits) in earlier model years in order to reduce costs in later model years.

Some commenters also questioned the model's use of externally-specified ''phase-in caps'' to constrain the speed at which technologies can practicably be adopted. NHTSA has reconsidered these inputs in light of the fact that the model also assumes that most technologies can only be practicably applied during a vehicle redesign or (in some cases) freshening, and tentatively concludes that these inputs can be significantly relaxed. The analysis supporting today's proposal therefore relies almost exclusively on the redesign- and refresh-related constraints to produce practicable estimates of potential technology adoption rates. We are seeking comment on this change to the model's inputs, and note that further changes to these inputs would impact our analysis.

Commenters had many other concerns regarding inputs to the model, such as economic inputs and technology-related estimates. Commenters often (and

[430] 74 FR 14371–72 (Mar. 30, 2009).

particularly in relation to the agency's estimate of the social value of avoided CO_2 emissions) mistakenly attributed these concerns to the model itself. In again reviewing commenters' concerns regarding NHTSA's analysis, the agency has carefully differentiated between (1) the model, (2) inputs to the model, and (3) ways in which the model is applied. We encourage commenters to do the same in reviewing the analysis supporting today's proposal.

Finally, some commenters expressed concern regarding the model's transparency. However, as NHTSA explained in in the MY 2011 final rule, these concerns appeared to have been mistakenly applied to the model itself, as the actual lack of transparency related only to the agency's use of manufacturers' product plans, which formed the basis for inputs to the model.[431] The agency had previously made publicly available the model, source code (*i.e.*, computer programming instructions), model documentation, and sample input files. To make the model more easily accessible to the public, the agency began (in March 2009) placing all of this information on NHTSA's Web site.[432] In connection with today's proposal, the agency is placing the updated model, code, and documentation on the Web site, along with inputs and outputs for agency's current analysis. Among those inputs are those defining the agency's baseline estimates of the MYs 2012–2016 U.S. market for passenger cars and light trucks, as these inputs do not, for today's proposal, make use of manufacturers' confidential product plans.

How should NHTSA develop and fit the target curves?

In the previous rulemaking, many commenters expressed concern about the steepness of the proposed curves for passenger cars, which occurred because of the way in which NHTSA fit the curves to the data. The more steep a curve is, the more rapidly mpg targets decrease as footprint increases.

For this NPRM, NHTSA reconsidered how to address this concern and decided to propose curves that are based on a constrained linear function rather than a constrained logistic function, that are considerably less steep than the curves proposed in the previous rulemaking. This issue is discussed in greater detail in Section IV.C.5 below, in the joint TSD, and in NHTSA's PRIA.

Should NHTSA set additional "backstop" standards besides the one established by Congress?

In the previous rulemaking, several commenters argued that NHTSA must establish absolute backstop standards for imported passenger cars and light trucks, in addition to the one for domestically-manufactured passenger cars required by EISA. NHTSA examined its statutory authority and concluded that only a backstop for domestic passenger cars was permissible under the statute.

For this NPRM, NHTSA has re-examined its authority, and while the agency still tentatively concludes that Congress' intent is clear from the text of the statute, we recognize commenters' concerns that attribute-based standards may not absolutely guarantee the level of fuel savings currently anticipated if market forces cause manufacturers to build larger vehicles in MYs 2012–2016. Thus, we seek comment on this issue, which is discussed in greater detail below in Section IV.C.5.

Should NHTSA classify more vehicles as passenger cars rather than as light trucks?

In the previous rulemaking, many commenters agreed with NHTSA's decision to move many 2WD SUVs from the light truck to the passenger car fleet, but some commenters argued that NHTSA should go further and reclassify more light trucks as passenger cars.

For this NPRM, NHTSA has reconsidered its vehicle classification system and has not included in the proposed regulatory text any changes to that system. However, NHTSA seeks comment on whether any changes should be adopted for that time period or whether changes, if any, should be deferred to MY 2017 and beyond. Classification issues are addressed in greater detail in Section IV.H below.

5. Summary of the Proposed MY 2012–2016 CAFE Standards

NHTSA is proposing CAFE standards that are, like the standards NHTSA promulgated in March 2009 for MY 2011, expressed as mathematical functions depending on vehicle footprint. Footprint is one measure of vehicle size, and is determined by multiplying the vehicle's wheelbase by the vehicle's average track width.[433] Under the proposed CAFE standards, each light vehicle model produced for sale in the United States would have a fuel economy target. The CAFE levels that must be met by the fleet of each manufacturer would be determined by computing the sales-weighted harmonic average of the targets applicable to each of the manufacturer's passenger cars and light trucks. These targets, the mathematical form and coefficients of which are presented later in today's notice, appear as follows when the values of the targets are plotted versus vehicle footprint:

[431] 74 FR 14372 (Mar. 30, 2009).

[432] *See http://www.nhtsa.dot.gov* (click on "Fuel Economy," then "Related Links—CAFE Compliance and Effects Modeling System (Volpe Model)")

[433] *See* 49 CFR 523.2 for the exact definition of "footprint."

Figure IV.A.5-1. Final MY 2011 and Proposed MY 2012-2016
Passenger Car Fuel Economy Targets

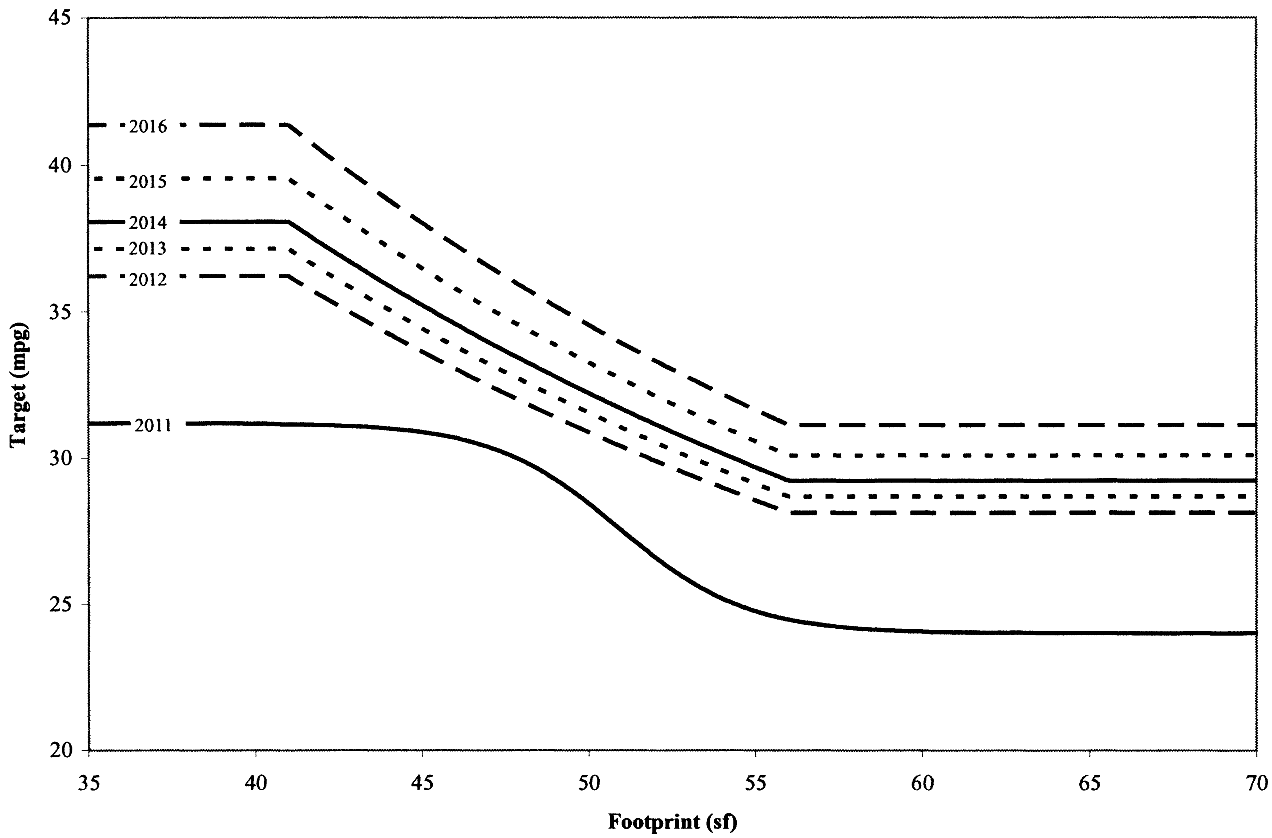
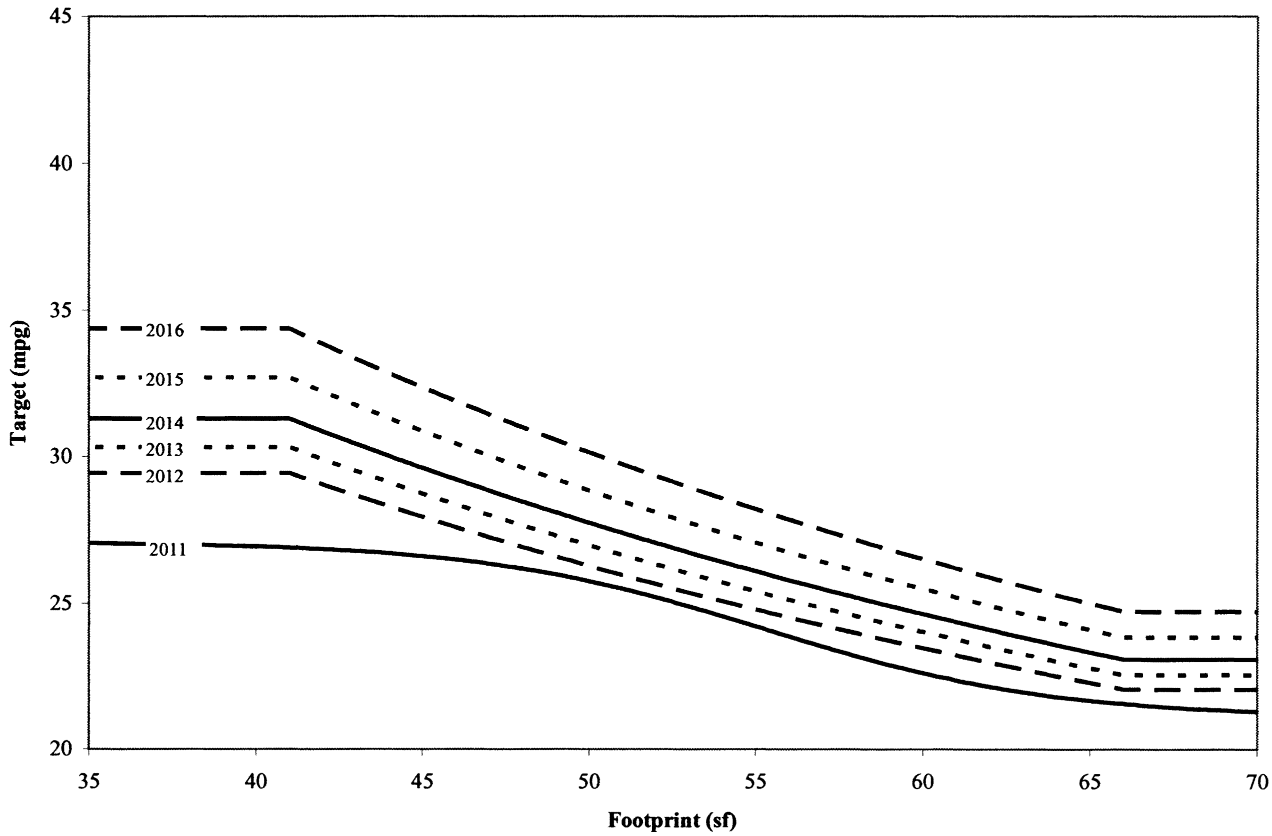


Figure IV.A.5-2. Final MY 2011 and Proposed MY 2012-2016 Light Truck Fuel Economy Targets



Under these proposed footprint-based CAFE standards, the CAFE levels required of individual manufacturers depend, as noted above, on the mix of vehicles sold. It is important to note that NHTSA's CAFE standards and EPA's GHG standards will both be in effect, and each will lead to increases in average fuel economy and CO_2 emissions reductions. The two agencies' standards together comprise the National Program, and this discussion of costs and benefits of NHTSA's CAFE standards does not change the fact that both the CAFE and GHG standards, jointly, are the source of the benefits and costs of the National Program.

Based on the forecast developed for this NPRM of the MYs 2012–2016 vehicle fleet, NHTSA estimates that the targets shown above would result in the following average required CAFE levels:

TABLE IV.A.5–1—AVERAGE REQUIRED FUEL ECONOMY (MPG) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016
Passenger Cars	33.6	34.4	35.2	36.4	38.0
Light Trucks	25.0	25.6	26.2	27.1	28.3
Combined	29.8	30.6	31.4	32.6	34.1

For the reader's reference, these miles per gallon would be equivalent to the following gallons per 100 miles for passenger cars and light trucks:

	2012	2013	2014	2015	2016
Passenger Cars	2.9762	2.907	2.8409	2.7473	2.6316
Light Trucks	4.0	3.9063	3.8168	3.8168	3.5336

NHTSA estimates that average achieved fuel economy levels will correspondingly increase through MY 2016, but that manufacturers will, on average, undercomply[434] in some model

[434] In NHTSA's analysis, "undercompliance" is mitigated either through use of FFV credits, use of existing or "banked" credits, or through fine payment. Because NHTSA cannot consider availability of credits in setting standards, the estimated achieved CAFE levels presented here do not account for their use. In contrast, because

Continued

years and overcomply[435] in others, reaching a combined average fuel economy of 33.7 mpg in MY 2016.[436] Table IV.A.5–1 is the estimated required fuel economy for the proposed CAFE standards while Table IV.A.5–2 includes the effects of some manufacturers' payment of CAFE fines. In addition, Section IV.G.4 below contains an analysis of the achieved levels (and projected fuel savings, costs, and benefits) when the use of FFV credits is also assumed.

TABLE IV.A.5–2—AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016
Passenger Cars	32.9	34.2	35.2	36.5	37.6
Light Trucks	24.9	25.7	26.5	27.4	28.1
Combined	29.3	30.5	31.5	32.7	33.7

For the reader's reference, these miles per gallon would be equivalent to the following gallons per 100 miles for passenger cars and light trucks:

	2012	2013	2014	2015	2016
Passenger Cars	3.0438	2.9267	2.8398	2.7434	2.6623
Light Trucks	4.0241	3.8952	3.7713	3.6495	3.5604

NHTSA estimates that these fuel economy increases will lead to fuel savings totaling 61.6 billion gallons during the useful lives of vehicles sold in MYs 2012–2016:

TABLE IV.A.5–3—FUEL SAVED (BILLION GALLONS) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.5	5.3	7.5	9.4	11.4	36.0
Light Trucks	1.8	3.7	5.4	6.8	7.8	25.6
Combined	4.3	9.1	12.9	16.1	19.2	61.6

The agency also estimates that these new CAFE standards will lead to corresponding reductions of CO_2 emissions totaling 656 million metric tons (mmt) during the useful lives of vehicles sold in MYs 2012–2016:

TABLE IV.A.5–4—AVOIDED CARBON DIOXIDE EMISSIONS (MMT) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	25	56	79	99	121	381
Light Trucks	19	40	58	73	85	275
Combined	44	96	137	173	206	656

The agency estimates that these fuel economy increases would produce other benefits (*e.g.*, reduced time spent refueling), as well as some disbenefits (*e.g.*, increase traffic congestion) caused by drivers' tendency to increase travel when the cost of driving declines (as it does when fuel economy increases). The agency has estimated the total monetary value to society of these benefits and disbenefits, and estimates that the proposed standards will produce significant benefits to society. NHTSA estimates that, in present value terms, these benefits would total $200 billion over the useful lives of vehicles sold during MYs 2012–2016:

TABLE IV.A.5–5—PRESENT VALUE OF BENEFITS ($BILLION) UNDER PROPOSED CAFE STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	7.6	17.0	24.4	31.2	38.7	119.1

NHTSA is not prohibited from considering fine payment, the estimated achieved CAFE levels presented here include the assumption that BMW, Daimler (*i.e.*, Mercedes), Porsche, and, Tata (*i.e.*, Jaguar and Rover) will only apply technology up to the point that it would be less expensive to pay civil penalties.

[435] In NHTSA's analysis, ''overcompliance'' occurs through multi-year planning: manufacturers apply some ''extra'' technology in early model years (*e.g.*, MY 2014) in order to carry that technology forward and thereby facilitate compliance in later model years (*e.g.*, MY 2016)

[436] Consistent with EPCA, NHTSA has not accounted for manufacturers' ability to earn CAFE credits for selling FFVs, carry credits forward and back between model years, and transfer credits between the passenger car and light truck fleets.

TABLE IV.A.5–5—PRESENT VALUE OF BENEFITS ($BILLION) UNDER PROPOSED CAFE STANDARDS—Continued

	2012	2013	2014	2015	2016	Total
Light Trucks	5.5	11.6	17.3	22.2	26.0	82.6
Combined	13.1	28.7	41.8	53.4	64.7	201.7

NHTSA attributes most of these benefits—about $157 billion, as noted above—to reductions in fuel consumption, valuing fuel (for societal purposes) at future pretax prices in the Energy Information Administration's (EIA's) reference case forecast from Annual Energy Outlook (AEO) 2009. The Preliminary Regulatory Impact Analysis (PRIA) accompanying today's proposed rule presents a detailed analysis of specific benefits of the proposed rule.

	Amount	$ Value
Fuel savings	61.6 billion gallons	$158.0 billion.
CO_2 emissions reductions	656 million metric tons (mmt)	$16.4 billion.

NHTSA estimates that the necessary increases in technology application will involve considerable monetary outlays, totaling $62.5 billion in incremental outlays (*i.e.,* beyond those attributable to the MY 2011 standards) by new vehicle purchasers during MYs 2012–2016:

TABLE IV.A.5–6—INCREMENTAL TECHNOLOGY OUTLAYS ($B) UNDER PROPOSED CAFE STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	4.1	6.5	8.4	9.9	11.8	40.8
Light Trucks	1.5	2.8	4.0	5.2	5.9	19.4
Combined	5.7	9.3	12.5	15.1	17.6	60.2

Corresponding to these outlays and, to a much lesser extent, civil penalties that some companies are expected to pay for noncompliance, the agency estimates that the proposed standards would lead to increases in average new vehicle prices, ranging from $476 per vehicle in MY 2012 to $1,091 per vehicle in MY 2016:

TABLE IV.A.5–7—INCREMENTAL INCREASES IN AVERAGE NEW VEHICLE PRICES ($) UNDER PROPOSED CAFE STANDARDS

	2012	2013	2014	2015	2016
Passenger Cars	591	735	877	979	1,127
Light Trucks	283	460	678	882	1,020
Combined	476	635	806	945	1,091

Tables IV.A.5–8 and IV.A.5–9 below present itemized costs and benefits for a 3 percent and a 7 percent discount rate, respectively, for the combined fleet (passenger cars and light trucks) in each model year and for all model years combined. Numbers in parentheses represent negative values.

TABLE IV.A.5–8—ITEMIZED COST AND BENEFIT ESTIMATES FOR THE COMBINED VEHICLE FLEET, 3% DISCOUNT RATE

	2012	2013	2014	2015	2016	Total
Costs:						
Technology Costs	$5,695	$9,295	$12,454	$15,080	$17,633	$60,157
Benefits:						
Lifetime Fuel Expenditures	$10,197	$22,396	$32,715	$41,880	$50,823	$158,012
Consumer Surplus from Additional Driving	$751	$1,643	$2,389	$3,029	$3,639	$11,451
Refueling Time Value	$776	$1,551	$2,198	$2,749	$3,277	$10,550
Petroleum Market Externalities	$559	$1,194	$1,700	$2,129	$2,538	$8,121
Congestion Costs	($460)	($934)	($1,332)	($1,657)	($1,991)	($6,376)
Noise Costs	($7)	($14)	($21)	($26)	($31)	($99)
Crash Costs	($217)	($437)	($625)	($776)	($930)	($2,985)
CO_2	$1,028	$2,287	$3,382	$4,376	$5,372	$16,446
CO	$0	$0	$0	$0	$0	$0
VOC	$41	$80	$108	$131	$156	$518
NO_X	$82	$132	$155	$174	$200	$744
PM	$220	$438	$621	$771	$904	$2,956

TABLE IV.A.5–8—ITEMIZED COST AND BENEFIT ESTIMATES FOR THE COMBINED VEHICLE FLEET, 3% DISCOUNT RATE—Continued

	2012	2013	2014	2015	2016	Total
SO_X	$161	$345	$490	$613	$731	$2,341
Total	$13,132	$28,680	$41,781	$53,394	$64,687	$201,676
Net Benefits	$7,044	$18,759	$27,090	$34,710	$41,386	$128,992

TABLE IV.A.5–9—ITEMIZED COST AND BENEFIT ESTIMATES FOR THE COMBINED VEHICLE FLEET, 7% DISCOUNT RATE

	2012	2013	2014	2015	2016	Total
Costs:						
Technology Costs	$5,695	$9,295	$12,454	$15,080	$17,633	$60,157
Benefits:						
Lifetime Fuel Expenditures	$7,991	$17,671	$25,900	$33,264	$40,478	$125,305
Consumer Surplus from Additional Driving	$590	$1,301	$1,896	$2,412	$2,904	$9,102
Refueling Time Value	$624	$1,249	$1,770	$2,215	$2,642	$8,500
Petroleum Market Externalities	$448	$960	$1,367	$1,712	$2,043	$6,531
Congestion Costs	($371)	($753)	($1,074)	($1,335)	($1,606)	($5,138)
Noise Costs	($6)	($12)	($16)	($21)	($24)	($80)
Crash Costs	($173)	($352)	($503)	($626)	($749)	($2,403)
CO_2	$797	$1,781	$2,634	$3,410	$4,189	$12,813
CO	$0	$0	$0	$0	$0	$0
VOC	$33	$65	$87	$106	$125	$416
NO_X	$60	$99	$120	$135	$156	$570
PM	$170	$344	$492	$613	$721	$2,339
SO_X	$129	$278	$394	$493	$588	$1,882
Total	$10,292	$22,631	$33,066	$42,380	$51,468	$159,837
Net Benefits	$4,281	$12,832	$18,818	$24,414	$29,293	$89,638

Neither EPCA nor EISA *requires* that NHTSA conduct a cost-benefit analysis in determining average fuel economy standards, but too, neither precludes its use.[437] EPCA does require that NHTSA consider economic practicability among other factors, and NHTSA has concluded, as discussed elsewhere herein, that the standards it proposes today are economically practicable. Further validating and supporting its conclusion that the standards it proposes today are reasonable, a comparison of the standards' costs and benefits shows that the standards' estimated benefits far outweigh its estimated costs. Based on the figures reported above, NHTSA estimates that the total benefits of today's proposed standards would be more three times the magnitude of the corresponding costs, such that the proposed standards would produce net benefits of nearly $138 billion over the useful lives of vehicles sold during MYs 2012–2016.

B. Background

1. Chronology of Events Since the National Academy of Sciences Called for Reforming and Increasing CAFE Standards

a. National Academy of Sciences Issues Report on Future of CAFE Program (February 2002)

i. Significantly Increasing CAFE Standards Without Making Them Attribute-Based Would Adversely Affect Safety

In the 2002 congressionally-mandated report entitled ''Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards,'' [438] a committee of the National Academy of Sciences (NAS) (''2002 NAS Report'') concluded that the then-existing form of passenger car and light truck CAFE standards permitted vehicle manufacturers to comply in part by downweighting and even downsizing their vehicles and that these actions had led to additional fatalities. The committee explained that this safety problem arose because, at that time, the CAFE standards were not attributed-based and thus subjected all passenger cars to the same fuel economy target and all light trucks to the same target, regardless of their weight, size, or load-carrying capacity.[439] The committee said that this experience suggests that consideration should be given to developing a new system of fuel economy targets that reflects differences in such vehicle attributes. Without a thoughtful restructuring of the program, there would be the trade-offs that must be made if CAFE standards were increased by any significant amount.[440]

In response to these conclusions, NHTSA issued attribute-based CAFE standards for light trucks and sought legislative authority to issue attribute-based CAFE standards for passenger cars before undertaking to raise the car

[437] *Center for Biological Diversity* v. *NHTSA,* 508 F.3d 508 (9th Cir. 2007) (rejecting argument that EPCA precludes the use of a marginal cost-benefit analysis that attempted to weigh all of the social benefits (*i.e.,* externalities as well as direct benefits to consumers) of improved fuel savings in determining the stringency of the CAFE standards). *See also Entergy Corp.* v. *Riverkeeper, Inc.,* 129 S.Ct. 1498, 1508 (2009) (''[U]nder *Chevron,* that an agency is not *required* to [conduct a cost-benefit analysis] does not mean that an agency is not *permitted* to do so.'')

[438] National Research Council, ''Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards,'' National Academy Press, Washington, DC (2002). *Available at http://www.nap.edu/openbook.php?isbn=0309076013* (last accessed August 9, 2009). The conference committee report for the Department of Transportation and Related Agencies Appropriations Act for FY 2001 (Pub. L. 106–346) directed NHTSA to fund a study by NAS to evaluate the effectiveness and impacts of CAFE standards (H. Rep. No. 106–940, p. 117–118). In response to the direction from Congress, NAS published this lengthy report.

[439] NHTSA formerly used this approach for CAFE standards. EISA prohibits its use after MY 2010.

[440] NAS, p. 9.

standards. Congress went a step further in enacting EISA, not only authorizing the issuance of attribute-based standards, but also mandating them.

ii. Climate Change and Other Externalities Justify Increasing the CAFE Standards

The NAS committee said that there are two compelling concerns that justify a government-mandated increase in fuel economy, both relating to externalities. The first and most important concern, it argued, is the accumulation in the atmosphere of greenhouse gases, principally carbon dioxide.[441]

A second concern is that petroleum imports have been steadily rising because of the nation's increasing demand for gasoline without a corresponding increase in domestic supply. The high cost of oil imports poses two risks: Downward pressure on the strength of the dollar (which drives up the cost of goods that Americans import) and an increase in U.S. vulnerability to macroeconomic shocks that cost the economy considerable real output.

To determine how much the fuel economy standards should be increased, the committee urged that all social benefits be considered. That is, it urged not only that the dollar value of the saved fuel be considered, but also that the dollar value to society of the resulting reductions in greenhouse gas emissions and in dependence on imported oil should be calculated and considered. The committee said that if it is possible to assign dollar values to these favorable effects, it becomes possible to make at least crude comparisons between the socially beneficial effects of measures to improve fuel economy on the one hand, and the costs (both out-of-pocket and more subtle) on the other.

iii. Reforming the CAFE Program Could Address Inequity Arising From the CAFE Structure

The 2002 NAS report expressed concerns about increasing the standards under the CAFE program as currently structured. While raising CAFE standards under the existing structure would reduce fuel consumption, doing so under alternative structures ''could accomplish the same end at lower cost, provide more flexibility to manufacturers, or address inequities arising from the present'' structure.[442]

To address those structural problems, the report suggested various possible reforms. The report found that the ''CAFE program might be improved significantly by converting it to a system in which fuel targets depend on vehicle attributes.''[443] The report noted further that under an attribute-based approach, the required CAFE levels could vary among the manufacturers based on the distribution of their product mix. NAS stated that targets could vary among passenger cars and among trucks, based on some attribute of these vehicles such as weight, size, or load-carrying capacity. The report explained that a particular manufacturer's average target for passenger cars or for trucks would depend upon the fractions of vehicles it sold with particular levels of these attributes.[444]

2. NHTSA Issues Final Rule Establishing Attribute-Based CAFE Standards for MY 2008–2011 Light Trucks (March 2006)

The 2006 final rule reformed the structure of the CAFE program for light trucks by introducing an attribute-based approach and using that approach to establish higher CAFE standards for MY 2008–2011 light trucks.[445] Reforming the CAFE program enables it to achieve larger fuel savings, while enhancing safety and preventing adverse economic consequences.

As noted above, under Reformed CAFE, fuel economy standards were restructured so that they are based on a vehicle attribute, a measure of vehicle size called ''footprint.'' It is the product of multiplying a vehicle's wheelbase by its track width. A target level of fuel economy was established for each increment in footprint (0.1 ft^2). Trucks with smaller footprints have higher fuel economy targets; conversely, larger ones have lower targets. A particular manufacturer's compliance obligation for a model year is calculated as the harmonic average of the fuel economy targets for the manufacturer's vehicles, weighted by the distribution of the manufacturer's production volumes among the footprint increments. Thus, each manufacturer is required to comply with a single overall average fuel economy level for each model year of production.

Compared to Unreformed (non-attributed-based) CAFE, Reformed CAFE enhances overall fuel savings while providing vehicle manufacturers with the flexibility they need to respond to changing market conditions. Reformed CAFE also provides a more equitable regulatory framework by creating a level playing field for manufacturers, regardless of whether they are full-line or limited-line manufacturers. We were particularly encouraged that Reformed CAFE will confer no compliance advantage if vehicle makers choose to downsize some of their fleet as a CAFE compliance strategy, thereby reducing the adverse safety risks associated with the Unreformed CAFE program.

3. Ninth Circuit Issues Decision re Final Rule for MY 2008–2011 Light Trucks (November 2007)

On November 15, 2007, the United States Court of Appeals for the Ninth Circuit issued its decision in *Center for Biological Diversity* v. *NHTSA,*[446] the challenge to the MY 2008–11 light truck CAFE rule. The court held that EPCA permits, but does not require, the use of a marginal cost-benefit analysis. The court specifically emphasized NHTSA's discretion to decide how to balance the statutory factors—as long as that balancing does not undermine the fundamental statutory purpose of energy conservation.

However, the Court found that NHTSA had been arbitrary and capricious in the following respects:

• NHTSA's decision that it could not monetize the benefit of reducing CO_2 emissions for the purpose of conducting its marginal benefit-cost analysis;

• NHTSA's lack, in the Court's view, of a reasoned explanation for its decision not to establish a ''backstop'' (*i.e.,* a fixed minimum CAFE standard applicable to manufacturers);

• NHTSA's lack, again in the Court's view, of a reasoned explanation for its decision not to revise the regulatory definitions for the passenger car and light truck categories of automobiles so that some vehicles currently classified as light trucks are instead classified as passenger cars;

• NHTSA's decision not to subject most medium- and heavy-duty pickups and most medium- and heavy-duty cargo vans (*i.e.,* those between 8,500 and 10,000 pounds gross vehicle weight rating (GVWR,) to the CAFE standards;

• NHTSA's decision to prepare and publish an Environmental Assessment (EA) and making a finding of no significant impact notwithstanding what the Court found to be an insufficiently broad range of alternatives, insufficient analysis of the climate change effects of the CO_2 emissions, and limited assessment of cumulative impacts in its EA under the National Environmental Policy Act (NEPA).

The Court did not vacate the standards, but instead said it would remand the rule to NHTSA to

[441] NAS, pp. 2, 13, and 83.

[442] NAS, pp. 4–5 (Finding 10).

[443] NAS, p. 5 (Finding 12).

[444] NAS, p. 87.

[445] 71 FR 17566 (Apr. 6, 2006).

[446] 508 F.3d 508.

promulgate new standards consistent with its opinion ''as expeditiously as possible and for the earliest model year practicable.[447] Under the decision, the standards established by the April 2006 final rule would remain in effect unless and until amended by NHTSA. In addition, it directed the agency to prepare an Environmental Impact Statement.

4. Congress Enacts Energy Security and Independence Act of 2007 (December 2007)

As noted above in Section I.B., EISA significantly changed the provisions of EPCA governing the establishment of future CAFE standards. These changes made it necessary for NHTSA to pause in its efforts so that it could assess the implications of the amendments made by EISA and then, as required, revise some aspects of the proposals it had been developing (*e.g.,* the model years covered and credit issues).

5. NHTSA Proposes CAFE Standards for MYs 2011–2015 (April 2008)

The agency cannot set out the exact level of CAFE that each manufacturer would have been required to meet for each model year under the passenger car or light truck standards since the levels would depend on information that would not be available until the end of each of the model years, *i.e.,* the final actual production figures for each of those years. The agency can, however, project what the industry-wide level of average fuel economy would have been for passenger cars and for light trucks if each manufacturer produced its expected mix of automobiles and just met its obligations under the proposed ''optimized'' standards for each model year.

	Passenger cars mpg	Light trucks mpg
MY 2011	31.2	25.0
MY 2012	32.8	26.4
MY 2013	34.0	27.8
MY 2014	34.8	28.2
MY 2015	35.7	28.6

The combined industry-wide average fuel economy (in miles per gallon, or mpg) levels for both cars and light trucks, if each manufacturer just met its obligations under the proposed ''optimized'' standards for each model year, would have been as follows:

	Combined mpg
MY 2011	27.8
MY 2012	29.2
MY 2013	30.5
MY 2014	31.0
MY 2015	31.6

The annual average increase during this five year period would have been approximately 4.5 percent. Due to the uneven distribution of new model introductions during this period and to the fact that significant technological changes could be most readily made in conjunction with those introductions, the annual percentage increases were greater in the early years in this period.

6. Ninth Circuit Revises its Decision re Final Rule for MY 2008–2011 Light Trucks (August 2008)

In response to the Government petition for rehearing, the Ninth Circuit modified its decision by replacing its direction to prepare an EIS with a direction to prepare either a new EA or, if necessary, an EIS.[448]

7. NHTSA Releases Final Environmental Impact Statement (October 2008)

On October 17, 2008, EPA published a notice announcing the availability of NHTSA's final environmental impact statement (FEIS) for this rulemaking.[449] Throughout the FEIS, NHTSA relied extensively on findings of the United Nations Intergovernmental Panel on Climate Change (IPCC) and the U.S. Climate Change Science Program (USCCSP). In particular, the agency relied heavily on the most recent, thoroughly peer-reviewed, and credible assessments of global climate change and its impact on the United States: the IPCC Fourth Assessment Report Working Group I4 and II5 Reports, and reports by the USCCSP that include *Scientific Assessments of the Effects of Global Climate Change on the United States* and Synthesis and Assessment Products.

In the FEIS, NHTSA compared the environmental impacts of its preferred alternative and those of reasonable alternatives. It considered direct, indirect, and cumulative impacts and describes these impacts to inform the decisionmaker and the public of the environmental impacts of the various alternatives.

Among other potential impacts, NHTSA analyzed the direct and indirect impacts related to fuel and energy use, emissions, including carbon dioxide and its effects on temperature and climate change, air quality, natural resources, and the human environment. Specifically, the FEIS used a climate model to estimate and report on four direct and indirect effects of climate change, driven by alternative scenarios of GHG emissions, including:

1. Changes in CO_2 concentrations;
2. Changes in global mean surface temperature;
3. Changes in regional temperature and precipitation; and
4. Changes in sea level.

NHTSA also considered the cumulative impacts of the proposed standards for MY 2011–2015 passenger cars and light trucks, together with estimated impacts of NHTSA's implementation of the CAFE program through MY 2010 and NHTSA's future CAFE rulemaking for MYs 2016–2020.

8. Department of Transportation Decides not to Issue MY 2011–2015 Final Rule (January 2009)

On January 7, 2009, the Department of Transportation announced that the Bush Administration would not issue the final rule, notwithstanding the Office of Information and Regulatory Affairs' completion of review of the rule under Executive Order 12866, Regulatory Planning and Review, on November 14, 2008.[450]

9. The President Requests NHTSA to Issue Final Rule for MY 2011 Only (January 2009)

As explained above, in his memorandum of January 26, 2009, the President requested the agency to issue a final rule adopting CAFE standards for MY 2011 only. Further, the President requested NHTSA to establish standards for MY 2012 and later after considering the appropriate legal factors, the comments filed in response to the May 2008 proposal, the relevant technological and scientific considerations, and, to the extent feasible, a forthcoming report by the

[447] The deadline in EPCA for issuing a final rule establishing, for the first time, a CAFE standard for a model year is 18 months before the beginning of that model year. 49 U.S.C. 32902(g)(2). The same deadline applies to issuing a final rule amending an existing CAFE standard so as to increase its stringency. Given that the agency has long regarded October 1 as the beginning of a model year, the statutory deadline for increasing the MY 2009 standard was March 30, 2007, and the deadline for increasing the MY 2010 standard is March 30, 2008. Thus, the only model year for which there was sufficient time at the time of the Court's decision to gather all of the necessary information, conduct the necessary analyses and complete a rulemaking was MY 2011. As noted earlier in this notice, however, EISA requires that a new standard be established for that model year.

[448] *See CBD* v. *NHTSA,* 538 F.3d 1172 (9th Cir. 2008).

[449] 73 FR 61859 (Oct. 18, 2008).

[450] The statement can be found at *http://www.dot.gov/affairs/dot0109.htm* (last accessed August 9, 2009).

National Academy of Sciences assessing automotive technologies that can practicably be used to improve fuel economy.

10. NHTSA Issues Final Rule for MY 2011 (March 2009)

a. Introduction

NHTSA's review and analysis of comments on its proposal led the agency to make many changes to its methods for analyzing potential MY 2011 CAFE standards, as well as to the data and other information to which the agency has applied these methods. The following are some of the more prominent changes:

- After receiving, reviewing, and integrating updated product plans from vehicle manufacturers, NHTSA revised its forecast of the future light vehicle market.
- NHTSA changed the methods and inputs it used to represent the applicability, availability, cost, and effectiveness of future fuel-saving technologies.
- NHTSA based its fuel price forecast on the AEO 2008 High Case price scenario instead of the AEO 2008 Reference Case.
- NHTSA reduced mileage accumulation estimates (*i.e.,* vehicle miles traveled) to levels consistent with this increased fuel price forecast.
- NHTSA applied increased estimates for the value of oil import externalities.
- NHTSA included all manufacturers—not just the largest seven—in the process used to fit the curve and estimate the stringency at which societal net benefits are maximized.
- NHTSA tightened its application of the definition of ''nonpassenger automobiles,'' causing a reassigning of over one million vehicles from the light truck fleet to the passenger car fleet, and lowering the average fuel economy for cars due to the inclusion of vehicles previously categorized as trucks, as well as the average fuel economy for trucks because the truck category then had a larger proportion of heavier trucks.
- NHTSA fitted the shape of the curve based on ''exhaustion'' of available technologies instead of on manufacturer-level optimization of CAFE levels.

These changes affected both the shape and stringency of the attribute-based standards. Taken together, the last three of the above changes reduced the steepness of the curves defining fuel economy targets for passenger cars, and also less significantly reduced the steepness of the light truck curves.

b. Standards

The final rule established footprint-based fuel economy standards for MY 2011 passenger cars and light trucks, where each vehicle manufacturer's required level of CAFE was based on target levels of average fuel economy set for vehicles of different sizes and on the distribution of that manufacturer's vehicles among those sizes. The curves defining the performance target at each footprint reflect the technological and economic capabilities of the industry. The target for each footprint is the same for all manufacturers, regardless of differences in their overall fleet mix. Compliance would be determined by comparing a manufacturer's harmonically averaged fleet fuel economy levels in a model year with a required fuel economy level calculated using the manufacturer's actual production levels and the targets for each footprint of the vehicles that it produces.

The agency analyzed seven regulatory alternatives, one of which maximizes net benefits within the limits of available information and was known at the time as the ''optimized standards.'' The optimized standards were set at levels, such that, considering all of the manufacturers together, no other alternative is estimated to produce greater net benefits to society. Upon a considered analysis of all information available, including all information submitted to NHTSA in comments, the agency adopted the ''optimized standard'' alternative as the final standards for MY 2011.[451] By limiting the standards to levels that can be achieved using technologies each of which are estimated to provide benefits that at least equal its costs, the net benefit maximization approach helped, at the time, to assure the marketability of the manufacturers' vehicles and thus economic practicability of the standards. Providing this assurance assumed increased importance in view of current and anticipated conditions in the industry in particular and the economy in general. As was widely reported in the public domain throughout that rulemaking, and as shown in public comments, the national and global economies raised serious concerns. Even before those recent developments, the automobile manufacturers were already facing substantial difficulties. Together, these problems made NHTSA's economic practicability analysis particularly important and challenging in that rulemaking.

The agency could not set out the exact level of CAFE that each manufacturer would be required to meet for MY 2011 under the passenger car or light truck standards because the levels will depend on information that will not be available until the end of that model year, *i.e.,* the final actual production figures for that year. However, the following levels were projected for what the industry-wide level of average fuel economy will be for passenger cars and for light trucks if each manufacturer produced its expected mix of automobiles and just met its obligations under the ''optimized'' standards.

	Passenger cars mpg	Light trucks mpg
MY 2011	30.2	24.1

The combined industry-wide average fuel economy (in miles per gallon, or mpg) levels for both cars and light trucks, if each manufacturer just met its obligations under the ''optimized'' standards, were projected as follows:

	Combined mpg	mpg increase over prior year
MY 2011	27.3	2.0

In addition, per EISA, each manufacturer's domestic passenger fleet is required in MY 2011 to achieve 27.5 mpg or 92 percent of the CAFE of the industry-wide combined fleet of domestic and non-domestic passenger cars[452] for that model year, whichever is higher. This requirement resulted in the following projected alternative minimum standard (not attribute-based) for domestic passenger cars:

	Domestic passenger cars mpg
MY 2011	27.8

c. Credits

NHTSA also adopted a new Part 536 on use of ''credits'' earned for exceeding applicable CAFE standards. Part 536 implements the provisions in EISA authorizing NHTSA to establish by regulation a credit trading program and directing it to establish by regulation a credit transfer program.[453] Since its

[451] The agency notes, for NEPA purposes, that the ''optimized standard'' alternative adopted as the final standards corresponds to the ''Optimized Mid-2'' scenario described in Section 2.2.2 of the FEIS.

[452] Those numbers set out several paragraphs above.

[453] Congress required that DOT establish a credit ''transferring'' regulation, to allow individual manufacturers to move credits from one of their

Continued

enactment, EPCA has permitted manufacturers to earn credits for exceeding the standards and to apply those credits to compliance obligations in years other than the model year in which it was earned. EISA extended the ''carry-forward'' period to five model years, and left the ''carry-back'' period at three model years. Under Part 536, credit holders (including, but not limited to, manufacturers) will have credit accounts with NHTSA, and will be able to hold credits, apply them to compliance with CAFE standards, transfer them to another ''compliance category'' for application to compliance there, or trade them. A credit may also be cancelled before its expiry date, if the credit holder so chooses. Traded and transferred credits will be subject to an ''adjustment factor'' to ensure total oil savings are preserved, as required by EISA. EISA also prohibits credits earned before MY 2011 from being transferred, so NHTSA has developed several regulatory restrictions on trading and transferring to facilitate Congress' intent in this regard.

11. Energy Policy and Conservation Act, as Amended by the Energy Independence and Security Act

NHTSA's statutory authority and obligations under the Energy Policy and Conservation Act of 1975 (EPCA), as amended by the Energy Independence and Security Act of 2007 (EISA), is discussed at length above in Section I.B.1.

C. Development and Feasibility of the Proposed Standards

1. How Was the Baseline Vehicle Fleet Developed?

a. Why Do the Agencies Establish a Baseline Vehicle Fleet?

In order to determine what levels of stringency are feasible in future model years, the agencies must project what vehicles will exist in those model years, and then evaluate what technologies can feasibly be applied to those vehicles in order to raise their fuel economy and lower their CO_2 emissions. The agencies therefore establish a baseline vehicle fleet representing those vehicles, based on the best available information. Each agency then developed a separate reference fleet, accounting (via their respective models) for the effect that the MY 2011 CAFE standards have on the baseline fleet. This reference fleet is then used for comparisons of technologies' incremental cost and effectiveness, as well as the other relevant comparisons in the rule.

b. What Data Did the Agencies Use To Construct the Baseline, and How Did They Do So?

As explained in the Technical Support Document (TSD) prepared jointly by NHTSA and EPA, both agencies used a baseline vehicle fleet constructed beginning with EPA fuel economy certification data for the 2008 model year, the most recent for which final data is currently available from manufacturers. This data was used as the source for MY 2008 production volumes and some vehicle engineering characteristics, such fuel economy ratings, engine sizes, numbers of cylinders, and transmission types.

Some information important for analyzing new CAFE standards is not contained in the EPA fuel economy certification data. EPA staff estimated vehicle wheelbase and track widths using data from Motortrend.com and Edmunds.com. This information is necessary for estimating vehicle footprint, which is required for the analysis of footprint-based standards. Considerable additional information regarding vehicle engineering characteristics is also important for estimating the potential to add new technologies in response to new CAFE standards. In general, such information helps to avoid ''adding'' technologies to vehicles that already have the same or a more advanced technology. Examples include valvetrain configuration (*e.g.,* OHV, SOHC, DOHC), presence of cylinder deactivation, and fuel delivery (*e.g.,* MPFI, SIDI). To the extent that such engineering characteristics were not available in certification data, EPA staff relied on data published by Ward's Automotive, supplementing this with information from Internet sites such as Motortrend.com and Edmunds.com. NHTSA staff also added some more detailed engineering characteristics (*e.g,* type of variable valve timing) using data available from ALLDATA® Online. Combined with the certification data, all of this information yielded a MY 2008 baseline vehicle fleet.

After the baseline was created the next step was to project the sales volumes for 2011–2016 model years. EPA used projected car and truck volumes for this period from Energy Information Administration's (EIA's) 2009 Annual Energy Outlook (AEO).[454] However, AEO projects sales only at the car and truck level, not at the manufacturer and model-specific level, which are needed in order to estimate the effects new standards will have on individual manufacturers. Therefore, EPA purchased data from CSM-Worldwide and used their projections of the number of vehicles of each type predicted to be sold by manufacturers in 2011–2015.[455] This provided the year-by-year percentages of cars and trucks sold by each manufacturer as well as the percentages of each vehicle segment. Although it was, therefore, necessary to assume the same manufacturer and segment shares in 2016 as in 2015, 2016 estimates from CSM should be available for the final rule. Using these percentages normalized to the AEO projected volumes then provided the manufacturer-specific market share and model-specific sales for model years 2011–2016.

The processes for constructing the MY 2008 baseline vehicle fleet and subsequently adjusting sales volumes to construct the MY 2011–2016 baseline vehicle fleet are presented in detail in Chapter 1 of the draft Joint Technical Support Document accompanying today's notice.

c. How Is This Different From NHTSA's Historical Approach and Why is This Approach Preferable?

As discussed above in Section II.B.3, NHTSA has historically based its analysis of potential new CAFE standards on detailed product plans the agency has requested from manufacturers planning to produce light vehicles for sale in the United States. In contrast, the current market forecast is based primarily on information sources which are all either in the public domain or available commercially. There are advantages to this approach, namely transparency and the potential to reduce some errors due to manufacturers' misunderstanding of NHTSA's request for information. There are also disadvantages, namely that the current market forecast does not represent certain changes likely to occur in the future vehicle fleet as opposed to the MY 2008 vehicle fleet, such as vehicles being discontinued and newly introduced. On balance, however, the agencies have carefully considered these

fleets to another (*e.g.,* using a credit earned for exceeding the light truck standard for compliance with the domestic passenger car standard). Congress allowed DOT to establish a credit ''trading'' regulation, so that credits may be bought and sold between manufacturers and other parties.

[454] *Available at http://www.eia.doe.gov/oiaf/aeo/index.html.* The agencies have also used fuel price forecasts from AEO2009. Both agencies regard AEO a credible source not only of such forecasts, but also of many underlying forecasts, including forecasts of the size the future light vehicle market.

[455] EPA also considered other sources of similar information, such as J.D. Powers, and concluded that CSM was better able to provide forecasts at the requisite level of detail for most of the model years of interest.

advantages and disadvantages of using a market forecast derived from public and commercial sources rather than from manufacturers' product plans, and conclude that the advantages outweigh the disadvantages.

Nevertheless, the agencies are hopeful that manufacturers will, in the future, agree to make public their plans regarding model years that are very near, such as MY 2010 or perhaps MY 2011, so that this information can be incorporated into an analysis that is available for public review and comment. In any event, because NHTSA and EPA are releasing market inputs used in the agencies' respective analyses, manufacturers, suppliers, and other automobile industry observers and participants can submit comments on how these inputs should be revised, as can all other reviewers. More information on the advantages and disadvantages of the current approach and the agencies' decision to follow it is available in Section II.B.3.

d. How Is This Baseline Different Quantitatively From the Baseline That NHTSA Used for the MY 2011 (March 2009) Final Rule?

As discussed above, the current baseline was developed from adjusted MY 2008 compliance data and covers MYs 2011–2016, while the baseline that NHTSA used for the MY 2011 CAFE rule was developed from confidential manufacturer product plans for MY 2011. This section describes, for the reader's comparison, some of the differences between the current baseline and the MY 2011 CAFE rule baseline.

Estimated vehicle sales:

The sales forecasts, based on the Energy Information Administration's (EIA's) Annual Energy Outlook 2009 (AEO 2009), used in the current baseline indicate that the total number of light vehicles expected to be sold during MYs 2011–2015 is 77 million, or about 15.4 million vehicles annually. NHTSA's MY 2011 final rule forecast, based on AEO 2008, of the total number of light vehicles likely to be sold during MY 2011 through MY 2015 was 83 million, or about 16.6 million vehicles annually. Light trucks are expected to make up 40 percent of the MY 2011 baseline market forecast in the current baseline, compared to 42 percent of the baseline market forecast in the MY 2011 final rule. These changes in both the overall size of the light vehicle market and the relative market shares of passenger cars and light trucks reflect changes in the economic forecast underlying AEO, and changes in AEO's forecast of future fuel prices.

The figures below attempt to demonstrate graphically the difference between the variation of fuel economy with footprint for passenger cars under the current baseline and MY 2011 final rule, and for light trucks under the current baseline and MY 2011 final rule, respectively. Figures IV.C.1–1 and 1–2 show the variation of fuel economy with footprint for passenger car models in the current baseline and in the MY 2011 final rule, while Figures IV.C.1–3 and 1–4 show the variation of fuel economy with footprint for light truck models in the current baseline and in the MY 2011 final rule. However, it is difficult to draw meaningful conclusions by comparing figures from the current baseline with those of the MY 2011 final rule. In the current baseline the number of make/models, and their associated fuel economy and footprint, are fixed and do not vary over time—this is why the number of data points in the current baseline figures appears smaller as compared to the number of data points in the MY 2011 final rule baseline. In contrast, the baseline fleet used in the MY 2011 final rule varies over time as vehicles (with different fuel economy and footprint characteristics) are added to and dropped from the product mix.

Figure IV.C.1-1. Planned Fuel Economy vs. Footprint, Passenger Cars in Current Baseline

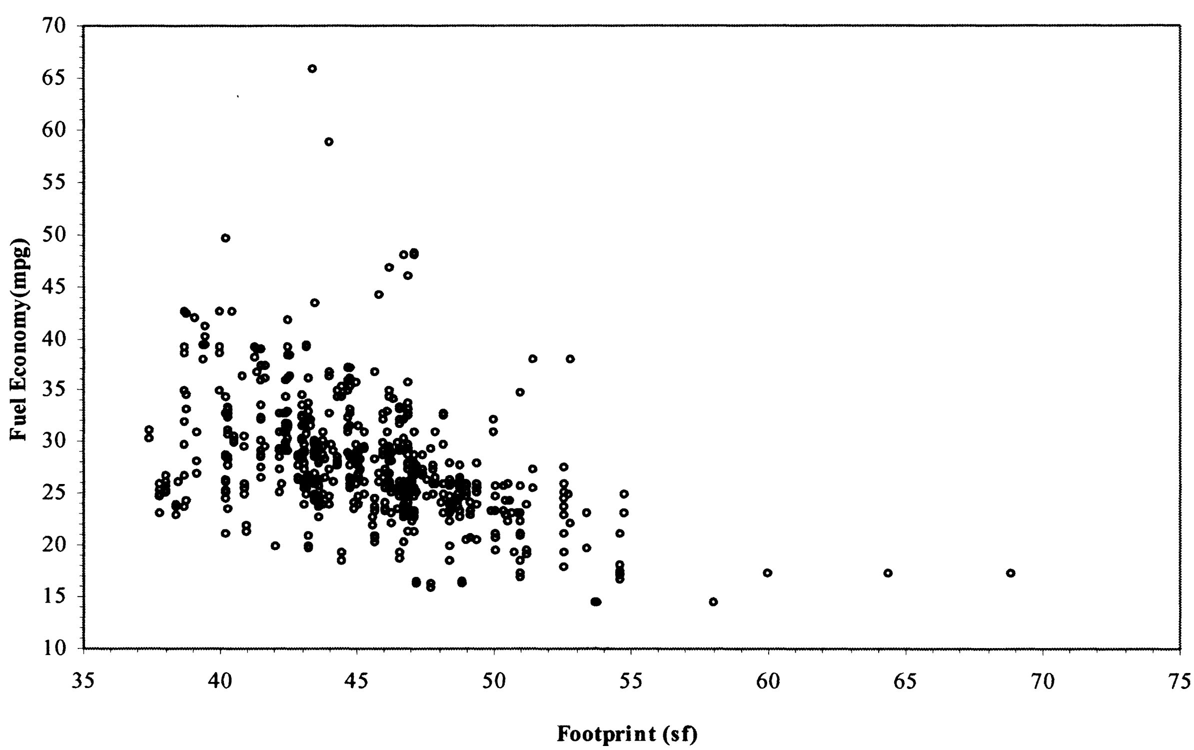


Figure IV.C.1-2. Planned Fuel Economy vs. Footprint, Passenger Cars in MY 2011 Final Rule

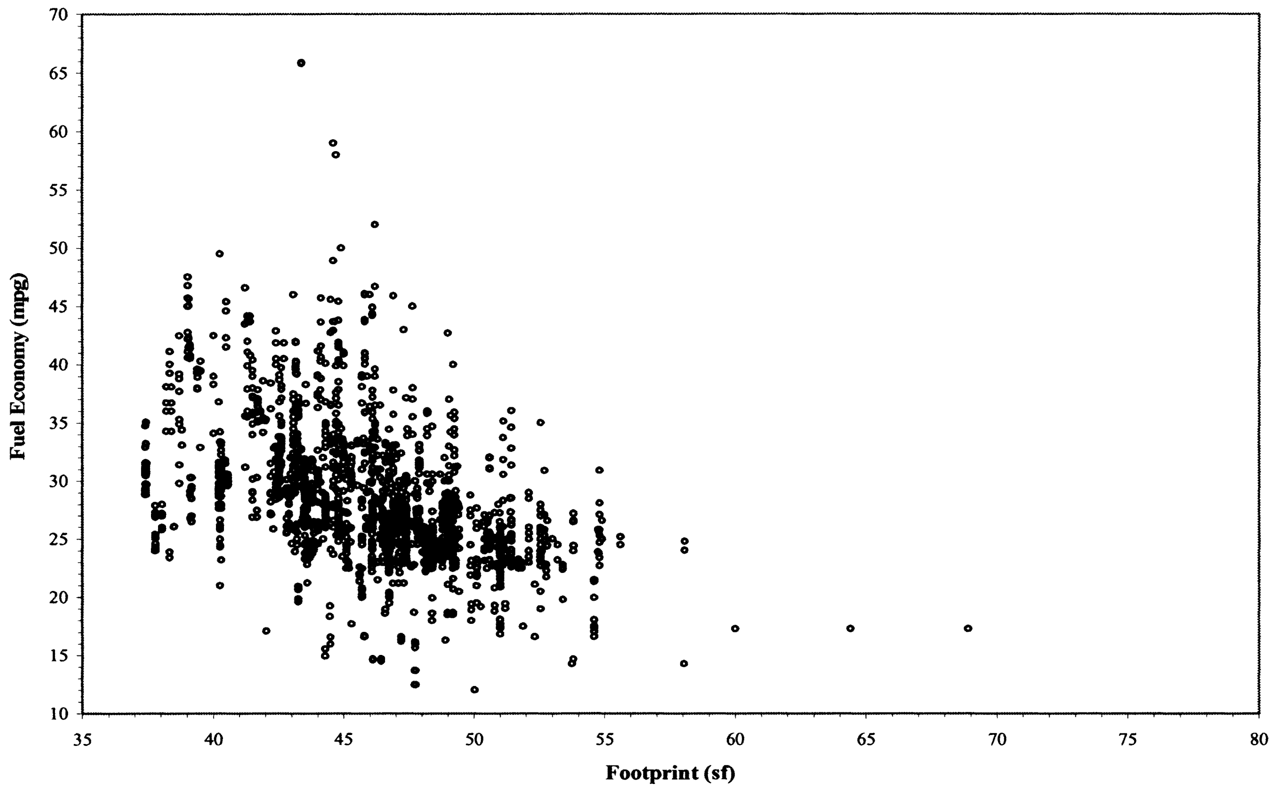


Figure IV.C.1-3. Planned Fuel Economy vs. Footprint, Light Trucks in Current Baseline

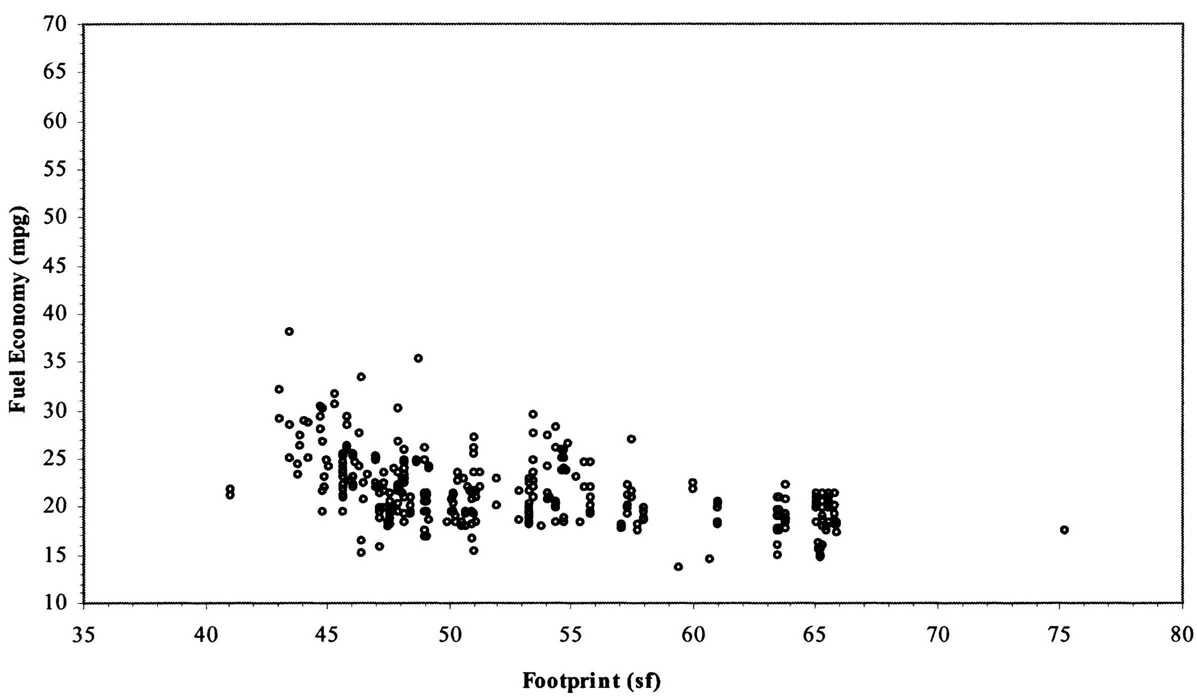
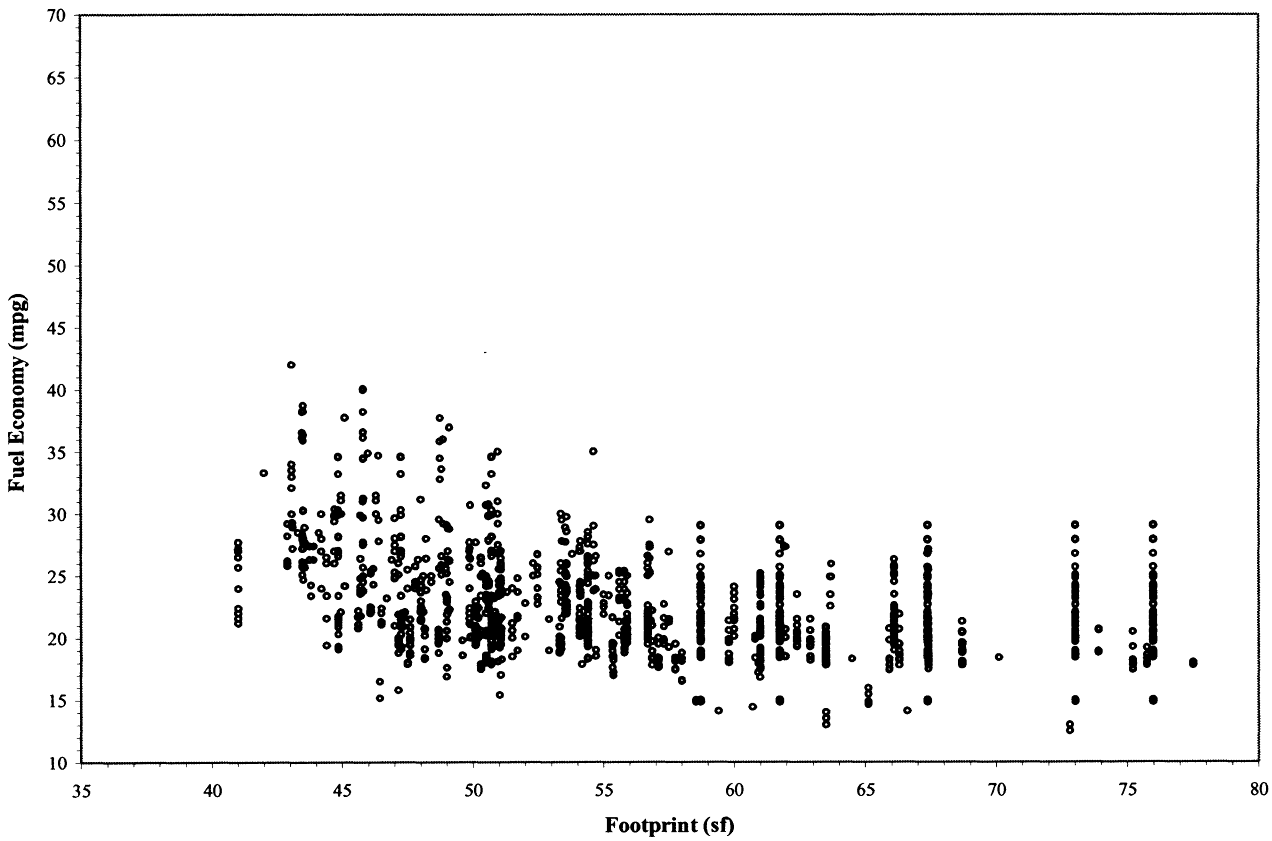


Figure IV.C.1-4. Planned Fuel Economy vs. Footprint, Light Trucks in MY 2011 Final Rule



Estimated manufacturer market shares:

NHTSA's expectations regarding manufacturers' market shares (the basis for which is discussed below) have also changed since the MY 2011 final rule. These changes are reflected below in Table IV.C.1–1, which shows the agency's sales forecasts for passenger cars and light trucks under the current baseline and the MY 2011 final rule.[456]

TABLE IV.C.1–1—SALES FORECASTS

[Production for U.S. sale in MY 2011, thousand units]

Manufacturer	Current baseline		MY 2011 final rule	
	Passenger	Nonpassenger	Passenger	Nonpassenger
Chrysler	194	403	707	1,216
Ford	1,230	944	1,615	1,144
General Motors	1,156	1,314	1,700	1,844
Honda	996	571	1,250	470
Hyundai	570	127	655	221
Kia[457]	302	98		
Nissan	794	421	789	479
Toyota	1,474	1,059	1,405	1,094
Other Asian	631	212	441	191
European	888	399	724	190
Total	8,235	5,547	9,286	6,849

Dual-fueled vehicles:

Manufacturers have also, during and since MY 2008, indicated plans to sell more dual-fueled or flexible-fuel vehicles (FFVs) in MY 2011 than

[456] As explained below, although NHTSA normalized each manufacturer's overall market share to produce a realistically-sized fleet, the product mix for each manufacturer that submitted product plans was preserved. The agency has reviewed manufacturers' product plans in detail, and understands that manufacturers do not sell the same mix of vehicles in every model year.

[457] Kia is not listed in the table for the MY 2011 final rule because it was considered as part of Hyundai for purposes of that analysis (*i.e.*, Hyundai-Kia).

indicated in the current baseline of adjusted MY 2008 compliance data. FFVs create a potential market for alternatives to petroleum-based gasoline and diesel fuel. For purposes of determining compliance with CAFE standards, the fuel economy of a FFV is, subject to limitations, adjusted upward to account for this potential.[458] However, NHTSA is precluded from ''taking credit'' for the compliance flexibility by accounting for manufacturers' ability to earn and use credits in setting the level of the standards.''[459] Some manufacturers plan to produce a considerably greater share of FFVs than can earn full credit under EPCA. The projected average FFV share of the market in MY 2011 is 6 percent for the current baseline, versus 17 percent for the MY 2011 final rule.

Estimated achieved fuel economy levels:

Because manufacturers' product plans also reflect simultaneous changes in fleet mix and other vehicle characteristics, the relationship between increased technology utilization and increased fuel economy cannot be isolated with any certainty. To do so would require an apples-to-apples ''counterfactual'' fleet of vehicles that are, except for technology and fuel economy, identical—for example, in terms of fleet mix and vehicle performance and utility. The current baseline market forecast shows industry-wide average fuel economy levels somewhat higher in MY 2011 than shown in the MY 2011 final rule. Under the current baseline, average fuel economy for MY 2011 is 26.7 mpg, versus 26.5 mpg under the baseline in the MY 2011 final rule.

These differences are shown in greater detail below in Table IV.C.1–2, which shows manufacturer-specific CAFE levels (not counting FFV credits that some manufacturers expect to earn) from the current baseline versus the MY 2011 final rule baseline (from manufacturers' 2008 product plans) for passenger cars and light trucks. Table IV.C.1–3 shows the combined averages of these planned CAFE levels in the respective baseline fleets. These tables demonstrate that, while the difference at the industry level is not so large, there are significant differences in CAFE at the manufacturer level between the current baseline and the MY 2011 final rule baseline. For example, while Honda and Hyundai are essentially the same under both, Toyota and Nissan show increased combined CAFE levels under the current baseline (by 2.4 and 0.8 mpg respectively), while Chrysler, Ford, and GM show decreased combined CAFE levels under the current baseline (by 1.1, 1.8, and 1.0 mpg, respectively) relative to the MY 2011 final rule baseline.

TABLE IV.C.1–2—CURRENT BASELINE PLANNED CAFE LEVELS IN MY 2011 VERSUS MY 2011 FINAL RULE PLANNED CAFE LEVELS

[Passenger and nonpassenger]

Manufacturer	Current baseline CAFE levels		MY 2011 planned CAFE levels	
	Passenger	Nonpassenger	Passenger	Nonpassenger
BMW	27.2	23.1	27.0	23.0
Chrysler	28.4	21.8	28.2	23.1
Ford	28.2	20.5	29.3	22.5
Subaru	29.1	25.6	28.6	28.6
General Motors	28.5	20.9	30.3	21.4
Honda	33.8	25.3	32.3	25.2
Hyundai	31.5	24.3	31.7	26.0
Tata	24.6	19.5	24.7	23.9
Kia [460]	31.7	23.7	....	....
Mazda [461]	31.0	26.7	....	....
Daimler	27.3	21.0	25.2	20.6
Mitsubishi	30.0	23.8	29.3	26.7
Nissan	31.9	21.5	31.3	21.4
Porsche	26.2	20.0	27.2	20.0
Ferrari [462]	....	....	16.2	....
Maserati [463]	....	....	18.2	....
Suzuki	30.5	23.3	28.7	24.0
Toyota	35.4	24.8	33.2	22.7
Volkswagen	28.6	20.2	28.5	20.1
Total/Average	30.8	22.3	30.4	22.6

[458] *See* 49 U.S.C. 32905 and 32906.

[459] 49 U.S.C. 32902(h).

[460] Again, Kia is not listed in the table for the MY 2011 final rule because it was considered as part of Hyundai for purposes of that analysis (*i.e.*, Hyundai-Kia).

[461] Mazda is not listed in the table for the MY 2011 final rule because it was considered as part of Ford for purposes of that analysis.

[462] EPA did not include Ferrari in the current baseline based on the conclusion that including them would not impact the results, and therefore Ferrari is not listed in the table for the current baseline.

[463] EPA did not include Maserati in the current baseline based on the conclusion that including them would not impact the results, and therefore Maserati is not listed in the table for the current baseline.

TABLE IV.C.1–3—CURRENT BASELINE PLANNED CAFE LEVELS IN MY 2011 VERSUS MY 2011 FINAL RULE PLANNED CAFE LEVELS (COMBINED)

Manufacturer	Current baseline	MY 2011 final rule baseline
BMW	25.6	26.0
Chrysler	23.6	24.7
Ford	24.2	26.0
Subaru	27.5	28.6
General Motors	23.9	24.9
Honda	30.1	30.0
Hyundai	29.9	30.0
Tata	21.1	24.4
Kia	29.3	....
Mazda	30.2	....
Daimler	24.7	23.6
Mitsubishi	29.1	29.1
Nissan	27.3	26.6
Porsche	23.2	22.0
Ferrari	....	16.2
Maserati	....	18.2
Suzuki	28.6	27.8
Toyota	30.0	27.6
Volkswagen	26.2	27.1
Total/Average	26.7	26.5

Tables IV.C.1–4 through 1–6 summarize other differences between the current baseline and manufacturers' product plans submitted to NHTSA in 2008 for the MY 2011 final rule. These tables present average vehicle footprint, curb weight, and power-to-weight ratios for each manufacturer represented in the current baseline and of the seven largest manufacturers represented in the product plan data, and for the overall industry. The tables containing product plan data do not identify manufacturers by name, and do not present them in the same sequence.

Tables IV.C.1–4a and 1–4b show that the current baseline reflects a slight decrease in overall average passenger vehicle size relative to the manufacturers' plans. This is a reflection of the market segment shifts underlying the sales forecasts of the current baseline.

TABLE IV.C.1–4a—CURRENT BASELINE AVERAGE MY 2011 VEHICLE FOOTPRINT

[Square Feet]

Manufacturer	PC	LT	Avg.
BMW	45.4	49.7	46.9
Chrysler	46.4	54.0	51.5
Ford	46.2	57.9	51.3
Subaru	43.1	46.3	44.4
General Motors	46.2	59.6	53.4
Honda	44.3	49.4	46.2
Hyundai	44.7	48.8	45.5
Tata	50.3	48.0	48.8
Kia	45.2	51.6	46.7
Mazda	44.3	46.9	44.7
Daimler	46.6	53.3	49.0
Mitsubishi	43.8	46.4	44.1
Nissan	45.2	55.4	48.8
Porsche	38.6	51.0	43.6
Suzuki	41.0	47.2	42.3
Toyota	44.0	51.1	47.0
Volkswagen	43.4	52.6	45.4
Industry Average	45.0	54.4	48.8

TABLE IV.C.1–4b—MY 2011 FINAL RULE AVERAGE PLANNED MY 2011 VEHICLE FOOTPRINT

[Square Feet]

	PC	LT	Avg.
Manufacturer 1	46.7	58.5	52.8
Manufacturer 2	46.0	5.4	47.1
Manufacturer 3	44.9	52.8	48.4
Manufacturer 4	45.4	55.8	49.3
Manufacturer 5	45.2	57.5	50.3
Manufacturer 6	48.5	54.7	52.4
Manufacturer 7	45.1	49.9	46.4
Industry Average	45.6	55.1	49.7

[460] Again, Kia is not listed in the table for the MY 2011 final rule because it was considered as part of Hyundai for purposes of that analysis (*i.e.,* Hyundai-Kia).

[461] Mazda is not listed in the table for the MY 2011 final rule because it was considered as part of Ford for purposes of that analysis.

[462] EPA did not include Ferrari in the current baseline based on the conclusion that including them would not impact the results, and therefore Ferrari is not listed in the table for the current baseline.

[463] EPA did not include Maserati in the current baseline based on the conclusion that including them would not impact the results, and therefore Maserati is not listed in the table for the current baseline.

Tables IV.C.1–5a and 1–5b show that the current baseline reflects a decrease in overall average vehicle weight relative to the manufacturers' plans. As above, this is most likely a reflection of the market segment shifts underlying the sales forecasts of the current baseline.

TABLE IV.C.1–5a—CURRENT BASELINE AVERAGE MY 2011 VEHICLE CURB WEIGHT

[Pounds]

Manufacturer	PC	LT	Avg.
BMW	3,535	4,612	3,900
Chrysler	3,498	4,506	4,178
Ford	3,516	4,596	3,985
Subaru	3,155	3,801	3,435
General Motors	3,495	5,030	4,311
Honda	3,021	4,064	3,401
Hyundai	3,135	4,080	3,307
Tata	3,906	5,198	4,717
Kia	3,034	4,057	3,284
Mazda	3,236	3,744	3,316
Daimler	3,450	5,123	4,045
Mitsubishi	3,238	3,851	3,312
Nissan	3,242	4,535	3,690
Porsche	3,159	4,907	3,874
Suzuki	2,870	3,843	3,080
Toyota	3,112	4,186	3,561
Volkswagen	3,479	5,673	3,959
Industry Average	3,280	4,538	3,786

TABLE IV.C.1–5b—MY 2011 FINAL RULE AVERAGE PLANNED MY 2011 VEHICLE CURB WEIGHT

[Pounds]

	PC	LT	Avg.
Manufacturer 1	3,197	4,329	3,692
Manufacturer 2	3,691	4,754	4,363
Manufacturer 3	3,293	4,038	3,481
Manufacturer 4	3,254	4,191	3,510
Manufacturer 5	3,547	5,188	4,401
Manufacturer 6	3,314	4,641	3,815
Manufacturer 7	3,345	4,599	3,865
Industry Average	3,380	4,687	3,935

Tables IV.C.1–6a and IV.C.1–6b show that the current baseline reflects a decrease in average performance relative to that of the manufacturers' product plans. This decreased performance is most likely a reflection of the market segment shifts underlying the sales forecasts of the current baseline, that is, an assumed shift away from higher performance vehicles.

TABLE IV.C.1–6a—CURRENT BASELINE AVERAGE MY 2011 VEHICLE POWER-TO-WEIGHT RATIO

[hp/lb]

Manufacturer	PC	LT	Avg.
BMW	0.072	0.061	0.068
Chrysler	0.055	0.052	0.053
Ford	0.058	0.053	0.056
Subaru	0.062	0.057	0.059
General Motors	0.056	0.056	0.056
Honda	0.057	0.054	0.056
Hyundai	0.051	0.055	0.052
Tata	0.077	0.057	0.064
Kia	0.050	0.056	0.051
Mazda	0.051	0.053	0.052
Daimler	0.066	0.056	0.062
Mitsubishi	0.053	0.056	0.053
Nissan	0.058	0.057	0.058
Porsche	0.105	0.073	0.092
Suzuki	0.049	0.062	0.052
Toyota	0.052	0.062	0.056
Volkswagen	0.058	0.052	0.056

TABLE IV.C.1–6a—CURRENT BASELINE AVERAGE MY 2011 VEHICLE POWER-TO-WEIGHT RATIO—Continued

[hp/lb]

Manufacturer	PC	LT	Avg.
Industry Average	0.056	0.056	0.056

TABLE IV.C.1–6b—MY 2011 FINAL RULE AVERAGE PLANNED MY 2011 VEHICLE POWER-TO-WEIGHT RATIO

[hp/lb]

	PC	LT	Avg.
Manufacturer 1	0.065	0.058	0.060
Manufacturer 2	0.061	0.065	0.062
Manufacturer 3	0.053	0.059	0.056
Manufacturer 4	0.060	0.058	0.059
Manufacturer 5	0.060	0.057	0.059
Manufacturer 6	0.063	0.065	0.065
Manufacturer 7	0.053	0.055	0.053
Industry Average	0.060	0.059	0.060

As discussed above, the agencies' market forecast for MY 2012–2016 holds the performance and other characteristics of individual vehicle models constant, adjusting the size and composition of the fleet from one model year to the next.

Refresh and redesign schedules (for application in NHTSA's modeling):

Expected model years in which each vehicle model will be redesigned or freshened constitute another important aspect of NHTSA's market forecast. As discussed in Section IV.C.2.c below, NHTSA's analysis supporting the current rulemaking times the addition of nearly all technologies to coincide with either a vehicle redesign or a vehicle freshening. Product plans submitted to NHTSA preceding the MY 2011 final rule contained manufacturers' estimates of vehicle redesign and freshening schedules and NHTSA's estimates of the timing of the five-year redesign cycle and the two- to three-year refresh cycle were made with reference to those plans. In the current baseline, in contrast, estimates of the timing of the refresh and redesign cycles were based on historical dates—*i.e.,* counting forward from known redesigns occurring in or prior to MY 2008 for each vehicle in the fleet and assigning refresh and redesign years accordingly. After applying these estimates, the shares of manufacturers' passenger car and light truck estimated to be redesigned in MY 2011 were as summarized below for the current baseline and the MY 2011 final rule. Table IV.C.1–7 below shows the percentages of each manufacturer's fleets expected to be redesigned in MY 2011 for the current baseline. Table IV.C.1–8 presents corresponding estimates from the market forecast used by NHTSA in the analysis supporting the MY 2011 final rule (again, to protect confidential information, manufacturers are not identified by name).

TABLE IV.C.1–7—CURRENT BASELINE, SHARE OF FLEET REDESIGNED IN MY 2011

Manufacturer	PC	LT	Avg.
BMW	32%	40%	34%
Chrysler	0%	11%	8%
Ford	12%	7%	10%
Subaru	0%	51%	22%
General Motors	20%	2%	11%
Honda	31%	33%	32%
Hyundai	20%	0%	16%
Tata	28%	100%	73%
Kia	35%	87%	48%
Mazda	0%	0%	0%
Daimler	0%	0%	0%
Mitsubishi	0%	56%	7%
Nissan	4%	18%	9%
Porsche	0%	100%	41%
Suzuki	8%	21%	11%
Toyota	4%	24%	12%
Volkswagen	23%	0%	18%
Industry Average	15%	17%	15%

TABLE IV.C.1–8—MY 2011 FINAL RULE, SHARE OF FLEET REDESIGNED IN MY 2011

	PC (percent)	LT (percent)	Avg. (percent)
Manufacturer 1	19	0	11

TABLE IV.C.1–8—MY 2011 FINAL RULE, SHARE OF FLEET REDESIGNED IN MY 2011—Continued

	PC (percent)	LT (percent)	Avg. (percent)
Manufacturer 2	34	27	29
Manufacturer 3	5	0	3
Manufacturer 4	7	0	5
Manufacturer 5	19	0	11
Manufacturer 6	34	28	33
Manufacturer 7	27	28	28
Overall	20	9	15

We continue, therefore, to estimate that manufacturers' redesigns will not be uniformly distributed across model years. This is in keeping with standard industry practices, and reflects what manufacturers actually do—NHTSA has observed that manufacturers in fact do redesign more vehicles in some years than in others. NHTSA staff have closely examined manufacturers' planned redesign schedules, contacting some manufacturers for clarification of some plans, and confirmed that these plans remain unevenly distributed over time. For example, although Table 8 shows that NHTSA expects Company 2 to redesign 34 percent of its passenger car models in MY 2011, current information indicates that this company will then redesign only (a different) 10 percent of its passenger cars in MY 2012. Similarly, although Table 8 shows that NHTSA expects four of the largest seven light truck manufacturers to redesign virtually no light truck models in MY 2011, current information also indicates that these four manufacturers will redesign 21–49 percent of their light trucks in MY 2012.

e. How Does Manufacturer Product Plan Data Factor Into the Baseline Used in This Proposal?

As discussed in Section II.B.4 above, while the agencies received updated product plans in Spring 2009 in response to NHTSA's request, the baseline data used in this proposal is not informed by these product plans, because they contain confidential business information the agencies are legally required to protect from disclosure, and because the agencies have concluded that, for purposes of this NPRM, a transparent baseline is preferable.

However, as also discussed above, NHTSA has conducted a separate analysis that does make use of these product plans, contained in NHTSA's PRIA. NHTSA performed this separate analysis for purposes of comparison only. NHTSA used the publicly available baseline for all analysis related to the development and evaluation of the proposed new CAFE standards.

2. How Were the Technology Inputs Developed?

As discussed above in Section II.E, for developing the technology inputs for the MY 2012–2016 CAFE and GHG standards, the agencies primarily began with the technology inputs used in the MY 2011 CAFE final rule and in the July 2008 EPA ANPRM, and then reviewed, as requested by President Obama in his January 26 memorandum, the technology assumptions that NHTSA used in setting the MY 2011 standards and the comments that NHTSA received in response to its May 2008 Notice of Proposed Rulemaking. In addition, the agencies supplemented their review with updated information from more current literature, new product plans and from EPA certification testing. More detail is available regarding how the agencies developed the technology inputs for this NPRM above in Section II.E, in Chapter 3 of the Draft Joint TSD, and in Section V of NHTSA's PRIA.

a. What Technologies Does NHTSA Consider?

Section II.E.1 above describes the fuel-saving technologies considered by the agencies that manufacturers could use to improve the fuel economy of their vehicles during MYs 2012–2016. The majority of the technologies described in this section are readily available, well known, and could be incorporated into vehicles once production decisions are made. As discussed, the technologies considered fall into five broad categories: Engine technologies, transmission technologies, vehicle technologies, electrification/accessory technologies, and hybrid technologies. Table IV.C.2–1 below lists all the technologies considered and provides the abbreviations used for them in the Volpe model,[464] as well as their year of availability, which for purposes of NHTSA's analysis means the first model year in the rulemaking period that the Volpe model is allowed to apply a technology to a manufacturer's fleet.[465] Year of availability recognizes that technologies must achieve a level of technical viability before they can be implemented in the Volpe model, and are thus a means of constraining technology use until such time as it is considered to be technologically feasible. For a more detailed description of each technology and their costs and effectiveness, we refer the reader to Chapter 3 of the joint TSD and Section V of NHTSA's PRIA.

TABLE IV.C.2–1—LIST OF TECHNOLOGIES IN NHTSA'S ANALYSIS

Technology	Model abbreviation	Year available
Low Friction Lubricants	LUB	2011
Engine Friction Reduction	EFR	2011
VVT—Coupled Cam Phasing (CCP) on SOHC	CCPS	2011
Discrete Variable Valve Lift (DVVL) on SOHC	DVVLS	2011
Cylinder Deactivation on SOHC	DEACS	2011

[464] The abbreviations are used in this section both for brevity and for the reader's reference if they wish to refer to the expanded decision trees and the model input and output sheets, which are available in Docket No. NHTSA–2009–0059 and on NHTSA's Web site.

[465] A date of 2011 means the technology can be applied in all model years, while a date of 2014 means the technology can only be applied in model years 2014 through 2016.

TABLE IV.C.2–1—LIST OF TECHNOLOGIES IN NHTSA'S ANALYSIS—Continued

Technology	Model abbreviation	Year available
VVT—Intake Cam Phasing (ICP)	ICP	2011
VVT—Dual Cam Phasing (DCP)	DCP	2011
Discrete Variable Valve Lift (DVVL) on DOHC	DVVLD	2011
Continuously Variable Valve Lift (CVVL)	CVVL	2011
Cylinder Deactivation on DOHC	DEADD	2011
Cylinder Deactivation on OHV	DEACO	2011
VVT—Coupled Cam Phasing (CCP) on OHV	CCPO	2011
Discrete Variable Valve Lift (DVVL) on OHV	DVVLO	2011
Conversion to DOHC with DCP	CDOHC	2011
Stoichiometric Gasoline Direct Injection (GDI)	SGDI	2011
Combustion Restart	CBRST	2014
Turbocharging and Downsizing	TRBDS	2011
Exhaust Gas Recirculation (EGR) Boost	EGRB	2013
Conversion to Diesel following CBRST	DSLC	2011
Conversion to Diesel following TRBDS	DSLT	2011
6-Speed Manual/Improved Internals	6MAN	2011
Improved Auto. Trans. Controls/Externals	IATC	2011
Continuously Variable Transmission	CVT	2011
6/7/8-Speed Auto. Trans with Improved Internals	NAUTO	2011
Dual Clutch or Automated Manual Transmission	DCTAM	2011
Electric Power Steering	EPS	2011
Improved Accessories	IACC	2011
12V Micro-Hybrid	MHEV	2011
Belt Integrated Starter Generator	BISG	2011
Crank Integrated Starter Generator	CISG	2011
Power Split Hybrid	PSHEV	2011
2-Mode Hybrid	2MHEV	2011
Plug-in Hybrid	PHEV	2011
Mass Reduction 1 (1.5%)	MS1	2011
Mass Reduction 2 (3.5%–8.5%)	MS2	2014
Low Rolling Resistance Tires	ROLL	2011
Low Drag Brakes	LDB	2011
Secondary Axle Disconnect 4WD	SAX	2011
Aero Drag Reduction	AERO	2011

For purposes of this NPRM and as discussed in greater detail in the joint TSD, NHTSA and EPA carefully reviewed the list of technologies used in the agency's analysis for the MY 2011 final rule. Given the relatively short amount of time, from a technology-development perspective, that has elapsed since March 2009 and this NPRM, NHTSA and EPA concluded that the considerable majority of technologies were correctly defined and continued to be appropriate for use in the analysis supporting the proposed standards. However, some refinements were made as discussed below.

Specific to its modeling, NHTSA has revised eight of the technologies used in the current analysis from those considered in the MY 2011 final rule. Specifically, two technologies which were previously unavailable in the MY 2011 time frame are now available (in the extended MY 2012–2016 period); one technology has been combined with another; one is newly introduced; three have revised names and/or definitions; and one has been deleted entirely. These changes are discussed further below, and NHTSA seeks comment on both these changes and the validation of the unchanged technology assumptions and estimates.

Availability: In the MY 2011 final rule, two of the engine technologies—EGR boost and combustion restart—were unavailable because they were not considered technologically feasible until beyond that rulemaking time frame. While both were described and discussed in the MY 2011 final rule, neither was applied in the modeling process that supported those standards.[466] In this analysis, EGR boost becomes available in MY 2013, and combustion restart in MY 2014, so both are being applied by the Volpe model, as needed, in this analysis.

Merging of technologies: In the MY 2011 final rule, higher voltage and improved alternator (HVIA) was used to represent changes in the design of the alternator, effectively optimizing it for higher efficiency (instead of for low cost as is typically done). For purposes of this analysis, the HVIA technology is no longer represented individually, but instead has been incorporated into a new-to-this-analysis technology called belt integrated starter generator, or BISG, as discussed next.

New technology: In the MY 2011 final rule, two levels of mild hybrid technology were defined: A 12 volt micro-hybrid (MHEV) system, which utilized a belt-driven starter generator operating at 12 volts, and the more capable integrated starter generator technology (ISG) operating at higher voltages (100 volts). ISG envisioned both belt and crank configured starter generator systems. In the current proposal, and in an effort to offer a broader spectrum of more diversified mild hybrid technologies for the modeling process to choose from, NHTSA has added the BISG technology to the electrification decision tree, and redefined the ISG technology to be a crank mounted version of ISG, accordingly renamed to CISG.

The BISG technology is a belt-coupled system like the 12-volt MHEV, but it operates at a higher voltage (*e.g.,* 42 volts) and thus can make use of regenerative braking, as well as

[466] As an additional note, since combustion restart was unavailable in the MY 2011 time frame, the technology titled diesel following combustion restart (DSLC), which as the name indicates was only applied after combustion restart, was also unavailable. Accordingly, DSLC, which was described and discussed in the MY 2011 final rule, is now available in the current analysis.

potentially adding some limited motive power. Since BISG is a higher voltage system, optimization of the alternator occurs as part of the BISG technology application; hence the HVIA technology is no longer needed as a separate technology. Additionally, the CISG technology is now defined as a crank mounted system that operates at higher voltages (100 volts) than BISG, yet at lower voltage than the strong hybrids (300 volts) that make greater use of regenerative braking and provide greater motive power capability. Thus, three levels of mild hybrid technology exist in the current proposal, as opposed to the two levels offered in the MY 2011 final rule.

Revisions and Deletions: The Mass Reduction/Material Substitution technologies have been revised for the current proposal. In the MY 2011 final rule, the Volpe model used three levels of material substitution technologies, referred to as MS1, MS2, and MS5, which were progressively applied to vehicles with curb weights in excess of 5,000 pounds (2,268 kg) so as to reduce weight by up to a 5 percent maximum. In keeping with the agency's desire to limit potential negative impacts to safety performance as a result of vehicle weight reduction, material substitution was not applied to vehicles with curb weights below 5,000 pounds. In contrast, in the current analysis, and in keeping with some manufacturers' stated plans to decrease overall fleet weights regardless of subclass or curb weight, NHTSA now defines two Mass Reduction/Material Substitution technologies as follows:

The Mass Reduction 1.5 percent (MS1) represents a 1.5 percent weight decrease through material substitution applicable to all vehicle subclasses, regardless of curb weight, that can be applied throughout the rulemaking period (and at refresh or redesign cycle times). This technology is similar to the MS1 technology used in the prior analysis in terms of the scale of the weight reduction (1 versus 1.5 percent), the methods and techniques manufacturers are anticipated to use in achieving the reductions, and when in the product cycle the model applies it (at refresh or redesign).

A second technology, Mass Reduction 3.5–8.5 percent (MS2), has also been defined. The MS2 technology is unavailable until MY 2014, and can only be applied by the Volpe model at a product redesign cycle. MS2 assumes a 3.5 to 8.5 percent weight reduction dependent on subclass (with the smaller/lighter subclasses receiving the lowest amounts of reduction, 3.5 percent, and the larger/heavier vehicles the 8.5 percent) via the types of more intrusive and complex mass reduction associated with a complete vehicle redesign.[467] MS2 is cumulative to MS1, as it is only applied after MS1, therefore the maximum weight reduction that can occur for smaller subclass vehicles is 5 percent, while large cars, truck, and SUVs could experience 10 percent weight reductions. Restricting weight reduction on smaller vehicle to lower limits, and vice versa for larger vehicles, is intended to mitigate or minimize the potential safety consequences from the modeled weight reductions. Postponing the availability of the technology until MY 2014 recognizes the lead time required to implement platform redesigns that would be necessary for these levels of weight reduction and mass reduction. NHTSA seeks comment on the agency's use of a two-step process, with the higher applications of MS in MYs 2014 and beyond, and the process of applying smaller mass reductions to lighter vehicles and higher reductions to heavier vehicles for the purpose of maintaining safety neutrality.

The MS5 technology used in the MY 2011 final rule is deleted.

Additionally, for purposes of this NPRM, NHTSA has revised the applicability of the diesel technologies to restrict it to vehicles with engines of 6 cylinders or more. NHTSA seeks comment on its decision not to apply diesel technologies to vehicles with 4-cylinder engines. NHTSA also seeks comment on the revised costing methodology for diesel technologies.

Besides these, all other technologies considered in this analysis were also considered in the analysis for the MY 2011 final rule, and although the costs and effectiveness estimates may have been revised as discussed further below, the other technologies remain otherwise unchanged for the purposes of this analysis in terms of their definition, functionality, and configuration. Thus, with this catalog of technologies as a starting point, NHTSA could then review and consider effectiveness and cost estimates for each technology, and, through the Volpe model analysis, how a manufacturer might feasibly apply these technologies to their MY 2012–2016 vehicles in order to achieve compliance with the proposed standards.

[467] Examples of such weight savings associated with new platform introductions have been provided in confidential product plan information provided by some manufacturers.

b. How Did NHTSA Determine the Costs and Effectiveness of Each of These Technologies for Use in Its Modeling Analysis?

Building on NHTSA's estimates developed for the MY 2011 CAFE final rule and EPA's Advanced Notice of Proposed Rulemaking, which relied on the 2008 Staff Technical Report,[468] the agencies took a fresh look at technology cost and effectiveness values for purposes of the joint proposal under the National Program. This joint work is reflected in Chapter 3 of the Draft Joint TSD and in Section II of this preamble, which is summarized below. For more detailed information on the effectiveness and cost of fuel-saving technologies, please refer to Chapter 3 of the joint TSD and Section V of NHTSA's PRIA.

Generally speaking, while NHTSA and EPA found that much of the cost information used in NHTSA's MY 2011 final rule and EPA's 2008 staff report was consistent to a great extent, the agencies, in reconsidering information from many sources, revised several component costs of several major technologies: turbocharging/downsizing, mild and strong hybrids, diesels, SGDI, and Valve Train Lift Technologies. These are discussed at length in the joint TSD and in NHTSA's PRIA. Additionally, most effectiveness estimates used in both the MY 2011 final rule and the 2008 EPA staff report were determined to be accurate and were carried forward without significant change into this rulemaking. When NHTSA and EPA's estimates for effectiveness diverged slightly due to differences in how agencies apply technologies to vehicles in their respective models, we report the ranges for the effectiveness values used in each model. For much more information on the costs and effectiveness of individual technologies, we refer the reader to Chapter 3 of the joint TSD and Section V of NHTSA's PRIA.

NHTSA notes that, in developing technology cost and effectiveness estimates, the agencies have made every effort to hold constant aspects of vehicle performance and utility typically valued by consumers, such as horsepower, carrying capacity, and towing and hauling capacity. For example, NHTSA includes in its analysis technology cost and effectiveness estimates that are specific to performance passenger cars (*i.e.,* sports cars), as compared to non-performance passenger cars. When

[468] EPA Staff Technical Report: Cost and Effectiveness Estimates of Technologies Used to Reduce Light-Duty Vehicle Carbon Dioxide Emissions. EPA420–R–08–008, March 2008.

commenting on the agencies' technology cost and effectiveness estimates, NHTSA urges commenters either to place any related comments within the same context, or explain any assumptions or estimates regarding increases or decreases in vehicle performance or utility. Additionally, NHTSA seeks comment on the extent to which commenters believe that the agencies have been successful in holding constant these elements of vehicle performance and utility in developing the technology cost and effectiveness estimates.

Additionally, NHTSA notes that the technology costs included in this NPRM take into account only those associated with the initial build of the vehicle. The agencies seek comments on the additional lifetime costs, if any, associated with the implementation of advanced technologies, including warranty, maintenance and replacement costs, such as the replacement costs for low rolling resistance tires, low friction lubricants, and hybrid batteries, and maintenance costs for diesel aftertreatment components.

While the agencies believe that the ideal estimates for the final rule would be based on tear down studies or BOM approach and subjected to a transparent peer-reviewed process, NHTSA and EPA are confident that the thorough review conducted, led to the best available conclusion regarding technology costs and effectiveness estimates for the current rulemaking and resulted in excellent consistency between the agencies' respective analyses for developing the CAFE and CO_2 standards.

NHTSA seeks comment on the incremental cost and effectiveness estimates employed by the agency in the Volpe modeling analysis for this NPRM, examples of which are provided in table form below. These example Tables present effectiveness and cost estimates which are incremental in nature, according to the decision trees used in the Volpe modeling analysis. Thus, the effectiveness and cost estimates are not absolute to a single baseline vehicle, but are incremental to the technology that precedes it.

BILLING CODE 6560–50–C

Table IV.C.2-2. Technology Effectiveness Estimates Employed in the Volpe Model for Certain Technologies

VEHICLE TECHNOLOGY INCREMENTAL FUEL CONSUMPTION REDUCTION (-%)

	Subcompact Car	Compact Car	Midsize Car	Large Car	Perform. Subcomp. Car	Perform. Compact Car	Perform. Midsize Car	Perform. Large Car	Minivan LT	Small LT	Midsize LT	Large LT
Nominal Baseline Engine (For Cost Basis)	Inline 4	Inline 4	Inline 4	V6	Inline 4	V6	V6	V8	V6	Inline 4	V6	V8
Low Friction Lubricants	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
VVT - Dual Cam Phasing (DCP)	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Discrete Variable Valve Lift (DVVL) on DOHC	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0
Cylinder Deactivation on OHV	n.a.	n.a.	n.a.	3.9 - 5.5	n.a.	3.9 - 5.5	3.9 - 5.5	3.9 - 5.5	3.9 - 5.5	n.a.	3.9 - 5.5	3.9 - 5.5
Stoichiometric Gasoline Direct Injection (GDI)	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Turbocharging and Downsizing	1.8 - 6.7	1.8 - 6.7	1.8 - 6.7	1.8 - 2.4	1.8 - 6.7	0.3 - 2.4	0.3 - 2.4	0.3 - 2.4	1.8 - 2.4	1.8 - 6.7	0.3 - 2.4	0.3 - 2.4
6/7/8-Speed Auto. Trans with Improved Internals	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4	1.4 - 3.4
Electric Power Steering	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0
12V Micro-Hybrid	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.5 - 3.5	2.0 - 3.0	2.5 - 3.5	2.5 - 3.5	3.0 - 4.0	2.5 - 3.5	2.0 - 3.0	2.5 - 3.5	n.a.
Crank mounted Integrated Starter Generator	8.6 - 8.9	8.6 - 8.9	8.6 - 8.9	8.6 - 8.9	8.6 - 8.9	8.7 - 8.9	8.7 - 8.9	8.6 - 8.9	8.7 - 8.9	8.6 - 8.9	8.7 - 8.9	14.1 - 16.3
Power Split Hybrid	3.0 - 12.3	3.0 - 12.3	3.0 - 12.3	3.0 - 12.3	3.0 - 12.3	3.0 - 12.3	3.0 - 12.3	3.0 - 12.3	3.0 - 12.3	3.0 - 12.3	3.0 - 12.3	n.a.
Aero Drag Reduction	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	n.a.	n.a.	n.a.	n.a.	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0

Table IV.C.2-3. Technology Cost Estimates Employed in the Volpe Model for Certain Technologies

VEHICLE TECHNOLOGY ICM COSTS PER VEHICLE ($)

	Subcompact Car	Compact Car	Midsize Car	Large Car	Perform. Subcomp. Car	Perform. Compact Car	Perform. Midsize Car	Perform. Large Car	Minivan LT	Small LT	Midsize LT	Large LT
Nominal Baseline Engine (For Basis)	Inline 4	Inline 4	Inline 4	V6	Inline 4	V6	V6	V8	V6	Inline 4	V6	V8
Low Friction Lubricants	3	3	3	3	3	3	3	3	3	3	3	3
VVT - Dual Cam Phasing (DCP)	38	38	38	83	38	83	83	82	83	38	83	83
Discrete Variable Valve Lift (DVVL) on DOHC	142	142	142	205	142	205	205	206	205	142	205	293
Cylinder Deactivation on OHV	n.a.	n.a.	n.a.	170	n.a.	170	170	192	170	n.a.	170	190
Stoichiometric Gasoline Direct Injection (GDI)	251	251	251	326	252	326	326	352	326	251	326	353
Turbocharging and Downsizing	420 - 644	420 - 644	420 - 644	242 - 900	420 - 644	242 - 900	242 - 900	692 - 1,238	242 - 900	420 - 644	242 - 900	692 - 1,238
6/7/8-Speed Auto. Trans with Improved Internals	170	170	170	170	170 - 272	170 - 272	170 - 272	170 - 272	170	170	170 - 272	170 - 272
Electric Power Steering	106	106	106	106	106	106	106	106	106	106	106	106
12V Micro-Hybrid	288	311	342	367	314	337	372	410	367	325	376	n.a.
Crank mounted Integrated Starter Generator	2,791	3,107	3,319	3,547	2,839	3,149	3,335	3,571	3,547	3,141	3,611	5,124
Power Split Hybrid	1,600 - 1,606	2,133 - 2,139	2664 - 2742	3,183 - 3,261	3,566 - 3,668	3,838 - 4,018	5,106 - 5,287	6,543 - 6,723	3,183 - 3,261	2,377 - 2,384	3,282 - 3,462	n.a.
Aero Drag Reduction	48	48	48	48	n.a.	n.a.	n.a.	n.a.	48	48	48	48

BILLING CODE 6560–50–C

c. How Does NHTSA Use These Assumptions in Its Modeling Analysis?

NHTSA's analysis, using the Volpe model, relies on several inputs and data files to conduct the compliance analysis, as discussed further below and in Section V of the PRIA. For the purposes of applying technologies, the Volpe model primarily uses three data files, one that contains data on the vehicles expected to be manufactured in the model years covered by the rulemaking, one that identifies the appropriate stage within the vehicle's life-cycle for the technology to be applied, and one that contains data/parameters regarding the available technologies the model can apply. These inputs are discussed below.

As discussed above, the Volpe model begins with an initial state of the domestic vehicle market, which in this case is the market for passenger cars and light trucks to be sold during the period covered by the proposed standards. The vehicle market is defined on a model-by-model, engine-by-engine, and transmission-by-transmission basis, such that each defined vehicle model refers to a separately defined engine and a separately defined transmission.

For the current proposal, which covers MYs 2012–2016, the light vehicle (passenger car and light truck) market forecast was developed jointly by NHTSA and EPA staff using MY 2008 CAFE compliance data. The MY 2008 compliance data includes about 1,100 vehicle models, about 400 specific engines, and about 200 specific transmissions, which is a somewhat lower level of detail in the representation of the vehicle market than that used by NHTSA in recent CAFE analyses.[469] However, within the limitations of information that can be made available to the public, it provides the foundation for a realistic analysis of manufacturer-specific costs and the analysis of attribute-based CAFE standards, and is much greater than the level of detail used by many other models and analyses relevant to light vehicle fuel economy.[470]

In addition to containing data about each vehicle, engine, and transmission, this file contains information for each technology under consideration as it pertains to the specific vehicle (whether the vehicle is equipped with it or not), the model year the vehicle is undergoing redesign, and information about the vehicle's subclass for purposes of technology application. In essence, the model considers whether it is appropriate to apply a technology to a vehicle.

Is a vehicle already equipped, or can it not be equipped, with a particular technology?

The market forecast file provides NHTSA the ability to identify, on a technology by technology basis, which technologies may already be present (manufactured) on a particular vehicle, engine, or transmission, or which technologies are not applicable (due to technical considerations) to a particular vehicle, engine, or transmission. These identifications are made on a model-by-model, engine-by-engine, and transmission-by-transmission basis. For example, if the market forecast file indicates that Manufacturer X's Vehicle Y is manufactured with Technology Z, then for this vehicle Technology Z will be shown as used. Additionally, NHTSA has determined that some technologies are only suitable or unsuitable when certain vehicle, engine, or transmission conditions exist. For example, secondary axle disconnect is only suitable for 4WD vehicles, and cylinder deactivation is unsuitable for any engine with fewer than 6 cylinders, while CVTs can only be applied to unibody vehicles. Similarly, comments received to the 2008 NPRM indicated that cylinder deactivation could not be applied to vehicles equipped with manual transmissions, due primarily to driveability and NVH concerns. The Volpe model employs "engineering constraints" to address issues like these, which are a programmatic method of controlling technology application that is independent of other constraints. Thus, the market forecast file would indicate that the technology in question should not be applied to the particular vehicle/engine/transmission (*i.e.*, is unavailable). Since multiple vehicle models may be equipped with an engine or transmission, this may affect multiple models. In using this aspect of the market forecast file, NHTSA ensures the Volpe model only applies technologies in an appropriate manner, since before any application of a technology can occur, the model checks the market forecast to see if it is either already present or unavailable.

NHTSA seeks comment on whether this approach is reasonable and ensures that technologies are applied in an appropriate manner.

Is a vehicle being redesigned or refreshed?

Manufacturers typically plan vehicle changes to coincide with certain stages of a vehicle's life cycle that are appropriate for the change, or in this case the technology being applied. In the automobile industry there are two terms that describe *when* technology changes to vehicles occur: redesign and refresh (*i.e.*, freshening). Vehicle *redesign* usually refers to significant changes to a vehicle's appearance, shape, dimensions, and powertrain. Redesign is traditionally associated with the introduction of "new" vehicles into the market, often characterized as the "next generation" of a vehicle, or a new platform. Vehicle *refresh* usually refers to less extensive vehicle modifications, such as minor changes to a vehicle's appearance, a moderate upgrade to a powertrain system, or small changes to the vehicle's feature or safety equipment content. Refresh is traditionally associated with mid-cycle cosmetic changes to a vehicle, within its current generation, to make it appear "fresh." Vehicle refresh generally occurs no earlier than two years after a vehicle redesign, or at least two years before a scheduled redesign. For the majority of technologies discussed today, manufacturers will only be able to apply them at a refresh or redesign, because their application would be significant enough to involve some level of engineering, testing, and calibration work.[471]

Some technologies (*e.g.*, those that require significant revision) are nearly always applied only when the vehicle is expected to be redesigned, like turbocharging and engine downsizing, or conversion to diesel or hybridization. Other technologies, like cylinder deactivation, electric power steering, and aerodynamic drag reduction can be applied either when the vehicle is expected to be refreshed or when it is expected to be redesigned, while a few others, like low friction lubricants, can be applied at any time, regardless of whether a refresh or redesign event is conducted. Accordingly, the model will only apply a technology at the particular point deemed suitable. These constraints are intended to produce results consistent with manufacturers' technology application practices. For each technology under consideration, NHTSA stipulates whether it can be applied any time, at refresh/redesign, or only at redesign. The data forms another input to the Volpe model. NHTSA develops redesign and refresh schedules for each of a manufacturer's vehicles included in the analysis, essentially based on the last known redesign year for each vehicle and projected forward in a 5-year redesign and a 2–3 year refresh cycle, and this data is also stored in the market forecast file. We note that this approach is different than NHTSA has employed previously for determining redesign and refresh schedules, where NHTSA included the redesign and refresh dates in the market forecast file as provided by manufacturers in confidential product plans. The new approach is necessary

[469] The market file for the MY 2011 final rule, which included data for MYs 2011–2015, had 5500 records, or rows, about 5 times what we are using in this analysis of the MY 2008 certification data. However, both market files had the same number of fields, or rows.

[470] Because CAFE standards apply to the average performance of each manufacturer's fleet of cars and light trucks, the impact of potential standards on individual manufacturers cannot be credibly estimated without analysis of fleets manufacturers can be expected to produce in the future. Furthermore, because required CAFE levels under an attribute-based CAFE standard depend on manufacturers' fleet composition, the stringency of an attribute-based standard cannot be predicted without performing analysis at this level of detail.

[471] For example, applying material substitution through weight reduction, or even something as simple as low rolling-resistance tires, to a vehicle will likely require some level of validation and testing to ensure that the vehicle may continue to be certified as compliant with NHTSA's Federal Motor Vehicle Safety Standards (FMVSS). Weight reduction might affect a vehicle's crashworthiness; low rolling-resistance tires might change vehicle's braking characteristics or how it performs in crash avoidance tests.

given the nature of the new baseline which as a single year of data does not contain its own refresh and redesign cycle cues for future model years, and to ensure the complete transparency of the agency's analysis. Vehicle redesign/refresh assumptions are discussed in more detail in Section V of the PRIA and in Chapter 3 of the TSD. NHTSA seeks comment on its application for this proposal of refresh and redesign schedules to manufacturers' vehicles counting from the last known redesign in or prior to the baseline fleet, as compared to its approach in the MY 2011 final rule.

Once the model has concluded that a technology should be applied to a vehicle, the model must evaluate which technology should be applied. This will depend on the vehicle subclass to which the vehicle is assigned; what technologies have already been applied to the vehicle (*i.e.*, where in the ''decision tree'' the vehicle is); when the technology is first available (*i.e.*, year of availability); whether the technology is still available (*i.e.*, ''phase-in caps''); and the costs and effectiveness of the technologies being considered. Technology costs may be reduced, in turn, by learning effects, while technology effectiveness may be increased or reduced by synergistic effects between technologies. In the technology input file, NHTSA has developed a separate set of technology data variables for each of the twelve vehicle subclasses. Each set of variables is referred to as an ''input sheet,'' so for example, the subcompact input sheet holds the technology data that is appropriate for the subcompact subclass. Each input sheet contains a list of technologies available for members of the particular vehicle subclass. The following items are provided for each technology: the name of the technology, its abbreviation, the decision tree with which it is associated, the (first) year in which it is available, the upper and lower cost and effectiveness (fuel consumption reduction) estimates, the learning type and rate, the cost basis, its applicability, and the phase-in values.

To which vehicle subclass is the vehicle assigned?

As part of its consideration of technological feasibility, the agency evaluates whether each technology could be implemented on all types and sizes of vehicles, and whether some differentiation is necessary in applying certain technologies to certain types and sizes of vehicles, and with respect to the cost incurred and fuel consumption and CO_2 emissions reduction achieved when doing so. The 2002 NAS Report differentiated technology application using ten vehicle ''classes'' (4 cars classes and 6 truck classes),[472] but did not determine how cost and effectiveness values differ from class to class. NAS's purpose in separating vehicles into these classes was to create groups of ''like'' vehicles, *i.e.*, vehicles similar in size, powertrain configuration, weight, and consumer use, and for which similar technologies are applicable. NHTSA similarly differentiates vehicles by ''subclass'' for the purpose of applying technologies to vehicles and assessing their incremental costs and effectiveness. NHTSA assigns each vehicle manufactured in the rulemaking period to one of 12 subclasses: for passenger cars, Subcompact, Subcompact Performance, Compact, Compact Performance, Midsize, Midsize Performance, Large, and Large Performance; and for light trucks, Small SUV/Pickup/Van, Midsize SUV/Pickup/Van, Large SUV/Pickup/Van, and Minivan.

For this NPRM as for the MY 2011 final rule, NHTSA divides the vehicle fleet into subclasses based on model inputs, and applies subclass-specific estimates, also from model inputs, of the applicability, cost, and effectiveness of each fuel-saving technology. Therefore, the model's estimates of the cost to improve the fuel economy of each vehicle model depend upon the subclass to which the vehicle model is assigned.

Each vehicle's subclass is stored in the market forecast file. When conducting a compliance analysis, if the Volpe model seeks to apply technology to a particular vehicle, it checks the market forecast to see if the technology is available and if the refresh/redesign criteria are met. If these conditions are satisfied, the model determines the vehicle's subclass from the market data file, which it then uses to reference another input called the technology input file. NHTSA reviewed its methodology for dividing vehicles into subclasses for purposes of technology application that it used in the MY 2011 final rule, and concluded that the same methodology would be appropriate for this NPRM for MYs 2012–2016, but the agency invites comments on the method of assigning vehicles to subclasses for the purposes of technology application in the CAFE model, and on the issue of technology-application subclasses generally. The subclasses and the methodology for dividing vehicles among them are discussed in more detail in Section V of the PRIA and in Chapter 3 of the TSD.

For the reader's reference, the subclasses and example vehicles from the market forecast file are provided in the tables below.

PASSENGER CAR SUBCLASSES EXAMPLE (MY 2008) VEHICLES

Class	Example vehicles
Subcompact	Chevy Aveo, Honda Civic.
Subcompact Performance	Mazda Miata, Saturn Sky.
Compact	Chevy Cobalt, Nissan Sentra and Altima.
Compact Performance	Audi S4 Quattro, Mazda RX8.
Midsize	Chevy Camaro (V6), Toyota Camry, Honda Accord, Hyundai Azera.
Midsize Performance	Chevy Corvette, Ford Mustang (V8), Nissan G37 Coupe.
Large	Audi A8, Cadillac CTS and DTS.
Large Performance	Bentley Arnage, Daimler CL600.

LIGHT TRUCK SUBCLASSES EXAMPLE (MY 2008) VEHICLES

Class	Example vehicles
Minivans	Dodge Caravan, Toyota Sienna.

[472] The NAS classes included subcompact cars, compact cars, midsize cars, large cars, small SUVs, midsize SUVs, large SUVs, small pickups, large pickups, and minivans.

LIGHT TRUCK SUBCLASSES EXAMPLE (MY 2008) VEHICLES—Continued

Class	Example vehicles
Small SUV/Pickup/Van	Ford Escape & Ranger, Nissan Rogue.
Midsize SUV/Pickup/Van	Chevy Colorado, Jeep Wrangler 4-door, Volvo XC70, Toyota Tacoma.
Large SUV/Pickup/Van	Chevy Silverado, Ford Econoline, Toyota Sequoia.

What technologies have already been applied to the vehicle (i.e., where in the ''decision trees'' is it)?

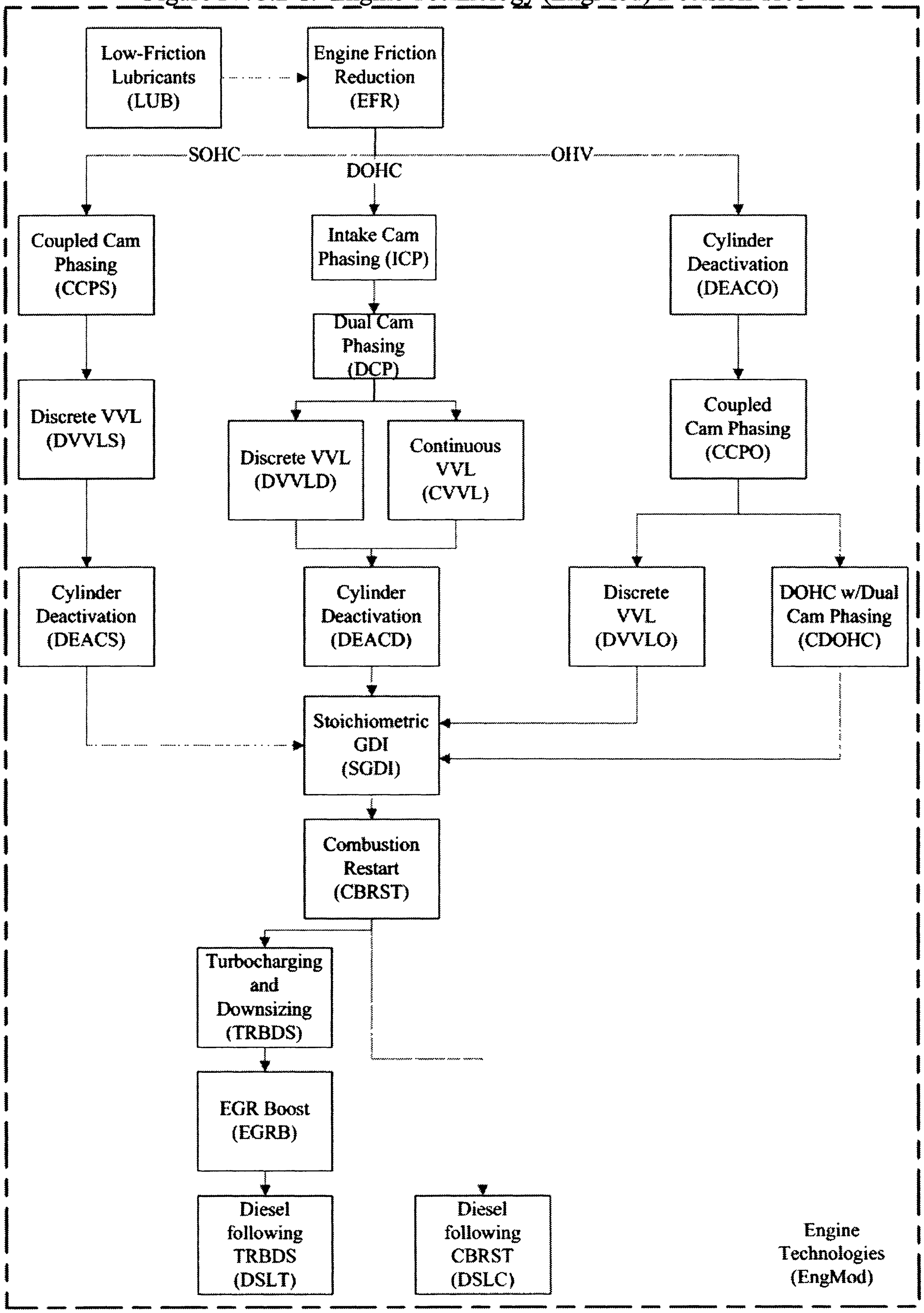
NHTSA's methodology for technology application analysis developed out of the approach taken by NAS in the 2002 Report, and evaluates the application of individual technologies and their incremental costs and effectiveness. Incremental costs and effectiveness of individual technologies are relative to the prior technology state, which means that it is crucial to understand what technologies are already present on a vehicle in order to determine correct incremental cost and effectiveness values. The benefit of the incremental approach is transparency in accounting, insofar as when individual technologies are added incrementally to individual vehicles, it is clear and easy to determine how costs and effectiveness adds up as technology levels increase.

To keep track of incremental costs and effectiveness and to know which technology to apply and in which order, the Volpe model's architecture uses a logical sequence, which NHTSA refers to as ''decision trees,'' for applying fuel economy-improving technologies to individual vehicles. In the MY 2011 final rule, NHTSA worked with Ricardo to modify previously-employed decision trees in order to allow for a much more accurate application of technologies to vehicles. For purposes of the NPRM, NHTSA reviewed the technology sequencing architecture and updated, as appropriate, the decision trees used in the analysis reported in the final rule for MY 2011.

In general, and as described in great detail in the MY 2011 final rule and in Section V of the current PRIA, each technology is assigned to one of the five following categories based on the system it affects or impacts: engine, transmission, electrification/accessory, hybrid or vehicle. Each of these categories has its own decision tree that the Volpe model uses to apply technologies sequentially during the compliance analysis. The decision trees were designed and configured to allow the Volpe model to apply technologies in a cost-effective, logical order that also considers ease of implementation. For example, software or control logic changes are implemented before replacing a component or system with a completely redesigned one, which is typically a much more expensive option. In some cases, and as appropriate, the model may combine the sequential technologies shown on a decision tree and apply them simultaneously, effectively developing dynamic technology packages on an as-needed basis. For example, if compliance demands indicate, the model may elect to apply LUB, EFR, and ICP on a dual overhead cam engine, if they are not already present, in one single step. An example simplified decision tree for engine technologies is provided below; the other simplified decision trees may be found in Chapter 3 of the joint TSD and in the PRIA. Expanded decision trees are available in the docket for this NPRM.

BILLING CODE 6560–50–C

Figure IV.C.2-1. Engine Technology (EngMod) Decision Tree



BILLING CODE 6560–50–C

Each technology within the decision trees has an incremental cost and an incremental effectiveness estimate associated with it, and estimates are specific to a particular vehicle subclass (*see* the tables in Section V of the PRIA). Each technology's incremental estimate takes into account its position in the decision tree path. If a technology is located further down the decision tree, the estimates for the costs and effectiveness values attributed to that technology are influenced by the incremental estimates of costs and effectiveness values for prior technology applications. In essence, this approach accounts for ''in-path'' effectiveness synergies, as well as cost effects that occur between the technologies in the same path. When comparing cost and effectiveness estimates from various sources and those provided by commenters in the previous CAFE rulemakings, it is important that the estimates evaluated are analyzed in the proper context, especially as concerns their likely position in the decision trees and other technologies that may be present or missing. Not all estimates available in the public domain or offered for the agencies' consideration during the comment period can be evaluated in an ''apples-to-apples'' comparison with those used by the Volpe model, since in some cases the order of application, or included technology content, is inconsistent with that assumed in the decision tree.

The MY 2011 final rule discussed in detail the revisions and improvements made to the Volpe model and decision trees during that rulemaking process, including the improved handling and accuracy of valve train technology application and the development and implementation of a method for accounting path-dependent correction factors in order to ensure that technologies are evaluated within the proper context. The reader should consult the MY 2011 final rule documents for further information on these modeling techniques, all of which continued to be utilized in developing this proposal.[473] To the extent that the decision trees have changed for purposes of this NPRM, it was due not to revisions in the order of technology application, but rather to redefinitions of technologies or addition or subtraction of technologies. NHTSA seeks comment on the decision trees described here and in the PRIA.

Is the next technology available in this model year?

As discussed above, the majority of technologies considered are available on vehicles today, and thus will be available for application in the rulemaking time frame. Some technologies, however, will not become available for purposes of NHTSA's analysis until later in the rulemaking time frame. When the model is considering whether to add a technology to a vehicle, it checks its year of availability—if the technology is available, it may be added; if it is not available, the model will consider whether to switch to a different decision tree to look for another technology, or will skip to the next vehicle in a manufacturer's fleet. The year of availability for each technology is provided above in Table IV.C.2–1.

Has the technology reached the phase-in cap for this model year?

Besides the refresh/redesign cycles used in the Volpe model, which constrain the rate of technology application at the vehicle level so as to ensure a period of stability following any modeled technology applications, the other constraint on technology application employed in NHTSA's analysis is ''phase-in caps.'' Unlike vehicle-level cycle settings, phase-in caps constrain technology application at the vehicle manufacturer level.[474] They are intended to reflect a manufacturer's overall resource capacity available for implementing new technologies (such as engineering and development personnel and financial resources), thereby ensuring that resource capacity is accounted for in the modeling process. At a high level, phase-in caps and refresh/redesign cycles work in conjunction with one another to avoid the modeling process out-pacing an OEM's limited pool of available resources during the rulemaking time frame, especially in years where many models may be scheduled for refresh or redesign. This helps to ensure technological feasibility and economic practicability in determining the stringency of the standards.

NHTSA has been developing the concept of phase-in caps over the course of the last several CAFE rulemakings, as discussed in greater detail in the MY 2011 final rule,[475] and in Section V of the PRIA and Chapter 3 of the joint TSD. The MY 2011 final rule employed non-linear phase-in caps (that is, caps that varied from year to year) that were designed to respond to comments raising lead-time concerns in reference to the agency's proposed MY 2011–2015 standards, but because the final rule covered only one model year, many phase-in caps for that model year were lower than had originally been proposed. NHTSA emphasized that the MY 2011 phase-in caps were based on assumptions for the full five year period of the proposal (2011–2015), and stated that it would reconsider the phase-in settings for all years beyond 2011 in a future rulemaking analysis.

For purposes of the current proposal for MYs 2012–2016, as in the MY 2011 final rule, NHTSA combines phase-in caps for some groups of similar technologies, such as valve phasing technologies that are applicable to different forms of engine design (SOHC, DOHC, OHV), since they are very similar from an engineering and implementation standpoint. When the phase-in caps for two technologies are combined, the maximum total application of either or both to any manufacturer's fleet is limited to the value of the cap.[476] In contrast to the phase-in caps used in the MY 2011 final rule, NHTSA has increased the phase-in caps for most of the technologies, as discussed below.

In developing phase-in cap values for purposes of the current proposal, NHTSA initially considered the fact that many of the technologies commonly applied by the model, those placed near the top of the decision trees, such as low friction lubes, valve phasing, electric power steering, improved automatic transmission controls, and others, have been commonly available to manufacturers for several years now. Many technologies, in fact, precede the 2002 NAS Report, which estimated that such technologies would take 4 to 8 years to penetrate the fleet. Since the current proposal would take effect in MY 2012, nearly 10 years beyond the NAS report, and extends to MY 2016, and in the interest of harmonization with EPA's proposal, NHTSA tentatively determined that higher phase-in caps were likely justified. Additionally, NHTSA considered the fact that manufacturers, as part of the agreements supporting the National Program, appear to be anticipating higher technology application rates than those used in the MY 2011 final rule. This also supported higher phase-in caps for purposes of the proposal.

Thus, while phase-in caps for the MY 2011 final rule reached a maximum of 50 percent for a couple of technologies and generally fell in the range between 0 and 20 percent, phase-in caps for this NPRM for the majority of technologies are set to reach 85 or 100 percent by MY 2016, although more advanced technologies like diesels and strong hybrids reach only 15 percent by MY 2016.

Theoretically, significantly higher phase-in caps, such as those used in the current proposal as compared to those used in the MY 2011 final rule, should

[473] *See, e.g.,* 74 FR 14238–46 (Mar. 30, 2009) for a full discussion of the decision trees in NHTSA's MY 2011 final rule, and Docket No. NHTSA–2009–0062–0003.1 for an expanded decision tree used in that rulemaking.

[474] While phase-in caps are expressed as specific percentages of a manufacturer's fleet to which a technology may be applied in a given model year, phase-in caps cannot always be applied as precise limits, and the Volpe model in fact allows ''override'' of a cap in certain circumstances. When only a small portion of a phase-in cap limit remains, or when the cap is set to a very low value, or when a manufacturer has a very limited product line, the cap might prevent the technology from being applied at all since any application would cause the cap to be exceeded. Therefore, the Volpe model evaluates and enforces each phase-in cap constraint after it has been exceeded by the application of the technology (as opposed to evaluating it before application), which can result in the described overriding of the cap.

[475] 74 FR 14268–14271 (Mar. 30, 2009).

[476] *See* 74 FR 14270 (Mar 30, 2009) for further discussion and examples.

result in higher levels of technology penetration in the modeling results. Reviewing the modeling output does not, however, indicate unreasonable levels of technology penetration for the proposed standards.[477] NHTSA believes that this is due to the interaction of the various changes in methodology for the current proposal—changes to phase-in caps are but one of a number of revisions to the Volpe model and its inputs that could potentially impact the rate at which technologies are applied in this proposal as compared to prior rulemakings. Other revisions that could impact application rates include the use of transparent CAFE certification data in baseline fleet formulation and the use of other data for projecting it forward,[478] or the use of a multi-year planning programming technique to apply technology retroactively to earlier-MY vehicles, both of which may have a direct impact on the modeling process. Conversely the model and inputs remain unchanged in other areas that also could impact technology application, such as in the refresh/ redesign cycle settings, estimates used for the technologies, both of which remain largely unchanged from the MY 2011 final rule. These changes together make it difficult to predict how phase-in caps should be expected to function in the new modeling process.

Thus, after reviewing the output files, NHTSA tentatively concludes that the higher phase-in caps, and the resulting technology application rates produced by the Volpe model, at both the industry and manufacturer level, are appropriate for this proposal, achieving a suitable level of stringency without requiring unrealistic or unachievable penetration rates. However, the agency will consider comments received on this approach in determining what phase-in caps to employ in the analysis for the final rule, and may change the caps in response to comments and/or further analysis. One additional question the agency has, which may be primarily academic at this point, is what impact lower phase-in caps, such as those used in earlier rulemakings, would have on compliance costs (and whether they might counter-intuitively increase costs by forcing more expensive technologies). NHTSA seeks comment on the revised phase-in caps as compared to the MY 2011 final rule, and particularly on whether, combined with the refresh and redesign assumptions, they help to ensure sufficient lead time for manufacturers to make the technology changes required by the proposed standards. Readers are invited to review and assess the phase-in caps listed and described more fully in Section V of the PRIA, along with the application and penetration rates found in the Volpe model's output files, and after making their own assessment, provide comment and recommendations to the agency as appropriate.

Is the technology less expensive due to learning effects?

Historically, NHTSA did not explicitly account for the cost reductions a manufacturer might realize through learning achieved from experience in actually applying a technology. Since working with EPA to develop the 2008 NPRM for MYs 2011–2015, and with Ricardo to refine the concept for the March 2009 MY 2011 final rule, NHTSA has accounted for these cost reductions through two kinds of mutually exclusive learning, ''volume-based'' and ''time-based'' which it continues to use in this proposal, as discussed below.

In the 2008 NPRM, NHTSA applied learning factors to technology costs for the first time. These learning factors were developed using the parameters of learning threshold, learning rate, and the initial cost, and were based on the ''experience curve'' concept which describes reductions in production costs as a function of accumulated production volume. The typical curve shows a relatively steep initial decline in cost which flattens out to a gentle downwardly sloping line as the volume increase to large values. In the NPRM, NHTSA applied a learning rate discount of 20 percent for each successive doubling of production volume (on a per manufacturer basis), and a learning threshold of 25,000 units was assumed (thus a technology was viewed as being fully learned out at 100,000 units). The factor was only applied to certain technologies that were considered emerging or newly implemented on the basis that significant cost improvements would be achieved as economies of scale were realized (*i.e.*, the technologies were on the steep part of the curve).

In the MY 2011 final rule, NHTSA continued to use this learning factor, referring to it as volume-based learning since the cost reductions were determined by production volume increases, and again only applied it to emerging technologies. However, and in response to comments, NHTSA revised its assumptions on learning threshold, basing them instead on an industry-wide production basis, and increasing the threshold to 300,000 units annually.

Commenters to the 2008 NPRM also described another type of learning factor which NHTSA decided to adopt and implement in the MY 2011 final rule. Commenters described a relatively small negotiated cost decrease that occurred on an annual basis through contractual agreements with first tier component and systems suppliers for readily available, high volume technologies commonly in use by multiple OEMs. Based on the same experience curve principal, however at production volumes that were on the flatter part of the curve (and thus the types of volumes that represent annual industry volumes), NHTSA adopted this type learning and referred to it as time-based learning. An annual cost reduction of 3 percent in the second and each subsequent year, which was consistent with estimates from commenters and supported by work Ricardo conducted for NHTSA, was used in the final rule.

In developing this proposal, NHTSA and EPA have reviewed both types of learning factors, and the thresholds (300,000) and reduction rates (20 percent for volume,[479] 3 percent for time-based) they rely on, and as implemented in the MY 2011 final rule, and agreed that both factors continue to be accurate and appropriate; each agency has thus implemented time- and volume-based learning in their analyses. Noting that only one type of learning can be applied to any single technology, if any learning is applied at all, the agencies reviewed each to determine which learning factor was appropriate. Volume-based learning is applied to the higher complexity hybrid technologies, while no learning is applied to technologies likely to be affected by commodity costs (LUB, ROLL) or that have loosely-defined BOMs (EFR, LDB), as was the case in the MY 2011 final rule. Chapter 3 of the joint TSD shows the specific learning factors that NHTSA has applied in this analysis for each technology, and discusses learning factors and each agencies' use of them further. NHTSA seeks comment on its use of learning factors, including the types, the thresholds, and the reduction rates proposed, and particularly on the revisions to the learning (time- and volume-based) logic as compared to the MY 2011 final rule.

Is the technology more or less effective due to synergistic effects?

When two or more technologies are added to a particular vehicle model to

[477] The modeling output for the analysis underlying these proposed standards is available on NHTSA's Web site.

[478] The baseline fleet sets the starting point, from a technology point of view, for where the model begins the technology application process, so changes have a direct impact on the net application of technology.

[479] NHTSA will conduct a sensitivity analysis on the volume-based learning value of 20 percent for the final rule.

improve its fuel efficiency and reduce CO_2 emissions, the resultant fuel consumption reduction may sometimes be higher or lower than the product of the individual effectiveness values for those items.[480] This may occur because one or more technologies applied to the same vehicle partially address the same source (or sources) of engine, drivetrain or vehicle losses. Alternately, this effect may be seen when one technology shifts the engine operating points, and therefore increases or reduces the fuel consumption reduction achieved by another technology or set of technologies. The difference between the observed fuel consumption reduction associated with a set of technologies and the product of the individual effectiveness values in that set is referred to for purposes of this rulemaking as a ''synergy.'' Synergies may be positive (increased fuel consumption reduction compared to the product of the individual effects) or negative (decreased fuel consumption reduction). An example of a positive synergy might be a vehicle technology that reduces road loads at highway speeds (*e.g.*, lower aerodynamic drag or low rolling resistance tires), that could extend the vehicle operating range over which cylinder deactivation may be employed. An example of a negative synergy might be a variable valvetrain system technology, which reduces pumping losses by altering the profile of the engine speed/load map, and a six-speed automatic transmission, which shifts the engine operating points to a portion of the engine speed/load map where pumping losses are less significant. As the complexity of the technology combinations is increased, and the number of interacting technologies grows accordingly, it becomes increasingly important to account for these synergies.

NHTSA and EPA determined synergistic impacts for this rulemaking using EPA's ''lumped parameter'' analysis tool, which EPA described at length in its March 2008 Staff Technical Report.[481] The lumped parameter tool is a spreadsheet model that represents energy consumption in terms of average performance over the fuel economy test procedure, rather than explicitly analyzing specific drive cycles. The tool begins with an apportionment of fuel consumption across several loss mechanisms and accounts for the average extent to which different technologies affect these loss mechanisms using estimates of engine, drivetrain and vehicle characteristics that are averaged over the EPA fuel economy drive cycle. Results of this analysis were generally consistent with those of full-scale vehicle simulation modeling performed in 2007 by Ricardo, Inc.

For the current rulemaking, NHTSA used the lumped parameter tool as modified in the MY 2011 CAFE final rule. NHTSA modified the lumped parameter tool from the version described in the EPA Staff Technical Report in response to public comments received in its rulemaking. The modifications included updating the list of technologies and their associated effectiveness values to match the updated list of technologies used in the final rule. NHTSA also expanded the list of synergy pairings based on further consideration of the technologies for which a competition for losses would be expected. These losses are described in more detail in Section V of the PRIA.

NHTSA and EPA incorporate synergistic impacts in their analyses in slightly different manners. Because NHTSA applies technologies individually in its modeling analysis, NHTSA incorporates synergistic effects between pairings of individual technologies. The use of discrete technology pair incremental synergies is similar to that in DOE's National Energy Modeling System (NEMS).[482] Inputs to the Volpe model incorporate NEMS-identified pairs, as well as additional pairs from the set of technologies considered in the Volpe model.

NHTSA notes that synergies that occur within a decision tree are already addressed within the incremental values assigned and therefore do not require a synergy pair to address. For example, all engine technologies take into account incremental synergy factors of preceding engine technologies, and all transmission technologies take into account incremental synergy factors of preceding transmission technologies. These factors are expressed in the fuel consumption improvement factors in the input files used by the Volpe model.

For applying incremental synergy factors in separate path technologies, the Volpe model uses an input table (see the tables in Chapter 3 of the TSD and in the PRIA) which lists technology pairings and incremental synergy factors associated with those pairings, most of which are between engine technologies and transmission/electrification/hybrid technologies. When a technology is applied to a vehicle by the Volpe model, all instances of that technology in the incremental synergy table which match technologies already applied to the vehicle (either pre-existing or previously applied by the Volpe model) are summed and applied to the fuel consumption improvement factor of the technology being applied. Synergies for the strong hybrid technology fuel consumption reductions are included in the incremental value for the specific hybrid technology block since the model applies technologies in the order of the most effectiveness for least cost and also applies all available electrification and transmission technologies before applying strong hybrid technologies. NHTSA seeks comment on whether the synergistic effects presented are accurate, and whether there are other synergies that the agency may have overlooked.

d. Where Can Readers Find More Detailed Information About NHTSA's Technology Analysis?

Much more detailed information is provided in Section V of the PRIA, and a discussion of how NHTSA and EPA jointly reviewed and updated technology assumptions for purposes of this NPRM is available in Chapter 3 of the TSD. Additionally, all of NHTSA's model input and output files are now public and available for the reader's review and consideration. The technology input files can be found in the docket for this NPRM, Docket No. NHTSA–2009–0059, and on NHTSA's Web site. And finally, because much of NHTSA's technology analysis for purposes of this NPRM builds on the work that was done for the MY 2011 final rule, we refer readers to that document as well for background information concerning how NHTSA's methodology for technology application analysis has evolved over the past several rulemakings, both in response to comments and as a result of the agency's

[480] More specifically, the products of the differences between one and the technology-specific levels of effectiveness in reducing fuel consumption. For example, not accounting for interactions, if technologies A and B are estimated to reduce fuel consumption by 10% (*i.e.*, 0.1) and 20% (*i.e.*, 0.2) respectively, the ''product of the individual effectiveness values'' would be 1–0.1 times 1–0.2, or 0.9 times 0.8, which equals 0.72, corresponding to a combined effectiveness of 28% rather than the 30% obtained by adding 10% to 20%. The ''synergy factors'' discussed in this section further adjust these multiplicatively combined effectiveness values.

[481] EPA Staff Technical Report: Cost and Effectiveness Estimates of Technologies Used to Reduce Light-duty Vehicle Carbon Dioxide Emissions; EPA420–R–08–008, March 2008.

[482] U.S. Department of Energy, Energy Information Administration, *Transportation Sector Module of the National Energy Modeling System: Model Documentation 2007,* May 2007, Washington, DC, DOE/EIAM070(2007), at 29–30. *Available at http://tonto.eia.doe.gov/ftproot/modeldoc/m070(2007).pdf* (last accessed Jul. 6, 2009).

growing experience with this type of analysis.[483]

3. How Did NHTSA Develop the Economic Assumption Inputs?

NHTSA's preliminary analysis of alternative CAFE standards for the model years covered by this proposed rulemaking relies on a range of forecast variables, economic assumptions, and parameter values. This section describes the proposed sources of these forecasts, the rationale underlying each assumption, and the agency's preliminary choices of specific parameter values. These proposed economic values play a significant role in determining the benefits of alternative CAFE standards, as they have for the last several CAFE rulemakings. Under those alternatives where standards would be established by reference to their costs and benefits, these economic values also affect the levels of the CAFE standards themselves. Some of these variables have more important effects on the level of CAFE standards and the benefits from requiring alternative increases in fuel economy than do others.

In reviewing these variables and the agency's estimates of their values for purposes of this NPRM, NHTSA reconsidered previous comments it had received and reviewed newly available literature. As a consequence, the agency elected to revise some of its economic assumptions and parameter estimates, while retaining others. Some of the most important changes, which are discussed in greater detail below, as well as in Chapter 4 of the joint TSD and in Chapter VIII of the PRIA, include significant revisions to the markup factors for technology costs; reducing the rebound effect from 15 to 10 percent; and revising the value of reducing CO_2 emissions based on recent interagency efforts to develop estimates of this value for government-wide use. For the reader's reference, Table IV.C.3–1 below summarizes the values used to calculate the economic benefits from each alternative. The agency seeks comment on the economic assumptions presented in the table and discussed below.

TABLE IV.C.3–1—ECONOMIC VALUES FOR BENEFITS COMPUTATIONS

(2007$)

Fuel Economy Rebound Effect	10%
"Gap" between test and on-road MPG	20%
Value of refueling time per ($ per vehicle-hour)	$ 24.64
Annual growth in average vehicle use	1.1%
Fuel Prices (2012–50 average, $/gallon)	
Retail gasoline price	$3.77
Pre-tax gasoline price	$3.40
Economic Benefits from Reducing Oil Imports ($/gallon)	
"Monopsony" Component	$ 0.00
Price Shock Component	$ 0.17
Military Security Component	$ 0.00
Total Economic Costs ($/gallon)	$ 0.17
Emission Damage Costs (2020, $/ton or $/metric ton)	
Carbon monoxide	$ 0
Volatile organic compounds (VOC)	$ 1,283
Nitrogen oxides (NO_x)—vehicle use	$ 5,116
Nitrogen oxides (NO_x)—fuel production and distribution	$ 5,339
Particulate matter ($PM_{2.5}$)—vehicle use	$ 238,432
Particulate matter ($PM_{2.5}$)—fuel production and distribution	$ 292,180
Sulfur dioxide (SO_2)	$ 30,896
Carbon dioxide (CO_2)	$ 20
Annual Increase in CO_2 Damage Cost	3%
External Costs from Additional Automobile Use ($/vehicle-mile)	
Congestion	$ 0.054
Accidents	$ 0.023
Noise	$ 0.001
Total External Costs	$ 0.078
External Costs from Additional Light Truck Use ($/vehicle-mile)	
Congestion	$0.048
Accidents	$0.026
Noise	$0.001
Total External Costs	$0.075
Discount Rate Applied to Future Benefits	3%

a. Costs of Fuel Economy-Improving Technologies

We developed detailed estimates of the costs of applying fuel economy-improving technologies to vehicle models jointly with EPA for use in analyzing the impacts of alternative standards considered in this rulemaking. The estimates were based on those reported by the 2002 NAS Report analyzing costs for increasing fuel economy, but were modified for purposes of this analysis as a result of extensive consultations among engineers from NHTSA, EPA, and the Volpe Center. As part of this process, the agency also developed varying cost estimates for applying certain fuel economy technologies to vehicles of different sizes and body styles. We may adjust these cost estimates based on comments received to this NPRM.

The technology cost estimates used in this analysis are intended to represent

[483] 74 FR 14233–308 (Mar. 30, 2009).

manufacturers' direct costs for high-volume production of vehicles with these technologies and sufficient experience with their application so that all remaining cost reductions due to ''learning curve'' effects have been fully realized. However, NHTSA recognizes that manufacturers' actual costs for employing these technologies include additional outlays for accompanying design or engineering changes to models that use them, development and testing of prototype versions, recalibrating engine operating parameters, and integrating the technology with other attributes of the vehicle. Manufacturers' indirect costs for employing these technologies also include expenses for product development and integration, modifying assembly processes and training assembly workers to install them, increased expenses for operation and maintaining assembly lines, higher initial warranty costs for new technologies, any added expenses for selling and distributing vehicles that use these technologies, and manufacturer and dealer profit. In previous CAFE rulemakings and in NHTSA's safety rulemakings, the agency has accounted for these additional costs by using a Retail Price Equivalent (RPE) multiplier of 1.5. For purposes of this rulemaking, based on recent work by EPA, NHTSA has applied indirect cost multipliers ranging from 1.11 to 1.64 to the estimates of vehicle manufacturers' direct costs for producing or acquiring each technology to improve fuel economy.[484] These multipliers vary with the complexity of each technology and the time frame over which costs are estimated. More complex technologies are associated with higher multipliers because of the larger increases in manufacturers' indirect costs for developing, producing (or procuring), and deploying these more complex technologies. The appropriate multipliers decline over time for technologies of all complexity levels, since increased familiarity and experience with their application is assumed to reduce manufacturers' indirect costs for employing them. NHTSA seeks comment regarding the new indirect cost multiplier approach to technology costs estimates. We note additionally that this issue will be addressed in the upcoming revised NAS report.

[484] NHTSA notes that in addition to the technology cost analysis employing this ''ICM'' approach, the PRIA contains a sensitivity analysis using a technology cost multiplier of 1.5.

b. Potential Opportunity Costs of Improved Fuel Economy

An important concern is whether achieving the fuel economy improvements required by alternative CAFE standards would require manufacturers to compromise the performance, carrying capacity, safety, or comfort of their vehicle models. To the extent that it does so, the resulting sacrifice in the value of these attributes to consumers represents an additional cost of achieving the required improvements in fuel economy. While exact dollar values of these attributes to consumers are difficult to infer, differences in vehicle purchase prices and buyers' choices among competing models that feature different combinations of these characteristics clearly demonstrate that changing vehicle attributes clearly affect the utility and economic value that vehicles provide to potential buyers.[485]

NHTSA and EPA have approached this potential problem by developing cost estimates for fuel economy-improving technologies that include any additional manufacturing costs that would be necessary to maintain the originally planned levels of performance, comfort, carrying capacity, and safety of any light-duty vehicle model to which those technologies are applied. In doing so, the agencies followed the precedent established by the 2002 NAS Report, which estimated ''constant performance and utility'' costs for fuel economy technologies. NHTSA has used these as the basis for its continuing efforts to refine the technology costs it uses to analyze manufacturer's costs for complying with alternative passenger car and light truck CAFE standards for MYs 2012–2016. Although the agency has revised its estimates of manufacturers' costs for some technologies significantly for use in this rulemaking, these revised estimates are still intended to represent costs that would allow manufacturers to maintain the performance, carrying capacity, and utility of vehicle models while improving their fuel economy.

Although we believe that our tentative cost estimates for fuel economy-improving technologies should be generally sufficient to prevent significant reductions in consumer welfare provided by vehicle models to which manufacturers apply those technologies, it is possible that they do not include adequate allowance for the necessary efforts by manufacturers to prevent sacrifices in these attributes on all vehicle models. If this is the case, the true economic costs of achieving higher fuel economy should include the opportunity costs to vehicle owners of any sacrifices in vehicles' performance, carrying capacity, and utility and the agency's estimated technology costs would underestimate the true economic costs of improving fuel economy.

[485] *See, e.g.,* Kleit A.N., 1990. ''The Effect of Annual Changes in Automobile Fuel Economy Standards.'' Journal of Regulatory Economics 2: 151–172; Berry, Steven, James Levinsohn, and Ariel Pakes, 1995. ''Automobile Prices in Market Equilibrium,'' Econometrica 63(4): 841–940; McCarthy, Patrick S., 1996. ''Market Price and Income Elasticities of New Vehicle Demands.'' Review of Economics and Statistics 78: 543–547; and Goldberg, Pinelopi K., 1998. ''The Effects of the Corporate Average Fuel Efficiency Standards in the US,'' *Journal of Industrial Economics* 46(1): 1–33.

Recognizing this possibility, it may be preferable for NHTSA to estimate explicitly the changes in vehicle buyers' welfare from the combination of higher prices for new vehicle models, increases in their fuel economy, and any accompanying changes in vehicle attributes such as performance, passenger- and cargo-carrying capacity, or other dimensions of utility. The net change in buyer's welfare that results from the combination of these changes would provide a more accurate estimate of the true economic costs for improving fuel economy. The agency seeks comment on this or other possible ways to deal with this extremely important issue.

c. The On-Road Fuel Economy ''Gap''

Actual fuel economy levels achieved by light-duty vehicles in on-road driving fall somewhat short of their levels measured under the laboratory-like test conditions used by EPA to establish its published fuel economy ratings for different models. In analyzing the fuel savings from alternative CAFE standards, NHTSA has previously adjusted the actual fuel economy performance of each light truck model downward from its rated value to reflect the expected size of this on-road fuel economy ''gap.'' On December 27, 2006, EPA adopted changes to its regulations on fuel economy labeling, which were intended to bring vehicles' rated fuel economy levels closer to their actual on-road fuel economy levels.[486]

In its Final Rule, EPA estimated that actual on-road fuel economy for light-duty vehicles averages 20 percent lower than published fuel economy levels. For example, if the overall EPA fuel economy rating of a light truck is 20 mpg, the on-road fuel economy actually achieved by a typical driver of that vehicle is expected to be 16 mpg (20*.80). NHTSA employed EPA's revised estimate of this on-road fuel economy gap in its analysis of the fuel

[486] 71 FR 77871 (Dec. 27, 2006).

savings resulting from alternative CAFE standards evaluated in the MY 2011 final rule.

For purposes of this NPRM, NHTSA conducted additional analysis of this issue. The agency used data on the number of passenger cars and light trucks of each model year that were registered for use during calendar years 2000 through 2006, average fuel economy for passenger cars and light trucks produced during each model year, and estimates of average miles driven per year by cars and light trucks of different ages. These data were combined to develop estimates of the average fuel economy that the U.S. passenger car and light truck fleets *would have achieved* from 2000 through 2006 under test conditions.

NHTSA compared these estimates to the Federal Highway Administration's (FHWA) published values of actual on-road fuel economy for passenger cars and light trucks during each of those years.[487] FHWA's estimates of actual fuel economy for passenger cars averaged 22 percent lower than NHTSA's estimates of its fleet-wide average value under test conditions over this period, while FHWA's estimates for light trucks averaged 17 lower than NHTSA's estimates of average light truck fuel economy under test conditions. These results appear to confirm that the 20 percent on-road fuel economy discount or gap represents a reasonable estimate for use in evaluating the fuel savings likely to result from alternative CAFE standards for MY 2012–2016 vehicles.

d. Fuel Prices and the Value of Saving Fuel

Projected future fuel prices are a critical input into the preliminary economic analysis of alternative CAFE standards, because they determine the value of fuel savings both to new vehicle buyers and to society. NHTSA relied on the most recent fuel price projections from the U.S. Energy Information Administration's (EIA) *Annual Energy Outlook* (AEO) for this analysis. Specifically, we used the AEO 2009 (April 2009 release) Reference Case forecasts of inflation-adjusted (constant-dollar) retail gasoline and diesel fuel prices, which represent the EIA's most up-to-date estimate of the most likely course of future prices for petroleum products.[488]

While NHTSA relied on the forecasts of fuel prices presented in AEO 2008 High Price Case in the MY 2011 final rule, we noted at the time that we were relying on that estimate primarily because volatility in the oil market appeared to have overtaken the Reference Case, and that we anticipated that the Reference Case forecast would be significantly higher in the next AEO. In fact, EIA's AEO 2009 Reference Case forecast projects *higher* retail fuel prices in most future years than those forecast in the High Price Case from AEO 2008. NHTSA is thus confident that the AEO 2009 Reference Case is an appropriate forecast for projected future fuel prices.

Measured in constant 2007 dollars, the Reference Case forecast of retail gasoline prices during calendar year 2020 is $3.62 per gallon, rising gradually to $3.82 by the year 2030 (these values include *Federal,* State and local taxes). To obtain fuel price forecasts for the years 2031 through 2050, the agency assumes that retail fuel prices will continue to increase after 2030 at the average annual rates projected for 2020–2030 in the AEO 2009 Revised Reference Case.[489] This assumption results in a projected retail price of gasoline that reaches $4.25 in 2007 dollars by the year 2050.

The value of fuel savings resulting from improved fuel economy to buyers of light-duty vehicles is determined by the retail price of fuel, which includes *Federal,* State, and any local taxes imposed on fuel sales. Total taxes on gasoline, including *Federal,* State, and local levies averaged $0.42 per gallon during 2006, while those levied on diesel averaged $0.50. Because fuel taxes represent transfers of resources from fuel buyers to government agencies, however, rather than real resources that are consumed in the process of supplying or using fuel, their value must be deducted from retail fuel prices to determine the value of fuel savings resulting from more stringent CAFE standards to the U.S. economy as a whole.

NHTSA follows the assumptions used by EIA in AEO 2009 that State and local gasoline taxes will keep pace with inflation in nominal terms, and thus remain constant when expressed in constant 2007 dollars. In contrast, EIA assumes that *Federal* gasoline taxes will remain unchanged in *nominal* terms, and thus decline throughout the forecast period when expressed in constant 2007 dollars. These differing assumptions about the likely future behavior of *Federal* and State/local fuel taxes are consistent with recent historical experience, which reflects the fact that *Federal* as well as most State motor fuel taxes are specified on a cents-per-gallon basis, and typically require legislation to change.

The projected value of total taxes is deducted from each future year's forecast of retail gasoline and diesel prices reported in AEO 2009 to determine the economic value of each gallon of fuel saved during that year as a result of improved fuel economy. Subtracting fuel taxes results in a projected value for saving gasoline of $3.22 per gallon during 2020, rising to $3.45 per gallon by the year 2030.

EIA includes ''High Price Case'' and ''Low Price Case'' forecasts in each AEO, which reflect uncertainties regarding future levels of oil production and demand. These alternative scenarios project retail gasoline prices that range from a low of $2.02 to a high of $5.04 per gallon during 2020, and from $2.04 to $5.47 per gallon during 2030. In conjunction with our assumption that fuel taxes will remain constant in real or inflation-adjusted terms over this period, these forecasts imply pre-tax values of saving fuel ranging from $1.63 to $4.65 per gallon during 2020, and from $1.67 to $5.10 per gallon in 2030. In conducting the preliminary analysis of uncertainty in benefits and costs from alternative CAFE standards required by OMB, NHTSA evaluated the sensitivity of its benefits estimates to these alternative forecasts of future fuel prices. The results of this sensitivity analysis can be found in the PRIA.

e. Consumer Valuation of Fuel Economy and Payback Period

In estimating the value of fuel economy improvements that would result from alternative CAFE standards to potential vehicle buyers, NHTSA assumes, as in the MY 2011 final rule, that buyers value the resulting fuel savings over only part of the expected lifetime of the vehicles they purchase. Specifically, we assume that buyers value fuel savings over the first five years of a new vehicle's lifetime, and discount the value of these future fuel savings at a 3 percent annual rate. The five-year figure represents

[487] Federal Highway Administration, Highway Statistics, 2000 through 2006 editions, Table VM–1; *see http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.cfm* (last accessed July 27, 2009).

[488] Energy Information Administration, Annual Energy Outlook 2009, Revised Updated Reference Case (April 2009), Table 12. *Available at http://www.eia.doe.gov/oiaf/servicerpt/stimulus/excel/aeostimtab_12.xls*(last accessed July 26, 2009). EIA's Updated Reference Case reflects the effects of the American Reinvestment and Recovery Act of 2009, as well as the most recent revisions to the U.S. and global economic outlook.

[489] This projection uses the rate of increase in fuel prices for 2020–2030 rather than that over the complete forecast period (2009–2030) because there is extreme volatility in the forecasts for the years 2009 through approximately 2020. Using the average rate of change over the complete 2009–2030 forecast period would result in projections of declining fuel prices after 2030.

approximately the current average term of consumer loans to finance the purchase of new vehicles. We recognize that the period over which individual buyers finance new vehicle purchases may not correspond exactly to the time horizons they apply in valuing fuel savings from higher fuel economy.

The agency deducts the discounted present value of fuel savings over the first five years of a vehicle model's lifetime from the technology costs incurred by its manufacturer to improve that model's fuel economy to determine the increase in its ''effective price'' to buyers. The Volpe model uses these estimates of effective costs for increasing the fuel economy of each vehicle model to identify the order in which manufacturers would be likely to select models for the application of fuel economy-improving technologies in order to comply with stricter standards. The average value of the resulting increase in effective cost from each manufacturer's simulated compliance strategy is also used to estimate the impact of alternative standards on its total sales for future model years.

However, it is important to recognize that NHTSA estimates the aggregate value to the U.S. economy of fuel savings resulting from alternative standards—or their ''social'' value—over the *entire* expected lifetimes of vehicles manufactured under those standards, rather than over this shorter ''payback period'' we assume for their buyers. The procedure the agency uses for doing so is discussed in detail in the following section.

f. Vehicle Survival and Use Assumptions

NHTSA's first step in estimating lifetime fuel consumption by vehicles produced during a model year is to calculate the number expected to remain in service during each year following their production and sale.[490] This is calculated by multiplying the number of vehicles originally produced during a model year by the proportion typically expected to remain in service at their age during each later year, often referred to as a ''survival rate.''

To estimate production volumes of passenger cars and light trucks for individual manufacturers, NHTSA relied on a baseline market forecast constructed by EPA staff beginning with MY 2008 CAFE certification data. After constructing a MY 2008 baseline, EPA used projected car and truck volumes for this period from Energy Information Administration's (EIA's) 2009 Annual Energy Outlook (AEO).[491] However, AEO projects sales only at the car and truck level, not at the manufacturer and model-specific level, which are needed in order to estimate the effects new standards will have on individual manufacturers.[492] Therefore, EPA purchased data from CSM–Worldwide and used their projections of the number of vehicles of each type predicted to be sold by manufacturers in 2011–2015.[493] This provided the year-by-year percentages of cars and trucks sold by each manufacturer as well as the percentages of each vehicle segment. Although it was thus necessary to assume the same manufacturer and segment shares in 2016 as in 2015, 2016 estimates from CSM should be available for the final rule. Using these percentages normalized to the AEO projected volumes then provided the manufacturer-specific market share and model-specific sales for model years 2011–2016.

To estimate the number of passenger cars and light trucks originally produced during model years 2012 through 2016 that will remain in use during each subsequent year the agency applied age-specific survival rates for cars and light trucks to these adjusted forecasts of passenger car and light truck sales. In 2008, NHTSA updated its previous estimates of car and light truck survival rates using the most current registration data for vehicles produced during recent model years, in order to ensure that they reflected recent increases in the durability and expected life spans of cars and light trucks.[494]

The next step in estimating fuel use is to calculate the total number of miles that model year 2012–2016 cars and light trucks remaining in use will be driven each year. To estimate total miles driven, the number projected to remain in use during each future year is multiplied by the average number of miles they are expected to be driven at the age they will reach in that year. The agency estimated annual usage of cars and light trucks of each age using data from the Federal Highway Administration's 2001 National Household Transportation Survey (NHTS).[495] Because these estimates reflect the historically low gasoline prices that prevailed at the time the 2001 NHTS was conducted, however, NHTSA adjusted them to account for the effect on vehicle use of subsequent increases in fuel prices. Details of this adjustment are provided in Chapter VIII of the PRIA and Chapter of the draft joint TSD.

Increases in average annual use of cars and light trucks have been an important source of historical growth in the total number of miles they are driven each year. To estimate future growth in their average annual use for purposes of this rulemaking, NHTSA calculated the rate of growth in the adjusted mileage schedules derived from the 2001 NHTS necessary for *total* car and light truck travel to increase at the rate forecast in the AEO 2009 Reference Case.[496] This rate was calculated to be consistent with future changes in the overall size and age distributions of the U.S. passenger car and light truck fleets that result from the agency's forecasts of total car and light truck sales and updated survival rates. The resulting growth rate in average annual car and light truck use of approximately 1.1 percent per year was

[490] Vehicles are defined to be of age 1 during the calendar year corresponding to the model year in which they are produced; thus for example, model year 2000 vehicles are considered to be of age 1 during calendar year 2000, age 1 during calendar year 2001, and to reach their maximum age of 26 years during calendar year 2025. NHTSA considers the maximum lifetime of vehicles to be the age after which less than 2 percent of the vehicles originally produced during a model year remain in service. Applying these conventions to vehicle registration data indicates that passenger cars have a maximum age of 26 years, while light trucks have a maximum lifetime of 36 years. *See* Lu, S., NHTSA, Regulatory Analysis and Evaluation Division, ''Vehicle Survivability and Travel Mileage Schedules,'' DOT HS 809 952, 8–11 (January 2006). *Available at http://www-nrd.nhtsa.dot.gov/Pubs/809952.pdf* (last accessed July 27, 2009).

[491] Available at *http://www.eia.doe.gov/oiaf/aeo/index.html.* NHTSA and EPA made the simplifying assumption that projected sales of cars and light trucks during each calendar year from 2012 through 2016 represented the likely production volumes for the corresponding model year. The agency did not attempt to establish the exact correspondence between projected sales during individual calendar years and production volumes for specific model years.

[492] Because AEO 2009's ''car'' and ''truck'' classes did not reflect NHTSA's recent reclassification (in March 2009 for enforcement beginning MY 2011) of many two wheel drive SUVs from the nonpassenger (*i.e.,* light truck) fleet to the passenger car fleet, EPA staff made adjustments to account for such vehicles in the baseline.

[493] EPA also considered other sources of similar information, such as J.D. Powers, and concluded that CSM was better able to provide forecasts at the requisite level of detail for most of the model years of interest.

[494] Lu, S., NHTSA, Regulatory Analysis and Evaluation Division, ''Vehicle Survivability and Travel Mileage Schedules,'' DOT HS 809 952, 8–11 (January 2006). *Available at http://www-nrd.nhtsa.dot.gov/Pubs/809952.pdf* (last accessed August 9, 2009). These updated survival rates suggest that the expected lifetimes of recent-model passenger cars and light trucks are 13.8 and 14.5 years.

[495] For a description of the Survey, *see http://nhts.ornl.gov/quickStart.shtml* (last accessed August 9, 2009).

[496] This approach differs from that used in the MY 2011 final rule, where it was assumed that future growth in the total number of cars and light trucks in use resulting from projected sales of new vehicles was adequate by itself to account for growth in total vehicle use, without assuming continuing growth in average vehicle use.

applied to the mileage figures derived from the 2001 NHTS to estimate annual mileage during each year of the expected lifetimes of MY 2012–2016 cars and light trucks.[497]

Finally, the agency estimated total fuel consumption by passenger cars and light trucks remaining in use each year by dividing the total number of miles surviving vehicles are driven by the fuel economy they are expected to achieve under each alternative CAFE standard. Each model year's total lifetime fuel consumption is the sum of fuel use by the cars or light trucks produced during that model year during each year of their life spans. In turn, the *savings* in a model year's lifetime fuel use that will result from each alternative CAFE standard is the difference between its lifetime fuel use at the fuel economy level it attains under the Baseline alternative, and its lifetime fuel use at the higher fuel economy level it is projected to achieve under that alternative standard.[498]

g. Accounting for the Rebound Effect of Higher Fuel Economy

The fuel economy rebound effect refers to the fraction of fuel savings expected to result from an increase in vehicle fuel economy—particularly an increase required by the adoption of higher CAFE standards—that is offset by additional vehicle use. The increase in vehicle use occurs because higher fuel economy reduces the fuel cost of driving, typically the largest single component of the monetary cost of operating a vehicle, and vehicle owners respond to this reduction in operating costs by driving slightly more. By lowering the marginal cost of vehicle use, improved fuel economy may lead to an increase in the number of miles vehicles are driven each year and over their lifetimes. Even with their higher fuel economy, this additional driving consumes some fuel, so the rebound effect reduces the net fuel savings that result when new CAFE standards require manufacturers to improve fuel economy.

The magnitude of the rebound effect is an important determinant of the actual fuel savings that are likely to result from adopting stricter CAFE standards. Research on the magnitude of the rebound effect in light-duty vehicle use dates to the early 1980s, and generally concludes that a statistically significant rebound effect occurs when vehicle fuel efficiency improves.[499] The agency reviewed studies of the rebound effect it had previously relied upon, considered more recently published estimates, and developed new estimates of its magnitude for purposes of this NPRM.[500] Recent studies provide some evidence that the rebound effect has been declining over time, and may decline further over the immediate future if incomes rise faster than gasoline prices. This result appears plausible, because the responsiveness of vehicle use to variation in fuel costs is expected to decline as they account for a smaller proportion of the total monetary cost of driving, which has been the case until very recently. At the same time, rising personal incomes would be expected to reduce the sensitivity of vehicle use to fuel costs as the time component of driving costs—which is likely to be related to income levels—accounts for a larger fraction the total cost of automobile travel. NHTSA developed new estimates of the rebound effect by using national data on light-duty vehicle travel over the period from 1950 through 2006 to estimate various econometric models of the relationship between vehicle miles-traveled and factors likely to influence it, including household income, fuel prices, vehicle fuel efficiency, road supply, the number of vehicles in use, vehicle prices, and other factors.[501] The results of NHTSA's analysis are consistent with the findings from other recent research: The average long-run rebound effect ranged from 16 percent to 30 percent over the period from 1950 through 2007, while estimates of the rebound effect in 2007 range from 8 percent to 14 percent. Projected values of the rebound effect for the period from 2010 through 2030, which the agency developed using forecasts of personal income, fuel prices, and fuel efficiency from AEO 2009's Reference Case, range from 4 percent to 16 percent, depending on the specific model used to generate them.

In light of these results, the agency's judgment is that the apparent decline over time in the magnitude of the rebound effect justifies using a value for future analysis that is lower than historical estimates, which average 15–25 percent. Because the lifetimes of vehicles affected by the alternative CAFE standards considered in this rulemaking will extend from 2012 until nearly 2050, a value that is significantly lower than historical estimates appears to be appropriate. Thus NHTSA has elected to use a 10 percent rebound effect in its analysis of fuel savings and other benefits from higher CAFE standards for this NPRM.

NHTSA also invites comment on other alternatives for estimating the rebound effect. As one illustration, variation in the price per gallon of gasoline directly affects the per-mile cost of driving, and drivers may respond just as they would to a change in the cost of driving resulting from a change in fuel economy, by varying the number of miles they drive. Because vehicles' fuel economy is fixed in the short run, variation in the number of miles driven in response to changes in fuel prices will be reflected in changes in gasoline consumption. Under the assumption that drivers respond similarly to changes in the cost of driving whether they are caused by variation in fuel prices or fuel economy, the short-run price elasticity of gasoline—which measures the sensitivity of gasoline consumption to changes in its price per gallon—may provide some indication about the magnitude of the rebound effect itself. NHTSA invites comment on the extent to which the short-run elasticity of demand for gasoline with respect to its price can provide useful information about the size of the rebound effect. Specifically, we seek comment on whether it would be

[497] While the adjustment for future fuel prices reduces average mileage at each age from the values derived from the 2001 NHTS, the adjustment for expected future growth in average vehicle use increases it. The net effect of these two adjustments is to increase expected lifetime mileage by about 18 percent significantly for both passenger cars and about 16 percent for light trucks.

[498] To illustrate these calculations, the agency's adjustment of the AEO 2009 Revised Reference Case forecast indicates that 9.26 million passenger cars will be produced during 2012, and the agency's updated survival rates show that 83 percent of these vehicles, or 7.64 million, are projected to remain in service during the year 2022, when they will have reached an age of 10 years. At that age, passenger achieving the fuel economy level they are projected to achieve under the Baseline alternative are driven an average of about 800 miles, so surviving model year 2012 passenger cars will be driven a total of 82.5 billion miles (= 7.64 million surviving vehicles × 10,800 miles per vehicle) during 2022. Summing the results of similar calculations for each year of their 26-year maximum lifetime, model year 2012 passenger cars will be driven a total of 1,395 billion miles under the Baseline alternative. Under that alternative, they are projected to achieve a test fuel economy level of 32.4 mpg, which corresponds to actual on-road fuel economy of 25.9 mpg (= 32.4 mpg × 80 percent). Thus their lifetime fuel use under the Baseline alternative is projected to be 53.9 billion gallons (= 1,395 billion miles divided by 25.9 miles per gallon).

[499] Some studies estimate that the long-run rebound effect is significantly larger than the immediate response to increased fuel efficiency. Although their estimates of the adjustment period required for the rebound effect to reach its long-run magnitude vary, this long-run effect is most appropriate for evaluating the fuel savings and emissions reductions resulting from stricter standards that would apply to future model years.

[500] For details of the agency's analysis, see Chapter VIII of the PRIA and Chapter 4 of the draft joint TSD accompanying this proposed rule.

[501] The agency used several different model specifications and estimation procedures to control for the effect of fuel prices on fuel efficiency in order to obtain accurate estimates of the rebound effect.

appropriate to use the price elasticity of demand for gasoline, or other alternative approaches, to guide the choice of a value for the rebound effect.

Additionally, NHTSA recognizes that as the world price of oil falls in response to lower U.S. demand for oil, there is the potential for an increase in oil use and, in turn, greenhouse gas emissions outside the U.S. This so called international oil ''take back'' effect is difficult to estimate. Given that oil consumption patterns vary across countries, there will be different demand responses to a change in the world price of crude oil. In addition, many countries around the world subsidize their oil consumption. It is not clear how oil consumption would change due to changes in the market price of oil given the current pattern of demand and subsidies. Further, many countries, especially in the developed countries/regions (*i.e.,* the European Union), already have or anticipate implementing policies to limit GHG emissions. Further out in the future, it is anticipated that developing countries would take actions to reduce their GHG emissions as well. Any increases in petroleum consumption and GHG emissions in other nations that occurs in response to a decline in world petroleum prices would be attributed to those nations, and recorded in their respective GHG emissions inventories. Thus, including the same increase in emissions as part of the impact of adopting CAFE standards in the U.S. would risk double-counting of global emissions totals. NHTSA seeks comment on how to estimate the international ''take back'' effect and its impact on fuel consumption and GHG emissions. *See* the Energy Security section of the TSD, 4.2.8, for more discussion of the impact of the proposed vehicle rule on oil markets.

h. Benefits From Increased Vehicle Use

The increase in vehicle use from the rebound effect provides additional benefits to their owners, who may make more frequent trips or travel farther to reach more desirable destinations. This additional travel provides benefits to drivers and their passengers by improving their access to social and economic opportunities away from home. As evidenced by their decisions to make more frequent or longer trips when improved fuel economy reduces their costs for driving, the benefits from this additional travel exceed the costs drivers and passengers incur in making more frequent or longer trips.

The agency's analysis estimates the economic benefits from increased rebound-effect driving as the sum of fuel costs drivers incur plus the consumer surplus they receive from the additional accessibility it provides.[502] Because the increase in travel depends on the extent of improvement in fuel economy, the value of benefits it provides differs among model years and alternative CAFE standards. Under even those alternatives that would impose the highest standards, however, the magnitude of these benefits represents a small fraction of total benefits.

i. The Value of Increased Driving Range

Improving vehicles' fuel economy may also increase their driving range before they require refueling. By reducing the frequency with which drivers typically refuel, and by extending the upper limit of the range they can travel before requiring refueling, improving fuel economy thus provides some additional benefits to their owners.[503] NHTSA re-examined this issue for purposes of this rulemaking, and found no information in comments or elsewhere that would cause the agency to revise its previous approach. Since no direct estimates of the value of extended vehicle range are available, NHTSA calculates directly the reduction in the annual number of required refueling cycles that results from improved fuel economy, and applies DOT-recommended values of travel time savings to convert the resulting time savings to their economic value.[504]

As an illustration, a typical small light truck model has an average fuel tank size of approximately 20 gallons. Assuming that drivers typically refuel when their tanks are 55 percent full (*i.e.,* 11 gallons in reserve), increasing this model's actual on-road fuel economy from 24 to 25 mpg would extend its driving range from 216 miles (= 9 gallons $\times$ 24 mpg) to 225 miles (= 9 gallons $\times$ 25 mpg). Assuming that it is driven 12,000 miles/year, this reduces the number of times it needs to be refueled each year from 55.6 (= 12,000 miles per year/216 miles per refueling) to 53.3 (= 12,000 miles per year/225 miles per refueling), or by 2.3 refuelings per year.

Weighted by the nationwide mix of urban and rural driving, personal and business travel in urban and rural areas, and average vehicle occupancy for driving trips, the DOT-recommended values of travel time per vehicle-hour is $24.64 (in 2007 dollars).[505] Assuming that locating a station and filling up requires five minutes, the annual value of time saved as a result of less frequent refueling amounts to $4.72 (calculated as 5/60 $\times$ 2.3 $\times$ $24.64). This calculation is repeated for each future year that model year 2012–2016 cars and light trucks would remain in service. Like fuel savings and other benefits, the value of this benefit declines over a model year's lifetime, because a smaller number of vehicles originally produced during that model year remain in service each year, and those remaining in service are driven fewer miles.

NHTSA recognizes that many assumptions made in its estimate for the value of increased driving range are subject to uncertainty. Please see Chapter 4 of the TSD and Chapter 8 of NHTSA's PRIA for more information about the uncertainty regarding these assumptions.

j. Added Costs From Congestion, Crashes and Noise

Increased vehicle use associated with the rebound effect also contributes to increased traffic congestion, motor vehicle accidents, and highway noise. NHTSA relies on estimates of per-mile congestion, accident, and noise costs caused by increased use of automobiles and light trucks developed by the Federal Highway Administration to estimate these increased costs.[506] NHTSA employed these estimates previously in its analysis accompanying the MY 2011 final rule, and continues

[502] The consumer surplus provided by added travel is estimated as one-half of the product of the decline in fuel cost per mile and the resulting increase in the annual number of miles driven.

[503] If manufacturers respond to improved fuel economy by reducing the size of fuel tanks to maintain a constant driving range, the resulting cost savings will presumably be reflected in lower vehicle sales prices.

[504] *See* Department of Transportation, Guidance Memorandum, ''The Value of Saving Travel Time: Departmental Guidance for Conducting Economic Evaluations,'' Apr. 9, 1997. *http://ostpxweb.dot.gov/policy/Data/VOT97guid.pdf* (last accessed August 9, 2009); update *available at http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2-11-03.pdf* (last accessed August 9, 2009).

[505] The hourly wage rate during 2008 is estimated to average $25.50 when expressed in 2007 dollars. Personal travel in urban areas (which represents 94 percent of urban travel) is valued at 50 percent of the hourly wage rate, while business travel (the remaining 6 percent of urban travel) is valued at 100 percent of the hourly wage rate. For intercity travel, personal travel (87 percent of total intercity travel) is valued at 70 percent of the wage rate, while business travel (13 percent) is valued at 100 percent of the wage rate. The resulting values of travel time are $12.67 for urban travel and $17.66 for intercity travel, and must be multiplied by vehicle occupancy (1.6) to obtain the estimated values of time per vehicle hour in urban and rural driving. Finally, about 66% of driving occurs in urban areas, while the remaining 34% takes place in rural areas, and these percentages are used to calculate a weighted average of the value of time in all driving.

[506] 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 August 9, 2009).

to find them appropriate for this NPRM after reviewing the procedures used by FHWA to develop them and considering other available estimates of these values. The agency multiplies FHWA's estimates of per-mile costs by the annual increases in automobile and light truck use from the rebound effect to yield the estimated increases in congestion, accident, and noise externality costs during each future year.

k. Petroleum Consumption and Import Externalities

U.S. consumption and imports of petroleum products also impose costs on the domestic economy that are not reflected in the market price for crude petroleum, or in the prices paid by consumers of petroleum products such as gasoline. These costs include (1) higher prices for petroleum products resulting from the effect of U.S. oil import demand on the world oil price; (2) the risk of disruptions to the U.S. economy caused by sudden reductions in the supply of imported oil to the U.S.; and (3) expenses for maintaining a U.S. military presence to secure imported oil supplies from unstable regions, and for maintaining the strategic petroleum reserve (SPR) to cushion against resulting price increases.[507]

Higher U.S. imports of crude oil or refined petroleum products increase the magnitude of these external economic costs, thus increasing the true economic cost of supplying transportation fuels above their market prices. Conversely, lowering U.S. imports of crude petroleum or refined fuels by reducing domestic fuel consumption can reduce these external costs, and any reduction in their total value that results from improved fuel economy represents an economic benefit of more stringent CAFE standards, in addition to the value of saving fuel itself.

NHTSA has carefully reviewed its assumptions regarding the appropriate value of these benefits for this proposed rule. In analyzing benefits from its recent actions to increase light truck CAFE standards for model years 2005–07 and 2008–11, NHTSA relied on a 1997 study by Oak Ridge National Laboratory (ORNL) to estimate the value of reduced economic externalities from petroleum consumption and imports.[508] More recently, ORNL updated its estimates of the value of these externalities, using the analytic framework developed in its original 1997 study in conjunction with recent estimates of the variables and parameters that determine their value.[509] The updated ORNL study was subjected to a detailed peer review by experts selected by EPA, and its estimates of the value of oil import externalities were subsequently revised to reflect their comments and recommendations.[510]

At the request of EPA, ORNL further revised its 2008 estimates of external costs from U.S. oil imports to reflect recent changes in the outlook for world petroleum prices and continuing changes in the structure and characteristics of global petroleum supply and demand.

These most recent revisions increase ORNL's estimates of the ''monopsony premium'' associated with U.S. oil imports, which measures the reduced value of payments from U.S. oil purchasers to foreign oil suppliers *beyond* the savings from reduced purchases of petroleum itself that results when lower U.S. import demand reduces the world price of petroleum.[511] Consistency with NHTSA's use of estimates of the *global* benefits from reducing emissions of CO_2 and other greenhouse gases in this analysis, however, requires the use of a global perspective for assessing their net value. From this perspective, reducing these payments simply results in a transfer of resources from foreign oil suppliers to U.S. purchasers (or more properly, in a savings in the value of resources previously transferred from U.S. purchasers to foreign producers), and provides no real savings in resources to the global economy. Thus NHTSA's analysis of the benefits from adopting higher CAFE standards for MY 2012–2016 cars and light trucks *excludes* the reduced value of monopsony payments by U.S. oil consumers that might result from lower fuel consumption by these vehicles.

The literature on the energy security for the last two decades has routinely combined the monopsony and the macroeconomic disruption components when calculating the total value of the energy security premium. However, in the context of using a global value for the Social Cost of Carbon (SCC) the question arises: How should the energy security premium be used when some benefits from the proposed rule, such as the benefits of reducing greenhouse gas emissions, are calculated at a global level? Monopsony benefits represent avoided payments by the U.S. to oil producers in foreign countries that result from a decrease in the world oil price as the U.S. decreases its consumption of imported oil. Although there is clearly a benefit to the U.S. when considered from the domestic perspective, the decrease in price due to decreased demand in the U.S. also represents a loss of income to oil-producing countries. Given the redistributive nature of this effect, do the negative effects on other countries ''net out'' the positive impacts to the U.S.? If this is the case, then, the monopsony portion of the energy security premium should be excluded from the net benefits calculation for the rule.

As the preceding discussion has indicated, the agencies omitted the reduction in monopsony payments that occurs when U.S. petroleum consumption and imports are reduced from their estimates of economic benefits for the proposed rules. Since the reduction in monopsony payments by U.S. oil consumers is exactly offset by a decline in income to suppliers of imported oil, this omission ensures consistency of the agencies' analysis with the inclusion of global benefits from reducing emissions of greenhouse gas emissions. The agencies seek comment on whether, from other perspectives, it would be reasonable to include both the global value of reducing GHG emissions and the reduction in monopsony payments by U.S. consumers of petroleum products in their estimates of total economic benefits from reducing U.S. fuel consumption.

ORNL's most recently revised estimates of the increase in the expected costs associated with potential disruptions in U.S. petroleum imports imply that each gallon of imported fuel or petroleum saved reduces the expected costs of oil supply disruptions

[507] *See, e.g.,* Bohi, Douglas R. and W. David Montgomery (1982). Oil Prices, Energy Security, and Import Policy, Washington, DC: Resources for the Future, Johns Hopkins University Press; Bohi, D. R., and M. A. Toman (1993). ''Energy and Security: Externalities and Policies,'' Energy Policy 21:1093–1109; and Toman, M. A. (1993). ''The Economics of Energy Security: Theory, Evidence, Policy,'' in A. V. Kneese and J. L. Sweeney, eds. (1993). Handbook of Natural Resource and Energy Economics, Vol. III. Amsterdam: North-Holland, pp. 1167–1218.

[508] Leiby, Paul N., Donald W. Jones, T. Randall Curlee, and Russell Lee, *Oil Imports: An Assessment of Benefits and Costs,* ORNL–6851, Oak Ridge National Laboratory, November 1, 1997. *Available at http://pzl1.ed.ornl.gov/ORNL6851.pdf* (last accessed August 9, 2009).

[509] Leiby, Paul N. ''Estimating the Energy Security Benefits of Reduced U.S. Oil Imports,'' Oak Ridge National Laboratory, ORNL/TM–2007/028, Revised July 23, 2007. *Available at http://pzl1.ed.ornl.gov/energysecurity.html* (click on link below ''Oil Imports Costs and Benefits'') (last accessed August 9, 2009).

[510] *Peer Review Report Summary: Estimating the Energy Security Benefits of Reduced U.S. Oil Imports,* ICF, Inc., September 2007.

[511] The reduction in payments from U.S. oil purchasers to domestic petroleum producers is not included as a benefit, since it represents a transfer that occurs entirely within the U.S. economy.

to the U.S. economy by $0.16 per gallon (in 2007$). The reduction in expected disruption costs represents a real savings in resources, and thus contributes economic benefits *in addition to* the savings in fuel production costs that result from increasing fuel economy. NHTSA employs this value in its evaluation of the economic benefits from adopting higher CAFE standards for MY 2012–2016 cars and light trucks.

NHTSA's analysis does not include savings in budgetary outlays to support U.S. military activities among the benefits of higher fuel economy and the resulting fuel savings.[512] NHTSA's analysis of benefits from alternative CAFE standards for MY 2012–2016 also excludes any cost savings from maintaining a smaller SPR from its estimates of the external benefits of reducing gasoline consumption and petroleum imports. This view concurs with that of the recent ORNL study of economic costs from U.S. oil imports, which concludes that savings in government outlays for these purposes are unlikely to result from reductions in consumption of petroleum products and oil imports on the scale of those resulting from higher CAFE standards.

Based on a detailed analysis of differences in fuel consumption, petroleum imports, and imports of refined petroleum products among the Reference Case, High Economic Growth, and Low Economic Growth Scenarios presented in AEO 2009, NHTSA estimates that approximately 50 percent of the reduction in fuel consumption resulting from adopting higher CAFE standards is likely to be reflected in reduced U.S. imports of refined fuel, while the remaining 50 percent would be reduce domestic fuel refining.[513] 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.[514] Thus on balance, each 100 gallons of fuel saved as a consequence of higher CAFE standards is anticipated to reduce total U.S. imports of crude petroleum or refined fuel by 95 gallons.[515]

l. Air Pollutant Emissions

i. Impacts on Criteria Air Pollutant Emissions

Criteria air pollutants emitted by vehicles and during fuel production include carbon monoxide (CO), hydrocarbon compounds (usually referred to as ''volatile organic compounds,'' or VOC), nitrogen oxides (NO_X), fine particulate matter ($PM_{2.5}$), and sulfur oxides (SO_X). While reductions in domestic fuel refining and distribution that result from lower fuel consumption will reduce U.S. emissions of these pollutants, additional vehicle use associated with the rebound effect from higher fuel economy will increase their emissions. Thus the net effect of stricter CAFE standards on emissions of each criteria pollutant depends on the relative magnitudes of its reduced emissions in fuel refining and distribution, and increases in its emissions from vehicle use. Because the relationship between emissions in fuel refining and vehicle use is different for each criteria pollutant, the net effect of fuel savings from the proposed standards on total emissions of each pollutant is likely to differ. We note that any benefits in terms of criteria air pollutant reductions resulting from this rule would not be direct benefits.

With the exception of SO_2, NHTSA calculated annual emissions of each criteria pollutant resulting from vehicle use by multiplying its estimates of car and light truck use during each year over their expected lifetimes by per-mile emission rates appropriate to each vehicle type, fuel, model year, and age. These emission rates were developed by U.S. EPA using its Motor Vehicle Emission Simulator (Draft MOVES 2009).[516] Emission rates for SO_2 were calculated by NHTSA using average fuel sulfur content estimates supplied by EPA, together with the assumption that the entire sulfur content of fuel is emitted in the form of SO_2.[517] Total SO_2 emissions under each alternative CAFE standard were calculated by applying the resulting emission rates directly to estimated annual gasoline and diesel fuel use by cars and light trucks.

As with other impacts, the *changes* in emissions of criteria air pollutants resulting from alternative increases in CAFE standards for MY 2012–2016 cars and light trucks were calculated from the differences between emissions under each alternative that would increase CAFE standards, and emissions under the baseline alternative.

NHTSA estimated the reductions in criteria pollutant emissions from producing and distributing fuel that would occur under alternative CAFE standards using emission rates obtained by EPA from Argonne National Laboratories' Greenhouse Gases and Regulated Emissions in Transportation (GREET) model.[518] The GREET model provides separate estimates of air pollutant emissions that occur in different phases of fuel production and distribution, including crude oil extraction, transportation, and storage, fuel refining, and fuel distribution and storage.[519] EPA modified the GREET model to change certain assumptions about emissions during crude petroleum extraction and transportation, as well as to update its emission rates to reflect adopted and pending EPA emission standards. NHTSA converted these emission rates from the mass per fuel energy content basis on which GREET reports them to mass per gallon of fuel supplied using estimates of fuel energy content supplied by GREET.

The resulting emission rates were applied to the agency's estimates of fuel consumption under each alternative CAFE standard to develop estimates of total emissions of each criteria pollutant during fuel production and distribution. The assumptions about the effects of *changes* in fuel consumption on domestic and imported sources of fuel supply discussed above were then employed to calculate the effects of

[512] However, the agency conducted a sensitivity analysis of the potential effect of assuming that some reduction military spending would result from fuel savings and reduced petroleum imports in order to investigate its impacts on the standards and fuel savings.

[513] Differences between forecast annual U.S. imports of crude petroleum and refined products among these three scenarios range from 24–89 percent of differences in projected annual gasoline and diesel fuel consumption in the U.S. These differences average 49 percent over the forecast period spanned by AEO 2009.

[514] Differences between forecast annual U.S. imports of crude petroleum among these three scenarios range from 67–97 percent of differences in total U.S. refining of crude petroleum, and average 85 percent over the forecast period spanned by AEO 2009.

[515] This figure is calculated as 50 gallons + 50 gallons * 90% = 50 gallons + 45 gallons = 95 gallons.

[516] The MOVES model assumes that the per-mile rates at which these pollutants are emitted are determined by EPA regulations and the effectiveness of catalytic after-treatment of engine exhaust emissions, and are thus unaffected by changes in car and light truck fuel economy.

[517] These are 30 and 15 parts per million (ppm, measured on a mass basis) for gasoline and diesel respectively, which produces emission rates of 0.17 grams of SO_2 per gallon of gasoline and 0.10 grams per gallon of diesel.

[518] Argonne National Laboratories, *The Greenhouse Gas and Regulated Emissions from Transportation (GREET) Model,* Version 1.8, June 2007, *available at http://www.transportation.anl.gov/modeling_simulation/GREET/index.html* (last accessed August 9, 2009).

[519] Emissions that occur during vehicle refueling at retail gasoline stations (primarily evaporative emissions of volatile organic compounds, or VOCs) are already accounted for in the ''tailpipe'' emission factors used to estimate the emissions generated by increased light truck use. GREET estimates emissions in each phase of gasoline production and distribution in mass per unit of gasoline energy content; these factors are then converted to mass per gallon of gasoline using the average energy content of gasoline.

reductions in fuel use from alternative CAFE standards on changes in imports of refined fuel and domestic refining. NHTSA's analysis assumes that reductions in imports of refined fuel would reduce criteria pollutant emissions during fuel storage and distribution only. Reductions in domestic fuel refining using imported crude oil as a feedstock are assumed to reduce emissions during fuel refining, storage, and distribution, because each of these activities would be reduced. Reduced domestic fuel refining using domestically-produced crude oil is assumed to reduce emissions during all four phases of fuel production and distribution.[520]

Finally, NHTSA calculated the *net* changes in domestic emissions of each criteria pollutant by summing the increases in emissions projected to result from increased vehicle use, and the reductions anticipated to result from lower domestic fuel refining and distribution.[521] As indicated previously, the effect of adopting higher CAFE standards on total emissions of each criteria pollutant depends on the relative magnitudes of the resulting reduction in emissions from fuel refining and distribution, and the increase in emissions from additional vehicle use. Although these net changes vary significantly among individual criteria pollutants, the agency projects that on balance, adopting higher CAFE standards would reduce emissions of all criteria air pollutants except carbon monoxide (CO).

The net changes in domestic emissions of fine particulates ($PM_{2.5}$) and its chemical precursors (such as NO_X, SO_X, and VOCs) are converted to economic values using estimates of the reductions in health damage costs per ton of emissions of each pollutant that is avoided, which were developed and recently revised by EPA. These savings represent the estimated reductions in the value of damages to human health resulting from lower atmospheric concentrations and population exposure to air pollution that occur when emissions of each pollutant that contributes to atmospheric $PM_{2.5}$ concentrations are reduced. The value of reductions in the risk of premature death due to exposure to fine particulate pollution ($PM_{2.5}$) account for a majority of EPA's estimated values of reducing criteria pollutant emissions, although the value of avoiding other health impacts is also included in these estimates. These values do not include a number of unquantified benefits, such as reduction in the welfare and environmental impacts of $PM_{2.5}$ pollution, or reductions in health and welfare impacts related to other criteria pollutants (ozone, NO_2, and SO_2) and air toxics. EPA estimates different PM-related per-ton values for reducing emissions from vehicle use than for reductions in emissions of that occur during fuel production and distribution.[522] NHTSA applies these separate values to its estimates of changes in emissions from vehicle use and fuel production and distribution to determine the net change in total economic damages from emissions of these pollutants.

EPA projects that the per-ton values for reducing emissions of criteria pollutants from both mobile sources (including motor vehicles) and stationary sources such as fuel refineries and storage facilities will increase over time. These projected increases reflect rising income levels, which are assumed to increase affected individuals' willingness to pay for reduced exposure to health threats from air pollution, as well as future population growth, which increases population exposure to future levels of air pollution.

ii. Reductions in CO_2 Emissions

Emissions of carbon dioxide and other greenhouse gases (GHGs) occur throughout the process of producing and distributing transportation fuels, as well as from fuel combustion itself. By reducing the volume of fuel consumed by passenger cars and light trucks, higher CAFE standards will reduce GHG emissions generated by fuel use, as well as throughout the fuel supply cycle. Lowering these emissions is likely to slow the projected pace and reduce the ultimate extent of future changes in the global climate, thus reducing future economic damages that changes in the global climate are expected to cause. By reducing the probability that climate changes with potentially catastrophic economic or environmental impacts will occur, lowering GHG emissions may also result in economic benefits that exceed the resulting reduction in the expected future economic costs caused by gradual changes in the earth's climatic systems.

Quantifying and monetizing benefits from reducing GHG emissions is thus an important step in estimating the total economic benefits likely to result from establishing higher CAFE standards. The agency estimated emissions of CO_2 from passenger car and light truck use by multiplying the number of gallons of each type of fuel (gasoline and diesel) they are projected to consume under alternative CAFE standards by the quantity or mass of CO_2 emissions released per gallon of fuel consumed. This calculation assumes that the entire carbon content of each fuel is converted to CO_2 emissions during the combustion process. Carbon dioxide emissions account for nearly 95 percent of total GHG emissions that result from fuel combustion during vehicle use.

iii. Economic Value of Reductions in CO_2 Emissions

NHTSA has taken the economic benefits of reducing CO_2 emission into account in this rulemaking, both in developing proposed CAFE standards and in assessing the economic benefits of each alternative that was considered. Since direct estimates of the economic benefits from reducing GHG emissions are generally not reported in published literature on the impacts of climate change, these benefits are typically assumed to be the ''mirror image'' of the estimated incremental costs resulting from an increase in those emissions. That is, the benefits from reducing emissions are usually measured by the savings in estimated economic damages that an equivalent increase in emissions would otherwise have caused.

The ''social cost of carbon'' (SCC) is intended to be a monetary measure of the incremental damage resulting from carbon dioxide (CO_2) emissions, including (but not limited to) net agricultural productivity loss, human health effects, property damages from sea level rise, and changes in ecosystem services. Any effort to quantify and to monetize the consequences associated with climate change will raise serious questions of science, economics, and ethics. But with full regard for the limits of both quantification and monetization, the SCC can be used to provide an estimate of the social benefits of reductions in GHG emissions.

For at least four reasons, any particular figure will be contestable. First, scientific and economic knowledge about the impacts of climate change continues to grow. With new and better information about relevant questions, including the cost, burdens, and possibility of adaptation, current

[520] In effect, this assumes that the distances crude oil travels to U.S. refineries are approximately the same regardless of whether it travels from domestic oilfields or import terminals, and that the distances that gasoline travels from refineries to retail stations are approximately the same as those from import terminals to gasoline stations.

[521] All emissions from increased vehicle use are assumed to occur within the U.S., since CAFE standards would apply only to vehicles produced for sale in the U.S.

[522] These reflect differences in the typical geographic distributions of emissions of each pollutant, their contributions to ambient $PM_{2.5}$ concentrations, pollution levels (predominantly those of $PM_{2.5}$), and resulting changes in population exposure.

estimates will inevitably change over time. Second, some of the likely and potential damages from climate change—for example, the loss of endangered species—are generally not included in current SCC estimates. These omissions may turn out to be significant; in the sense that they may mean that the best current estimates are too low. As noted by the IPCC Fourth Assessment Report, ''It is *very likely* that globally aggregated figures underestimate the damage costs because they cannot include many non-quantifiable impacts.'' Third, it is unlikely that the damage estimates account for the directed technological change that will lead to innovations that reduce the costs of responding to climate change—for example, it is likely that scientists will develop crops that are better able to withstand high temperatures. In this respect, the current estimates may overstate the likely damages. Fourth, controversial ethical judgments, including those involving the treatment of future generations, play a role in judgments about the SCC (see in particular the discussion of the discount rate, below).

To date, SCC estimates presented in recent regulatory documents have varied within and among agencies, including DOT, DOE, and EPA. For example, a regulation proposed by DOT in 2008 assumed a value of $7 per ton CO_2 [523] (2006$) for 2011 emission reductions (with a range of $0–14 for sensitivity analysis). A regulation finalized by DOE used a range of $0–$20 (2007$). Both of these ranges were designed to reflect the value of damages to the United States resulting from carbon emissions, or the ''domestic'' SCC. In the final MY 2011 CAFE EIS, DOT used both a domestic SCC value of $2/t$CO_2$ and a global SCC value of $33/t$CO_2$ (with sensitivity analysis at $80/t$CO_2$), increasing at 2.4 percent per year thereafter. The final MY 2011 CAFE rule also presented a range from $2 to $80/t$CO_2$. EPA's Advance Notice of Proposed Rulemaking for Greenhouse Gases discussed the benefits of reducing GHG emissions and identified what it described as ''very preliminary'' SCC estimates ''subject to revision'' that spanned three orders of magnitude. EPA's global mean values were $68 and $40/t$CO_2$ for discount rates of 2 percent and 3 percent respectively (in 2006 real dollars for 2007 emissions).[524]

The current Administration has worked to develop a transparent methodology for selecting a set of interim SCC estimates to use in regulatory analyses until a more comprehensive characterization of the distribution of SCC is developed. This discussion proposes a set of values for the interim social cost of carbon. It should be emphasized that the analysis here is preliminary. Today's proposed joint rulemaking presents SCC estimates that reflect the Administration's current understanding of the relevant literature. These interim estimates are being used for the short-term while an interagency group develops a more comprehensive characterization of the distribution of SCC values for future economic and regulatory analyses. The interim values should not be viewed as a statement about the results of the longer-term process. The Administration will be evaluating and seeking comment in the preamble to today's proposed rule on all of the scientific, economic, and ethical issues before establishing final estimates for use in future rulemakings.

The outcomes of the Administration's process to develop interim values are judgments in favor of (a) global rather than domestic values, (b) an annual growth rate of 3%, and (c) interim global SCC estimates for 2007 (in 2006 dollars) of $55, $33, $19, $10, and $5 per ton of CO_2. Notably, we have centered our current attention on a SCC of $19. The proposed figures are based on the following judgments.

1. *Global and domestic measures.* Because of the distinctive nature of the climate change problem, we present both a global SCC and a fraction of that value that represents impacts that may occur within the borders of the U.S. alone, or a ''domestic'' SCC, but center our current attention on the global measure. This approach represents a departure from past practices, which relied, for the most part, on domestic measures. As a matter of law, both global and domestic values are permissible; the relevant statutory provisions are ambiguous and allow selection of either measure.[525]

It is true that under OMB guidance, analysis from the domestic perspective is required, while analysis from the international perspective is optional. The domestic decisions of one nation are not typically based on a judgment about the effects of those decisions on other nations. But the climate change problem is highly unusual in the sense that it involves (a) a global public good in which (b) the emissions of one nation may inflict significant damages on other nations and (c) the United States is actively engaged in promoting an international agreement to reduce worldwide emissions.

In these circumstances, we believe the global measure is preferred. Use of a global measure reflects the reality of the problem and is expected to contribute to the continuing efforts of the United States to ensure that emissions reductions occur in many nations.

Domestic SCC values are also presented. The development of a domestic SCC is greatly complicated by the relatively few region- or country-specific estimates of the SCC in the literature. One potential source of estimates comes from a recent unpublished EPA modeling effort using the FUND model. The resulting estimates suggest that the ratio of domestic to global benefits varies with key parameter assumptions. With a 3 percent discount rate, for example, the U.S. benefit is about 6 percent of the global benefit for the ''central'' (mean) FUND results, while, for the corresponding ''high'' estimates associated with a higher climate sensitivity and lower global economic growth, the U.S. benefit is less than 4 percent of the global benefit. With a 2 percent discount rate, the U.S. share is about 2–5 percent of the global estimate.

Based on this available evidence, an interim domestic SCC value equal to 6 percent of the global damages is proposed. This figure is in the middle of the range of available estimates from the literature. It is recognized that the 6 percent figure is approximate and highly speculative and alternative approaches will be explored before establishing final values for future rulemakings.

2. *Filtering existing analyses.* There are numerous SCC estimates in the existing literature, and it is reasonable to make use of those estimates in order to produce a figure for current use. A starting point is provided by the meta-analysis in Richard Tol, 2008.[526] With

[523] For the purposes of this discussion, we present all values of the SCC as the cost per ton of CO_2 emissions. Some discussions of the SCC in the literature use an alternative presentation of a dollar per ton of Carbon. The standard adjustment factor is 3.67, which means, for example, that a SCC of $10 per ton of CO_2 would be equivalent to a cost of $36.70 for a ton of carbon emitted.

[524] 73 FR 44416 (July 30, 2008). EPA, ''Advance Notice of Proposed Rulemaking for Greenhouse Gases Under the Clean Air Act, Technical Support Document on Benefits of Reducing GHG Emissions,'' June 2008. *www.regulations.gov.* Search for ID ''EPA–HQ–OAR–2008–0318–0078.''

[525] It is true that *Federal* statutes are presumed not to have extraterritorial effect, in part to ensure that the laws of the United States respect the interests of foreign sovereigns. But use of a global measure for the SCC does not give extraterritorial effect to *Federal* law and hence does not intrude on such interests.

[526] Richard Tol, The Social Cost of Carbon: Trends, Outliers, and Catastrophes, Economics: The Open-Access, Open-Assessment E-Journal, Vol. 2, 2008–25. *http://www.economics-ejournal.org/economics/journalarticles/2008-25* (2008).

that starting point, the Administration proposes to ''filter'' existing SCC estimates by using those that (1) are derived from peer-reviewed studies; (2) do not weight the monetized damages to one country more than those in other countries; (3) use a ''business as usual'' climate scenario; and (4) are based on the most recent published version of each of the three major integrated assessment models (IAMs): FUND, PAGE, and DICE.

Proposal (1) is based on the view that those studies that have been subject to peer review are more likely to be reliable than those that have not been. Proposal (2) is based on a principle of neutrality and simplicity; it does not treat the citizens of one nation (or different citizens within the U.S.) differently on the basis of speculative or controversial considerations. Further, it is consistent with the potential compensation tests of Kaldor (1939) and Hicks (1940), which use unweighted sums of willingness to pay. Finally, this is the approach used in rulemakings across a variety of settings and consequently keeps U.S. government policy consistent across contexts.

Proposal (3) stems from the judgment that as a general rule, the proper way to assess a policy decision is by comparing the implementation of the policy against a counterfactual state where the policy is not implemented. In addition, our expectation is that most policies to be evaluated using these interim SCC estimates will constitute small enough changes to the larger economy to safely assume that the marginal benefits of emissions reductions will not change between the baseline and policy scenarios. A departure from this approach would be to consider a more dynamic setting in which other countries might implement policies to reduce GHG emissions at an unknown future date and the U.S. could choose to implement such a policy now or at a future date.

Proposal (4) is based on four complementary judgments. First, the FUND, PAGE, and DICE models now stand as the most comprehensive and reliable efforts to measure the economic damages from climate change. Second, the latest versions of the three IAMs are likely to reflect the most recent evidence and learning, and hence they are presumed to be superior to those that preceded them. Third, any effort to choose among them, or to reject one in favor of the others, would be difficult to defend at the present time. In the absence of a clear reason to choose among them, it is reasonable to base the SCC on all of them. Fourth, in light of the uncertainties associated with the SCC, the additional information offered by different models is important.

3. *Use a model-weighted average of the estimates at each discount rate.* At this time, a scientifically valid reason to prefer any of the three major IAMs (FUND, PAGE, and DICE) has not been identified. Accordingly, to address the concern that certain models not be given unequal weight relative to the other models, the estimates are based on an equal weighting of the means of the estimates from each of the models. Among estimates that remain after applying the filter, we begin by taking the average of all estimates within a model. The estimated SCC is then calculated as the average of the three model-specific averages. This approach is used to ensure that models with a greater number of published results do not exert unequal weight on the interim SCC estimates.

4. *Apply a 3 percent annual growth rate to the chosen SCC values.* SCC is assumed to increase over time, because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed as the magnitude of climate change increases. Indeed, an implied growth rate in the SCC can be produced by most of the models that estimate economic damages caused by increased GHG emissions in future years. But neither the rate itself nor the information necessary to derive its implied value is commonly reported. In light of the limited amount of debate thus far about the appropriate growth rate of the SCC, applying a rate of 3 percent per year seems appropriate at this stage. This value is consistent with the range recommended by IPCC (2007) and close to the latest published estimate (Hope 2008).

(1) Discount Rates

For estimation of the benefits associated with the mitigation of climate change, one of the most complex issues involves the appropriate discount rate. OMB's current guidance offers a detailed discussion of the relevant issues and calls for discount rates of 3 percent and 7 percent. It also permits a sensitivity analysis with low rates (1–3 percent) for intergenerational problems: ''If your rule will have important intergenerational benefits or costs you might consider a further sensitivity analysis using a lower but positive discount rate in addition to calculating net benefits using discount rates of 3 and 7 percent.'' [527]

The choice of a discount rate, especially over long periods of time, raises highly contested and exceedingly difficult questions of science, economics, philosophy, and law. *See, e.g.,* William Nordhaus, The Challenge of Global Warming (2008); Nicholas Stern, The Economics of Climate Change (2007); Discounting and Intergenerational Equity (Paul Portney and John Weyant eds. 1999). It is not clear that future generations would be willing to trade environmental quality for consumption at the same rate as the current generations. Under imaginable assumptions, decisions based on cost-benefit analysis with high discount rates might harm future generations—at least if investments are not made for the benefit of those generations. *See* Robert Lind, Analysis for Intergenerational Discounting, *id.* at 173, 176–177. It is also possible that the use of low discount rates for particular projects might itself harm future generations, by ensuring that resources are not used in a way that would greatly benefit them. In the context of climate change, questions of intergenerational equity are especially important.

Reasonable arguments support the use of a 3 percent discount rate. First, that rate is among the two figures suggested by OMB guidance, and hence it fits with existing national policy. Second, it is standard to base the discount rate on the compensation that people receive for delaying consumption, and the 3 percent is close to the risk-free rate of return, proxied by the return on long term inflation-adjusted U.S. Treasury Bonds, as of this writing. Although these rates are currently closer to 2.5 percent, the use of 3 percent provides an adjustment for the liquidity premium that is reflected in these bonds' returns.

At the same time, others would argue that a 5 percent discount rate can be supported. The argument relies on several assumptions. First, that rate can also be justified by reference to the level of compensation for delaying consumption, because it fits with market behavior with respect to *individuals'* willingness to trade-off consumption across periods as measured by the estimated post-tax average real returns to risky private investments (*e.g.,* the S&P 500). In the climate setting, the 5 percent discount rate may be preferable to the riskless rate because it is based on risky investments and the return to projects to mitigate climate change is also risky. In contrast, the 3 percent riskless rate may be a more appropriate discount rate for

[527] *See* OMB Circular A–4, pp. 35–36, citing Portney and Weyant, eds. (1999), Discounting and Intergenerational Equity, Resources for the Future, Washington, DC.

projects where the return is known with a high degree of confidence (*e.g.,* highway guardrails). In principal, the correct discount rate would reflect the variance in payoff from climate mitigation policy and the correlation between the payoffs of the policy and the broader economy.[528]

Second, 5 percent, and not 3 percent, is roughly consistent with estimates implied by reasonable inputs to the theoretically derived Ramsey equation, which specifies the optimal time path for consumption. That equation specifies the optimal discount rate as the sum of two components. The first term (the product of the elasticity of the marginal utility of consumption and the growth rate of consumption) reflects the fact that consumption in the future is likely to be higher than consumption today, so diminishing marginal utility implies that the same monetary damage will cause a smaller reduction of utility in the future. Standard estimates of this term from the economics literature are in the range of 3 percent–5 percent. The second component reflects the possibility that a lower weight should be placed on utility in the future, to account for social impatience or extinction risk, which is specified by a pure rate of time preference (PRTP). A common estimate of the PRTP is 2 percent, though some observers believe that a principle of intergenerational equity suggests that the PRTP should be close to zero. It follows that discount rate of 5 percent is near the middle of the range of values that are able to be derived from the Ramsey equation.

It is recognized that the arguments above—for use of market behavior and the Ramsey equation—face objections in the context of climate change, and of course there are alternative approaches. In light of climate change, it is possible that consumption in the future will not be higher than consumption today, and if so, the Ramsey equation will suggest a lower figure. However, the historical evidence is consistent with rising consumption over time.

Some critics note that using observed interest rates for inter-generational decisions imposes current preferences on future generations, which some economists say may not be appropriate. For generational equity, they argue that the discount rate should be below market rates to correct for market distortions and inefficiencies in inter-generational transfers of wealth (which are presumed to compensate future generations for damage), and to treat generations equitably based on ethical principles (*see* Broome 2008).[529]

Additionally, some analyses attempt to deal with uncertainty with respect to interest rates over time. We explore below how this might be done.[530]

(2) Proposed Interim Estimates

The application of the methodology outlined above yields interim estimates of the SCC that are reported in Table IV.C.3–2. These estimates are reported separately using 3 percent and 5 percent discount rates. The cells are empty in rows 10 and 11, because these studies did not report estimates of the SCC at a 3 percent discount rate. The model-weighted means are reported in the final or summary row; they are $33 per tCO_2 at a 3 percent discount rate and $5 per tCO_2 with a 5 percent discount rate.

TABLE IV.C.3–2—GLOBAL SOCIAL COST OF CARBON (SCC) ESTIMATES ($/$tCO_2$ IN 2007 (2006$)), BASED ON 3% AND 5% DISCOUNT RATES*

Model	Study	Climate scenario	3%	5%
1 FUND	Anthoff *et al.* 2009	FUND default	6	−1
2 FUND	Anthoff *et al.* 2009	SRES A1b	1	−1
3 FUND	Anthoff *et al.* 2009	SRES A2	9	−1
4 FUND	Link and Tol 2004	No THC	12	3
5 FUND	Link and Tol 2004	THC continues	12	2
6 FUND	Guo *et al.* 2006	Constant PRTP	5	−1
7 FUND	Guo *et al.* 2006	Gollier discount 1	14	0
8 FUND	Guo *et al.* 2006	Gollier discount 2	7	−1
		FUND Mean	8.25	0
9 PAGE	Wahba & Hope 2006	A2-scen	57	7
10 PAGE	Hope 2006			7
11 DICE	Nordhaus 2008			8

[528] Specifically, if the benefits of the policy are highly correlated with the returns from broader economy, then the market rate should be used to discount the benefits. If the benefits are uncorrelated with the broader economy the long term government bond rate should be applied. Furthermore, if the benefits are negatively correlated with the broader economy a rate less than that on long term government bonds should be used (Lind, 1982 pp. 89–90).

[529] *See* Arrow, K.J., W.R. Cline, K-G Maler, M. Munasinghe, R. Squiteri, J.E. Stiglitz, 1996. ''Intertemporal equity, discounting and economic efficiency,'' in Climate Change 1995: Economic and Social Dimensions of Climate Change, Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change. *See* also Weitzman, M.L., 1999. In Portney, P.R. and Weyant J.P. (eds.), Discounting and Intergenerational Equity, Resources for the Future, Washington, DC.

[530] Richard Newell and William Pizer, Discounting the distant future: how much do uncertain rates increase valuations? J. Environ. Econ. Manage. 46 (2003) 52–71.

[531] Most of the estimates in Table 1 rely on climate scenarios developed by the Intergovernmental Panel on Climate Change (IPCC). The IPCC published a new set of scenarios in 2000 for use in the Third Assessment Report (Special Report on Emissions Scenarios—SRES). The SRES scenarios define four narrative storylines: A1, A2, B1 and B2, describing the relationships between the forces driving greenhouse gas and aerosol emissions and their evolution during the 21st century for large world regions and globally. Each storyline represents different demographic, social, economic, technological, and environmental developments that diverge in increasingly irreversible ways. The storylines are summarized in Nakicenovic et al., 2000 (*see* also *http://sedac.ciesin.columbia.edu/ddc/sres/*). Because the B1 and B2 storylines represent policy cases rather than business-as-usual projections, estimates derived from these scenarios to be less appropriate for use in benefit-cost analysis. They are therefore excluded.

[532] Guo et al. (2006) report estimates based on two Gollier discounting schemes. The Gollier discounting assumes complex specifications about individual utility functions and risk preferences. After various conditions are satisfied, declining social discount rates emerge. Gollier Discounting Scheme 1 employs a certainty-equivalent social rate of time preference (SRTP) derived by assuming the regional growth rate is equally likely to be 1% above or below the original forecast growth rate. Gollier Discounting Scheme 2 calculates a certainty-equivalent social rate of time preference (SRTP) using five possible growth rates, and applies the new SRTP instead of the original. Hope (2008) conducts Monte Carlo analysis on the PRTP component of the discount rate. The PRTP is modeled as a triangular distribution with a min value of 1%/yr, a most likely value of 2%/yr, and a max value of 3%/yr.

TABLE IV.C.3–2—GLOBAL SOCIAL COST OF CARBON (SCC) ESTIMATES ($/t$CO_2$ IN 2007 (2006$)), BASED ON 3% AND 5% DISCOUNT RATES*—Continued

Model	Study	Climate scenario	3%	5%
Summary		Model-weighted Mean	33	5

* The sample includes all peer reviewed, non-equity-weighted estimates included in Tol (2008), Nordhaus (2008), Hope (2008), and Anthoff *et al.* (2009), that are based on the most recent published version of FUND, PAGE, or DICE and use business-as-usual climate scenarios.[531] [532] All values are based on the best available information from the underlying studies about the base year and year dollars, rather than the Tol (2008) assumption that all estimates included in his review are 1995 values in 1995$. All values were updated to 2007 using a 3 percent annual growth rate in the SCC, and adjusted for inflation using GDP deflator.

Analyses have been conducted at $33 and $5 as these represent the estimates associated with the 3 percent and 5 percent discount rates, respectively.[533] The 3 percent and 5 percent estimates have independent appeal, and at this time a clear preference for one over the other is not warranted. Thus, we have also included—and centered our current attention on—the average of the estimates associated with these discount rates, which is $19. (Based on the $19 global value, the approximate domestic fraction of these benefits would be $1.14 per ton of CO_2 assuming that domestic benefits are 6 percent of the global benefits.

It is true that there is uncertainty about interest rates over long time horizons. Recognizing that point, Newell and Pizer (2003) have made a careful effort to adjust for that uncertainty. The Newell-Pizer approach models discount rate uncertainty as something that evolves over time.[534] This is a relatively recent contribution to the literature, and estimates based on this method are included with the aim of soliciting comment.

There are several concerns with using this approach in this context. First, it would be a departure from current OMB guidance. Second, an approach that would average what emerges from discount rates of 3 percent and 5 percent reflects uncertainty about the discount rate, but based on a different model of uncertainty. The Newell-Pizer approach models discount rate uncertainty as something that evolves over time; in contrast, the preferred approach (outlined above) assumes that there is a single discount rate with equal probability of 3 percent and 5 percent.

Table IV.C.3–3 reports on the application of the Newell-Pizer adjustments. The precise numbers depend on the assumptions about the data generating process that governs interest rates. Columns (1a) and (1b) assume that ''random walk'' model best describes the data and uses 3 percent and 5 percent discount rates, respectively. Columns (2a) and (2b) repeat this, except that it assumes a ''mean-reverting'' process. While the empirical evidence does not rule out a mean-reverting model, Newell and Pizer find stronger empirical support for the random walk model.

TABLE IV.C.3–3—GLOBAL SOCIAL COST OF CARBON (SCC) ESTIMATES ($/t$CO_2$ IN 2007 (2006$))*, USING NEWELL & PIZER (2003) ADJUSTMENT FOR FUTURE DISCOUNT RATE UNCERTAINTY**

Model	Study	Climate scenario	Random-walk model		Mean-reverting model	
			3% (1a)	5% (1b)	3% (2a)	5% (2b)
1 FUND	Anthoff *et al.* 2009	FUND default	10	0	7	−1
2 FUND	Anthoff *et al.* 2009	SRES A1b	2	0	1	−1
3 FUND	Anthoff *et al.* 2009	SRES A2	15	0	10	−1
4 FUND	Link and Tol 2004	No THC	20	6	13	4
5 FUND	Link and Tol 2004	THC continues	20	4	13	2
6 FUND	Guo *et al.* 2006	Constant PRTP	9	0	6	−1
7 FUND	Guo *et al.* 2006	Gollier discount 1	14	0	14	0
8 FUND	Guo *et al.* 2006	Gollier discount 2	7	−1	7	−1
		FUND Mean	12	1	9	0
9 PAGE	Wahba & Hope 2006	A2-scen	97	13	63	8
10 PAGE	Hope 2006			13		8
11 DICE	Nordhaus 2008			15		9
Summary		Model-weighted Mean	55	10	36	6

* The sample includes all peer reviewed, non-equity-weighted estimates included in Tol (2008), Nordhaus (2008), Hope (2008), and Anthoff *et al.* (2009), that are based on the most recent published version of FUND, PAGE, or DICE and use business-as-usual climate scenarios. All values are based on the best available information from the underlying studies about the base year and year dollars, rather than the Tol (2008) assumption that all estimates included in his review are 1995 values in 1995$. All values were updated to 2007 using a 3 percent annual growth rate in the SCC, and adjusted for inflation using GDP deflator. *See* the Notes to Table 1 for further details.

** Assumes a starting discount rate of 3 percent or 5 percent. Newell and Pizer (2003) based adjustment factors are not applied to estimates from Guo *et al.* (2006) that use a different approach to account for discount rate uncertainty (rows 7–8).

Note that the correction factor from Newell and Pizer is based on the DICE model. The proper adjustment may differ for other integrated assessment models that produce different time schedules of marginal damages. We would expect this difference to be minor.

[533] It should be noted that reported discount rates may not be consistently derived across models or specific applications of models: While the discount rate may be identical, it may reflect different assumptions about the individual components of the Ramsey equation identified earlier.

[534] In contrast, an alternative approach based on Weitzman (2001) would assume that there is a constant discount rate that is uncertain and represented by a probability distribution. The Newell and Pizer, and Weitzman approaches are relatively recent contributions, and we invite comment on the advantages and disadvantages of each.

The resulting estimates of the social cost of carbon are necessarily greater. When the adjustments from the random walk model are applied, the estimates of the social cost of carbon are $10 and $55 per ton of CO_2, with the 5 percent and 3 percent discount rates, respectively. The application of the mean-reverting adjustment yields estimates of $6 and $36. Relying on the random walk model, analyses are also conducted with the value of the SCC set at $10 and $55.

(3) Caveats

There are at least four caveats to the approach outlined above.

First, the impacts of climate change are expected to be widespread, diverse, and heterogeneous. In addition, the exact magnitude of these impacts is uncertain, because of the inherent randomness in the Earth's atmospheric processes, the U.S. and global economies, and the behaviors of current and future populations. Current IAM do not currently individually account for and assign value to all of the important physical and other impacts of climate change that are recognized in the climate change literature. Although it is likely that our capability to quantify and monetize impacts will improve with time, it is also likely that even in future applications, there are a number of potentially significant benefits categories that will remain unmonetized.

Second, in the opposite direction, it is unlikely that the damage estimates adequately account for the directed technological change that climate change will cause. In particular, climate change will increase the return on investment to develop technologies that allow individuals to better cope with climate change. For example, it is likely that scientists will develop crops that are better able to withstand high temperatures. In this respect, the current estimates may overstate the likely damages.

Third, there has been considerable recent discussion of the risk of catastrophic impacts and of how best to account for worst-case scenarios. Recent research by Weitzman (2009) specifies some conditions under which the possibility of catastrophe would undermine the use of IAMs and conventional cost-benefit analysis. This research requires further exploration before its generality is known and the optimal way to incorporate it into regulatory reviews is understood.

Fourth, it is also worth noting that the SCC estimates are only relevant for incremental policies relative to the projected baselines, which capture business-as-usual scenarios. To evaluate non-marginal changes, such as might occur if the U.S. acts in tandem with other nations, then it might be necessary to go beyond the simple expedient of using the SCC along the BAU path. In particular, it would be correct to calculate the aggregate WTP to move from the BAU scenario to the policy scenario, without imposing the restriction that the marginal benefit remains constant over this range.

All of the values derived from this process are expressed in 2006 dollars. NHTSA has adjusted them to their equivalent values in 2007 dollars for consistency with other values used in its analysis of benefits from adopting higher CAFE standards for MY 2012–2016 passenger cars and light trucks. The resulting value upon which we have centered our analysis, which is derived from the figures reported in the tables above, is equivalent to $20 per metric ton of CO_2 emissions avoided when expressed in 2007$, and the agency has relied on this value in its analysis. NHTSA has also analyzed the sensitivity of its benefit estimates to alternative values of $5, $10, $34, and $56 per metric ton of CO_2 emissions avoided, with all figures again in 2007$. Each of these values applies to emissions during 2007, and are assumed to grow in real terms by 3 percent annually beginning in 2007. NHTSA seeks comments on these values and the approach used to derive them.

m. Discounting Future Benefits and Costs

Discounting future fuel savings and other benefits is intended to account for the reduction in their value to society when they are deferred until some future date, rather than received immediately. The discount rate expresses the percent decline in the value of these benefits—as viewed from today's perspective—for each year they are deferred into the future. In evaluating the benefits from alternative increases in CAFE standards for MY 2012–2016 passenger cars and light trucks, NHTSA has employed a discount rate of 3 percent per year. The agency has also tested the sensitivity of these benefit and cost estimates to the use of a 7 percent discount rate. Although these are the same discount rates analyzed in the MY 2011 final rule, NHTSA has chosen to use 3 percent as the basis for the Reference Case in this proposed rule rather than the 7 percent rate it employed previously, for the reasons discussed below.

The primary reason that NHTSA has selected 3 percent as the appropriate rate for discounting future benefits from increased CAFE standards is that most or all of vehicle manufacturers' costs for complying with higher CAFE standards are likely to be reflected in higher sales prices for their new vehicle models. By increasing sales prices for new cars and light trucks, CAFE regulation will thus primarily affect vehicle purchases and other private consumption decisions. Both economic theory and OMB guidance on discounting indicate that the future benefits and costs of regulations that mainly affect private consumption should be discounted at the social rate of time preference.[535]

OMB guidance also indicates that savers appear to discount future consumption at an average real (that is, adjusted to remove the effect of inflation) rate of about 3 percent when they face little risk about its likely level. Since the real rate that savers use to discount future consumption represents a reasonable estimate of the social rate of time preference, NHTSA has employed the 3 percent rate to discount projected future benefits and costs resulting from higher CAFE standards for MY 2012–2016 passenger cars and light trucks.[536]

Because there is some uncertainty about the extent to which vehicle manufacturers will be able to recover their costs for complying with higher CAFE standards by increasing vehicle sales prices, however, NHTSA has also tested the sensitivity of these benefit and cost estimates to the use of a higher percent discount rate. OMB guidance indicates that the real economy-wide opportunity cost of capital is the appropriate discount rate to apply to future benefits and costs when the primary effect of a regulation is ''* * * to displace or alter the use of capital in the private sector,'' and estimates that this rate currently averages about 7 percent.[537] Thus the agency has also tested the sensitivity of its benefit and cost estimates for alternative MY 2012–2016 CAFE standards to the use of a 7 percent real discount rate. NHTSA seeks comment on whether it should evaluate CAFE standards using a discount rate of 3 percent, 7 percent, or an alternative value.

n. Accounting for Uncertainty in Benefits and Costs

In analyzing the uncertainty surrounding its estimates of benefits and costs from alternative CAFE standards,

[535] *Id.*

[536] Office of Management and Budget, Circular A–4, ''Regulatory Analysis,'' September 17, 2003, 33. *Available at http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf* (last accessed August 9, 2009).

[537] *Id.*

NHTSA has considered alternative estimates of those assumptions and parameters likely to have the largest effect. These include the projected costs of fuel economy-improving technologies and their expected effectiveness in reducing vehicle fuel consumption, forecasts of future fuel prices, the magnitude of the rebound effect, the reduction in external economic costs resulting from lower U.S. oil imports, the value to the U.S. economy of reducing carbon dioxide emissions, and the discount rate applied to future benefits and costs. The range for each of these variables employed in the uncertainty analysis is presented in the section of this notice discussing each variable.

The uncertainty analysis was conducted by assuming independent normal probability distributions for each of these variables, using the low and high estimates for each variable as the values below which 5 percent and 95 percent of observed values are believed to fall. Each trial of the uncertainty analysis employed a set of values randomly drawn from each of these probability distributions, assuming that the value of each variable is independent of the others. Benefits and costs of each alternative standard were estimated using each combination of variables. A total of 1,000 trials were used to establish the likely probability distributions of estimated benefits and costs for each alternative standard.

o. Where Can Readers Find More Information About the Economic Assumptions?

Much more detailed information is provided in Chapter VIII of the PRIA, and a discussion of how NHTSA and EPA jointly reviewed and updated economic assumptions for purposes of this NPRM is available in Chapter 4 of the TSD. In addition, all of NHTSA's model input and output files are now public and available for the reader's review and consideration. The economic input files can be found in the docket for this NPRM, NHTSA–2009–0059, and on NHTSA's Web site. Finally, because much of NHTSA's economic analysis for purposes of this NPRM builds on the work that was done for the MY 2011 final rule, we refer readers to that document as well for background information concerning how NHTSA's assumptions regarding economic inputs for CAFE analysis have evolved over the past several rulemakings, both in response to comments and as a result of the agency's growing experience with this type of analysis.[538]

4. How Does NHTSA Use the Assumptions in Its Modeling Analysis?

In developing today's proposed CAFE standards, NHTSA has made significant use of results produced by the CAFE Compliance and Effects Model (commonly referred to as ''the CAFE model'' or ''the Volpe model''), which DOT's Volpe National Transportation Systems Center developed specifically to support NHTSA's CAFE rulemakings. The model, which has been constructed specifically for the purpose of analyzing potential CAFE standards, integrates the following core capabilities:

(1) Estimating how manufacturers could apply technologies in response to new fuel economy standards,

(2) Estimating the costs that would be incurred in applying these technologies,

(3) Estimating the physical effects resulting from the application of these technologies, such as changes in travel demand, fuel consumption, and emissions of carbon dioxide and criteria pollutants, and

(4) Estimating the monetized societal benefits of these physical effects.

An overview of the model follows below. Separate model documentation provides a detailed explanation of the functions the model performs, the calculations it performs in doing so, and how to install the model, construct inputs to the model, and interpret the model's outputs. Documentation of the model, along with model installation files, source code, and sample inputs are available at NHTSA's web site. The model documentation is also available in the docket for today's proposed rule, as are inputs for and outputs from analysis of today's proposed CAFE standards.

a. How Does the Model Operate?

As discussed above, the agency uses the Volpe model to estimate the extent to which manufacturers could attempt to comply with a given CAFE standard by adding technology to fleets that the agency anticipates they will produce in future model years. This exercise constitutes a simulation of manufacturers' decisions regarding compliance with CAFE standards.

This compliance simulation begins with the following inputs: (a) The baseline market forecast discussed above in Section IV.C.1, (b) technology-related estimates discussed above in Section IV.C.2, (c) economic inputs discussed above in Section IV.C.3, and (d) inputs defining the characteristics of potential new CAFE standards. For each manufacturer, the model applies technologies in a sequence that follows a defined engineering logic (''decision trees'' discussed in the MY 2011 final rule and in the model documentation) and a cost-minimizing strategy in order to identify a set of technologies the manufacturer could apply in response to new CAFE standards. The model applies technologies to each of the projected individual vehicles in a manufacturer's fleet, until one of three things occurs:

(1) The manufacturer's fleet achieves compliance with the applicable standard;

(2) The manufacturer ''exhausts''[539] available technologies; or

(3) For manufacturers estimated to be willing to pay civil penalties, the manufacturer reaches the point at which doing so would be more cost-effective (from the manufacturer's perspective) than adding further technology.[540]

As discussed below, the model has also been modified in order to apply additional technology in early model years if doing so will facilitate compliance in later model years.

The model accounts explicitly for each model year, applying most technologies when vehicles are scheduled to be redesigned or freshened, and carrying forward technologies between model years. The CAFE model accounts explicitly for each model year because EPCA requires that NHTSA make a year-by-year determination of the appropriate level of

[538] 74 FR 14308–14358 (Mar. 30, 2009).

[539] In a given model year, the model makes additional technologies available to each vehicle model within several constraints, including (a) whether or not the technology is applicable to the vehicle model's technology class, (b) whether the vehicle is undergoing a redesign or freshening in the given model year, (c) whether engineering aspects of the vehicle make the technology unavailable (*e.g.,* secondary axle disconnect cannot be applied to two-wheel drive vehicles), and (d) whether technology application remains within ''phase in caps'' constraining the overall share of a manufacturer's fleet to which the technology can be added in a given model year. Once enough technology is added to a given manufacturer's fleet in a given model year that these constraints make further technology application unavailable, technologies are exhausted for that manufacturer in that model year.

[540] This possibility was added to the model to account for the fact that under EPCA/EISA, manufacturers must pay fines if they do not achieve compliance with applicable CAFE standards. 49 U.S.C. 32912(b). NHTSA recognizes that some manufacturers will find it more cost-effective to pay fines than to achieve compliance, and believes that to assume these manufacturers would exhaust available technologies before paying fines would cause unrealistically high estimates of market penetration of expensive technologies such as diesel engines and strong hybrid electric vehicles, as well as correspondingly inflated estimates of both the costs and benefits of any potential CAFE standards.

stringency and then set the standard at that level, while ensuring ratable increases in average fuel economy.[541]

The model also calculates the costs, effects, and benefits of technologies that it estimates could be added in response to a given CAFE standard.[542] It calculates costs by applying the cost estimation techniques discussed above in Section IV.C.2, and by accounting for the number of affected vehicles. It accounts for effects such as changes in vehicle travel, changes in fuel consumption, and changes in greenhouse gas and criteria pollutant emissions. It does so by applying the fuel consumption estimation techniques also discussed in Section IV.C.2, and the vehicle survival and mileage accumulation forecasts, the rebound effect estimate and the fuel properties and emission factors discussed in Section IV.C.3. Considering changes in travel demand and fuel consumption, the model estimates the monetized value of accompanying benefits to society, as discussed in Section IV.C.3. The model calculates both the undiscounted and discounted value of benefits that accrue over time in the future.

The Volpe model has other capabilities that facilitate the development of a CAFE standard. It can be used to fit a mathematical function forming the basis for an attribute-based CAFE standard, following the steps described below. It can also be used to evaluate many (*e.g.,* 200 per model year) potential levels of stringency sequentially, and identify the stringency at which specific criteria are met. For example, it can identify the stringency at which net benefits to society are maximized, the stringency at which a specified total cost is reached, or the stringency at which a given average required fuel economy level is attained. This allows the agency to compare more easily the impacts in terms of fuel savings, emissions reductions, and costs and benefits of achieving different levels of stringency according to different criteria. The model can also be used to perform uncertainty analysis (*i.e.,* Monte Carlo simulation), in which input estimates are varied randomly according to specified probability distributions, such that the uncertainty of key measures (*e.g.,* fuel consumption, costs, benefits) can be evaluated.

b. Has NHTSA Considered Other Models?

Nothing in EPCA requires NHTSA to use the Volpe model. In principle, NHTSA could perform all of these tasks through other means. For example, in developing the standards proposed today, the agency did not use the Volpe model's curve fitting routines, because they could not be modified in time to reflect the change in the mathematical function defining the proposed CAFE standards. The Volpe model may be modified to do so for the final rule, although the agency can also continue to fit the mathematical function outside the model. In general, though, these model capabilities have greatly increased the agency's ability to rapidly, systematically, and reproducibly conduct key analyses relevant to the formulation and evaluation of new CAFE standards.

During its previous rulemaking, which led to the final MY 2011 standards promulgated earlier this year, NHTSA received comments from the Alliance and CARB encouraging NHTSA to examine the usefulness of other models. As discussed in that final rule, NHTSA, having undertaken such consideration, concluded that the Volpe model is a sound and reliable tool for the development and evaluation of potential CAFE standards.[543]

In reconsidering and reaffirming this conclusion for purposes of this NPRM, NHTSA notes that the Volpe model not only has been formally peer-reviewed and tested through three rulemakings, but also has some features especially important for the analysis of CAFE standards under EPCA/EISA. Among these are the ability to perform year-by-year analysis, and the ability to account for engineering differences between specific vehicle models.

EPCA requires that NHTSA set CAFE standards for each model year at the level appropriate for that year.[544] Doing so requires the ability to analyze each model year and, when developing regulations covering multiple model years, to account for the interdependency of model years in terms of the appropriate levels of stringency for each one. Also, as part of the evaluation of the economic practicability of the standards, as required by EPCA, NHTSA has traditionally assessed the annual costs and benefits of the standards as it is permitted to do so. The first (2002) version of DOT's model treated each model year separately, and did not perform this type of explicit accounting. Manufacturers took strong exception to these shortcomings. For example, GM commented in 2002 that ''although the table suggests that the proposed standard for MY 2007, considered in isolation, promises benefits exceeding costs, that anomalous outcome is merely an artifact of the peculiar Volpe methodology, which treats each year independently of any other * * *.'' In 2002, GM also criticized DOT's analysis for, in some cases, adding a technology in MY 2006 and then replacing it with another technology in MY 2007. GM (and other manufacturers) argued that this completely failed to represent true manufacturer product-development cycles, and therefore could not be technologically feasible or economically practicable.

In response to these concerns, and related concerns expressed by other manufacturers, DOT modified the CAFE model in order to account for dependencies between model years and to better represent manufacturers' planning cycles, in a way that still allowed NHTSA to comply with the statutory requirement to determine the appropriate level of the standards for each model year. This was accomplished by limiting the application of many technologies to model years in which vehicle models are scheduled to be redesigned (or, for some technologies, ''freshened''), and by causing the model to ''carry forward'' applied technologies from one model year to the next.

During the recent rulemaking for MY 2011 passenger cars and light trucks, DOT further modified the CAFE model to account for cost reductions attributable to ''learning effects'' related to volume (*i.e.,* economies of scale) and the passage of time (*i.e.,* time-based learning), both of which evolve on year-by-year basis. These changes were implemented in response to comments by environmental groups and other stakeholders.

The Volpe model is also able to account for important engineering differences between specific vehicle models, and to thereby reduce the risk of applying technologies that may be incompatible with or already present on

[541] 49 U.S.C. 32902(a) states that at least 18 months before the beginning of each model year, the Secretary of Transportation shall prescribe by regulation average fuel economy standards for automobiles manufactured by a manufacturer in that model year, and that each standard shall be the maximum feasible average fuel economy level that the Secretary decides the manufacturers can achieve in that year. NHTSA has long interpreted this statutory language to require year-by-year assessment of manufacturer capabilities. 49 U.S.C. 32902(b)(2)(C) also requires that standards increase ratably between MY 2011 and MY 2020.

[542] As for all of its other rulemakings, NHTSA is required by Executive Order 12866 and DOT regulations to analyze the costs and benefits of CAFE standards. Executive Order 12866, 58 FR 51735 (Oct. 4, 1993); DOT Order 2100.5, ''Regulatory Policies and Procedures,'' 1979, *available at http://regs.dot.gov/rulemakingrequirements.htm* (last accessed August 21, 2009).

[543] 74 FR 14372 (Mar. 30, 2009).

[544] 49 U.S.C. 32902(a).

a given vehicle model. Some commenters have previously suggested that manufacturers are most likely to broadly apply generic technology ''packages,'' and the Volpe model does tend to form ''packages'' dynamically, based on vehicle characteristics, redesign schedules, and schedules for increases in CAFE standards. For example, under the proposed CAFE standards for passenger cars, the CAFE model estimated that manufacturers could apply turbocharged SGDI engines mated with dual-clutch AMTs to 1.8 million passenger cars in MY 2016, about 16 percent of the MY 2016 passenger car fleet. Recent modifications to the model, discussed below, to represent multi-year planning, increase the model's tendency to add relatively cost-effective technologies when vehicles are estimated to be redesigned, and thereby increase the model's tendency to form such packages.

On the other hand, some manufacturers have indicated that especially when faced with significant progressive increases in the stringency of new CAFE standards, they are likely to also look for narrower opportunities to apply specific technologies. By progressively applying specific technologies to specific vehicle models, the CAFE model also produces such outcomes. For example, under the proposed CAFE standards for passenger cars, the CAFE model estimated that in MY 2012, some manufacturers could find it advantageous to apply SIDI to some vehicle models without also adding turbochargers.

By following this approach of combining technologies incrementally and on a model-by-model basis, the CAFE model is able to account for important engineering differences between vehicle models and avoid unlikely technology combinations. For example, the model does not apply dual-clutch AMTs (or strong hybrid systems) to vehicle models with 6-speed manual transmissions. Some vehicle buyers prefer a manual transmission; this preference cannot be assumed away. The model's accounting for manual transmissions is also important for vehicles with larger engines: For example, cylinder deactivation cannot be applied to vehicles with manual transmissions, because there is no reliable means of predicting when the driver will change gears. By retaining cylinder deactivation as a specific technology rather than part of a pre-determined package and by retaining differentiation between vehicles with different transmissions, DOT's model is able to target cylinder deactivation only to vehicle models for which it is technologically feasible.

The Volpe model also produces a single vehicle-level output file that, for each vehicle model, shows which technologies were present at the outset of modeling, which technologies were superseded by other technologies, and which technologies were ultimately present at the conclusion of modeling. For each vehicle, the same file shows resultant changes in vehicle weight, fuel economy, and cost. This provides for efficient identification, analysis, and correction of errors, a task with which the public can now assist the agency, since all inputs and outputs are public.

Such considerations, as well as those related to the efficiency with which the Volpe model is able to analyze attribute-based CAFE standards and changes in vehicle classification, and to perform higher-level analysis such as stringency estimation (to meet predetermined criteria), sensitivity analysis, and uncertainty analysis, lead the agency to conclude that the model remains the best available to the agency for the purposes of analyzing potential new CAFE standards.

c. What Changes Has DOT Made to the Model?

Prior to being used for analysis supporting today's proposal, the Volpe model was revised to make some minor improvements, and to add one significant new capability: the ability to simulate manufacturers' ability to engage in ''multi-year planning.'' Multi-year planning refers to the fact that when redesigning or freshening vehicles, manufacturers can anticipate future fuel economy or CO_2 standards, and add technologies accounting for these standards. For example, a manufacturer might choose to over-comply in a given model year when many vehicle models are scheduled for redesign, in order to facilitate compliance in a later model year when standards will be more stringent yet few vehicle models are scheduled for redesign.[545] Prior comments have indicated that the Volpe model, by not representing such manufacturer choices, tended to overestimate compliance costs. However, because of the technical complexity involved in representing these choices when, as in the Volpe model, each model year is accounted for separately and explicitly, the model could not be modified to add this capability prior to the statutory deadline for the MY 2011 final standards.

The model now includes this capability, and NHTSA has applied it in analyzing the standards proposed today. Consequently, this often produces results indicating that manufacturers could over-comply in some model years (with corresponding increases in costs and benefits in those model years) and thereby ''carry forward'' technology into later model years in order to reduce compliance costs in those later model years. NHTSA believes this better represents how manufacturers would actually respond to new CAFE standards, and thereby produces more realistic estimates of the costs and benefits of such standards.

The Volpe model has also been modified to accommodate inputs specifying the amount of CAFE credit to be applied to each manufacturer's fleet. Although the model is not currently capable of estimating manufacturers' decisions regarding the generation and use of CAFE credits, and EPCA does not allow NHTSA, in setting CAFE standards, to take into account manufacturers' potential use of credits, this additional capability in the Volpe model provides a basis for more accurately estimating costs, effects, and benefits that may actually result from new CAFE standards. Insofar as some manufacturers actually do earn and use CAFE credits, this provides NHTSA with some ability to examine outcomes more realistically than EPCA allows for purposes of setting new CAFE standards.

In comments on recent NHTSA rulemakings, some reviewers have suggested that the Volpe model should be modified to estimate the extent to which new CAFE standards would induce changes in the mix of vehicles in the new vehicle fleet. NHTSA, like EPA, agrees that a ''market shift'' model, also called a consumer vehicle choice model, could provide useful information regarding the possible effects of potential new CAFE standards. An earlier experimental version of the Volpe model included a multinomial logit model that estimated changes in sales resulting from CAFE-induced increases in new vehicle fuel economy and prices. A fuller description of this attempt can be found in Section V of the PRIA. However, NHTSA has thus far been unable to develop credible coefficients specifying such a model. In addition, as discussed in Section II.H.4, such a model is sensitive to the coefficients used in it, and there is great variation over some key values of these coefficients in published studies. NHTSA seeks comment on ways to

[545] Although a manufacturer may, in addition, generate CAFE credits in early model years for use in later model years (or, less likely, in later years for use in early years), EPCA does not allow NHTSA, when setting CAFE standards, to account for manufacturers' use of CAFE credits.

improve on this earlier work and develop this capability effectively. If the agency is able to do so prior to conducting analysis supporting decisions regarding final CAFE standards, it will attempt to reintegrate this capability in the Volpe model and include these effects in its analysis of final standards. If not, NHTSA will continue efforts to develop and make use of this capability in future rulemakings.

d. Does the Model Set the Standards?

Although NHTSA currently uses the Volpe model as a tool to inform its consideration of potential CAFE standards, the Volpe model does not determine the CAFE standards that NHTSA proposes or promulgates as final regulations. The results it produces are completely dependent on inputs selected by NHTSA, based on the best available information and data available in the agency's estimation at the time standards are set. Although the model has been programmed in previous rulemakings to estimate at what stringency net benefits are maximized, NHTSA has not done so here and has instead used the Volpe model to estimate stringency levels that produce roughly constant rates of increase in the combined average required fuel economy. Ultimately, NHTSA's selection of a CAFE standard is governed and guided by the statutory requirements of EPCA, as amended by EISA: NHTSA sets the standard at the maximum feasible average fuel economy level that it determines is achievable during a particular model year, considering technological feasibility, economic practicability, the effect of other standards of the Government on fuel economy, and the need of the nation to conserve energy.

NHTSA considers the results of analyses conducted by the Volpe model and analyses conducted outside of the Volpe model, including analysis of the impacts of carbon dioxide and criteria pollutant emissions, analysis of technologies that may be available in the long term and whether NHTSA could expedite their entry into the market through these standards, and analysis of the extent to which changes in vehicle prices and fuel economy might affect vehicle production and sales. Using all of this information—not solely that from the Volpe model—the agency considers the governing statutory factors, along with environmental issues and other relevant societal issues such as safety, and promulgates the standards based on its best judgment on how to balance these factors.

This is why the agency considered eight regulatory alternatives, only one of which reflects the agency's proposed standards, based on the agency's determinations and assumptions. Others assess alternative standards, some of which exceed the proposed standards and/or the point at which net benefits are maximized. These comprehensive analyses, which also included scenarios with different economic input assumptions as presented in the FEIS and FRIA, are intended to inform and contribute to the agency's consideration of the ''need of the United States to conserve energy,'' as well as the other statutory factors. 49 U.S.C. 32902(f). Additionally, the agency's analysis considers the need of the nation to conserve energy by accounting for economic externalities of petroleum consumption and monetizing the economic costs of incremental CO_2 emissions in the social cost of carbon. NHTSA uses information from the model when considering what standards to propose and finalize, but the model does not determine the standards.

e. How Does NHTSA Make the Model Available and Transparent?

Model documentation, which is publicly available in the rulemaking docket and on NHTSA's web site, explains how the model is installed, how the model inputs (all of which are available to the public)[546] and outputs are structured, and how the model is used. The model can be used on any Windows-based personal computer with Microsoft Office 2003 and the Microsoft .NET framework installed (the latter available without charge from Microsoft). The executable version of the model and the underlying source code are also available at NHTSA's Web site. The input files used to conduct the core analysis documented in this proposed rule are available in the public docket. With the model and these input files, anyone is capable of independently running the model to repeat, evaluate, and/or modify the agency's analysis.

5. How Did NHTSA Develop the Shape of the Target Curves for the Proposed Standards?

In developing the shape of the target curves for today's proposed standards, NHTSA took a new approach, primarily in response to comments received in the MY 2011 rulemaking. NHTSA's authority under EISA allows consideration of any ''attribute related to fuel economy'' and any ''mathematical function.'' While the attribute, footprint, is the same for these proposed standards as the attribute used for the MY 2011 standards, the mathematical function is new.

Both vehicle manufacturers and public interest groups expressed concern in the MY 2011 rulemaking process that the constrained logistic function, particularly the function for the passenger car standards, was overly steep and could lead, on the one hand, to fuel economy targets that were overly stringent for small footprint vehicles, and on the other hand, to a greater incentive for manufacturers to upsize vehicles in order to reduce their compliance obligation (because larger-footprint vehicles have less stringent targets) in ways that could compromise energy and environmental benefits. We tentatively believe that the constrained linear function developed here significantly mitigates steepness concerns, but we seek comment on whether readers agree, and whether there are any other issues relating to the new approach that NHTSA should consider in developing the curves for the final rule.

a. Standards Are Attribute-Based and Defined by a Mathematical Function

EPCA, as amended by EISA, expressly requires that CAFE standards for passenger cars and light trucks be based on one or more vehicle attributes related to fuel economy, and be expressed in the form of a mathematical function.[547] Like the MY 2011 standards, the MY 2012–2016 passenger car and light truck standards are attribute-based and defined by a mathematical function.[548] Also like the MY 2011 standards, the MY 2012–2016 standards are based on the footprint attribute. However, unlike the MY 2011 standards, the MY 2012–2016 standards are defined by a constrained linear rather than a constrained logistic function. The reasons for these similarities and differences are explained below.

As discussed above in Section II, under attribute-based standards, the fleet-wide average fuel economy that a particular manufacturer must achieve in a given model year depends on the mix of vehicles that it produces for sale.

[546] We note, however, that files from any supplemental analysis conducted that relied in part on confidential manufacturer product plans cannot be made public, as prohibited under 49 CFR part 512.

[547] 49 U.S.C. 32902(a)(3)(A).

[548] As discussed in Chapter 2 of the TSD, EPA is also proposing to set attribute-based CO_2 standards that are defined by a mathematical function, given the advantages of using attribute-based standards and given the goal of coordinating and harmonizing the CAFE and CO_2 standards as expressed by President Obama in his announcement of the new National Program and in the joint NOI.

Until NHTSA began to set ''Reformed'' attribute-based standards for light trucks in MYs 2008–2011, and until EISA gave NHTSA authority to set attribute-based standards for passenger cars beginning in MY 2011, NHTSA set ''universal'' or ''flat'' industry-wide average CAFE standards. Attribute-based standards are preferable to universal industry-wide average standards for several reasons. First, attribute-based standards increase fuel savings and reduce emissions when compared to an equivalent universal industry-wide standard under which each manufacturer is subject to the same numerical requirement. Absent a policy to require all full-line manufacturers to produce and sell essentially the same mix of vehicles, the stringency of the universal industry-wide standards is constrained by the capability of those full-line manufacturers whose product mix includes a relatively high proportion of larger and heavier vehicles. In effect, the standards are based on the mix of those manufacturers. As a result, the standards are generally set below the capabilities of full-line and limited-line manufacturers that sell predominantly lighter and smaller vehicles.

Under an attribute-based system, in contrast, every manufacturer is more likely to be required to continue adding more fuel-saving technology each year because the level of the compliance obligation of each manufacturer is based on its own particular product mix. Thus, the compliance obligation of a manufacturer with a higher percentage of lighter and smaller vehicles will have a higher compliance obligation than a manufacturer with a lower percentage of such vehicles. As a result, all manufacturers must use technologies to enhance the fuel economy levels of the vehicles they sell. Therefore, fuel savings and CO_2 emissions reductions should be higher under an attribute-based system than under a comparable industry-wide standard.

Second, attribute-based standards minimize the incentive for manufacturers to respond to CAFE in ways harmful to safety.[549] Because each vehicle model has its own target (based on the attribute chosen), attribute-based standards provide no incentive to build smaller vehicles simply to meet a fleet-wide average. Since smaller vehicles are subject to more stringent fuel economy targets, a manufacturer's increasing its proportion of smaller vehicles would simply cause its compliance obligation to increase.

Third, attribute-based standards provide a more equitable regulatory framework for different vehicle manufacturers.[550] A universal industry-wide average standard imposes disproportionate cost burdens and compliance difficulties on the manufacturers that need to change their product plans and no obligation on those manufacturers that have no need to change their plans. Attribute-based standards spread the regulatory cost burden for fuel economy more broadly across all of the vehicle manufacturers within the industry.

And fourth, attribute-based standards respect economic conditions and consumer choice, instead of having the government mandate a certain fleet mix. Manufacturers are required to invest in technologies that improve the fuel economy of their fleets, regardless of vehicle mix. Additionally, attribute-based standards help to avoid the need to conduct rulemakings to amend standards if economic conditions change, causing a shift in the mix of vehicles demanded by the public. NHTSA conducted three rulemakings during the 1980s to amend passenger car standards for MYs 1986–1989 in response to unexpected drops in fuel prices and resulting shifts in consumer demand that made the passenger car standard of 27.5 mpg infeasible for several years following the change in fuel prices.

As discussed above in Section II, for purposes of the CAFE standards proposed in this NPRM, NHTSA recognizes that the risk, even if small, does exist that low fuel prices in MYs 2012–2016 might lead indirectly to less than currently anticipated fuel savings and emissions reductions. Thus, we seek comment on whether backstop standards, or any other method within the agencies' statutory authority, should and can be implemented for the import and light truck fleets in order to achieve the fuel savings that attribute-based standards might not absolutely guarantee. Commenters are encouraged, but not required, to review and respond to NHTSA's discussion of this issue in the MY 2011 final rule as a starting point.[551]

b. What Attribute Does NHTSA Use, and Why?

Consistent with the MY 2011 CAFE standards, NHTSA is proposing to use footprint as the attribute for the MY 2012–2016 CAFE standards. There are several policy reasons why NHTSA and EPA both believe that footprint is the most appropriate attribute on which to base the standards, as discussed below.

As discussed in the PRIA, in NHTSA's judgment, from the standpoint of vehicle safety, it is important that the CAFE standards be set in a way that does not encourage manufacturers to respond by selling vehicles that are in any way less safe. While NHTSA's research also indicates that reductions in vehicle mass tend to compromise vehicle safety, footprint-based standards provide an incentive to use advanced lightweight materials and structures that would be discouraged by weight-based standards, because manufacturers can use them to improve a vehicle's fuel economy without their use necessarily resulting in a change in the vehicle's target level of fuel economy.

Further, although we recognize that weight is better correlated with fuel economy than is footprint, we continue to believe that 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. We also agree with concerns raised in 2008 by some commenters in the MY 2011 CAFE rulemaking that there would be greater potential for gaming under multi-attribute standards, such as standards under which targets would also depend on attributes such as weight, torque, power, towing capability, and/or off-road capability. Standards that incorporate such attributes in conjunction with footprint would not only be significantly more complex, but by providing degrees of freedom with respect to more easily-adjusted attributes, they would make it less certain that the future fleet would actually achieve the projected average fuel economy and CO_2 reduction levels.

However, while NHTSA tentatively concludes that footprint is the most appropriate attribute upon which to base the proposed standards, recognizing strong public interest in this issue, we seek comment on whether the agency should consider setting standards for the final rule based on another attribute or another combination of attributes. If commenters suggest that the agency should consider another attribute or another combination of attributes, the agency specifically requests that the commenters address the concerns raised

[549] The 2002 NAS Report described at length and quantified the potential safety problem with average fuel economy standards that specify a single numerical requirement for the entire industry. *See* NAS Report at 5, finding 12.

[550] *Id.* at 4–5, finding 10.

[551] 74 FR 14409–14412 (Mar. 30, 2009).

in the paragraphs above regarding the use of other attributes, and explain how standards should be developed using the other attribute(s) in a way that contributes more to fuel savings and CO_2 reductions than the footprint-based standards, without compromising safety.

c. What Mathematical Function Did NHTSA Use for the Recently-Promulgated MY 2011 CAFE Standards?

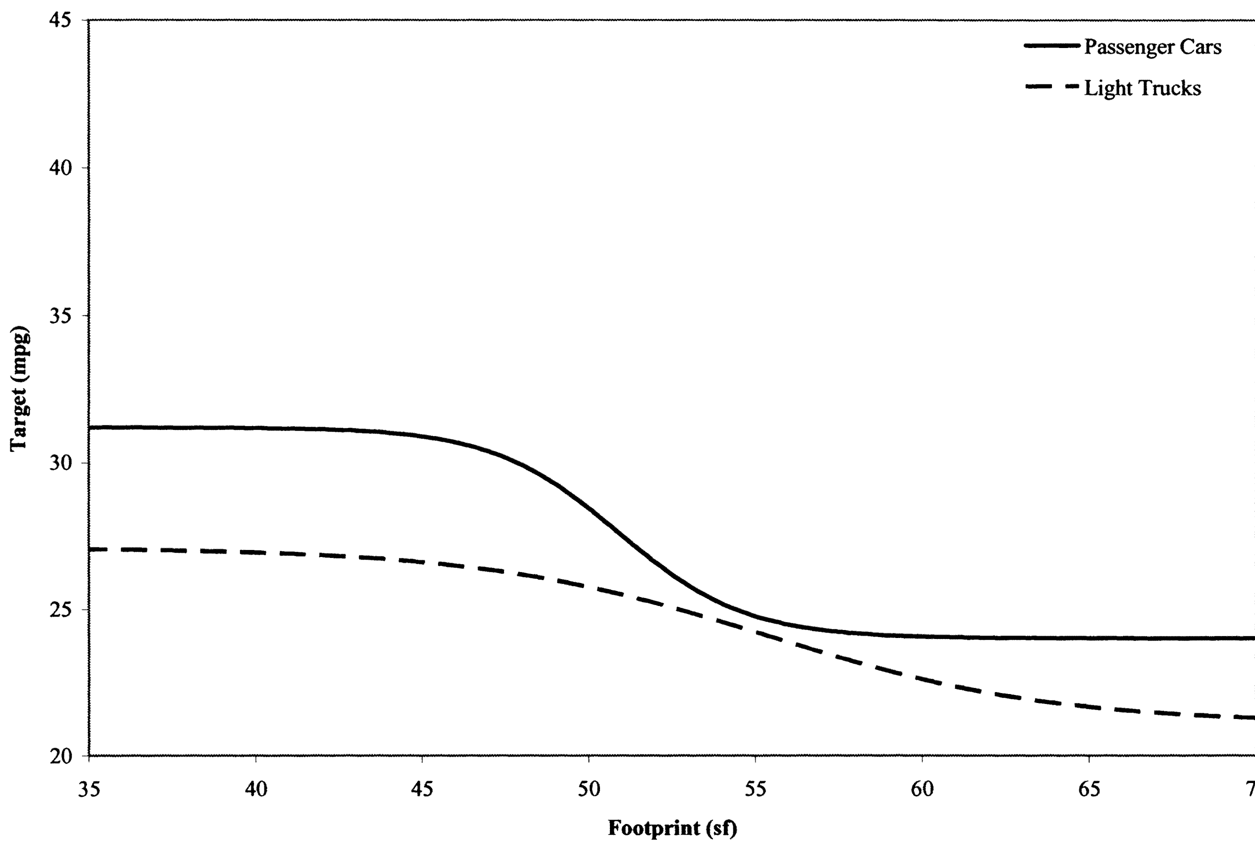
The MY 2011 CAFE standards are defined by a continuous, constrained logistic function, which takes the form of an S-curve, and is defined according to the following formula:

$$TARGET = \frac{1}{\frac{1}{a} + \left(\frac{1}{b} - \frac{1}{a}\right)\frac{e^{(FOOTPRINT-c)/d}}{1+e^{(FOOTPRINT-c)/d}}}$$

Here, *TARGET* is the fuel economy target (in mpg) applicable to vehicles of a given footprint (*FOOTPRINT,* in square feet), *b* and *a* are the function's lower and upper asymptotes (also in mpg), *e* is approximately equal to 2.718,[552] *c* is the footprint (in square feet) at which the inverse of the fuel economy target falls halfway between the inverses of the lower and upper asymptotes, and *d* is a parameter (in square feet) that determines how gradually the fuel economy target transitions from the upper toward the lower asymptote as the footprint increases.

After fitting this mathematical form (separately) to the passenger car and light truck fleets and determining the stringency of the standards (*i.e.*, the vertical positions of the curves), NHTSA arrived at the following curves to define the MY 2011 standards:

Figure IV.C.5-2. MY 2011 CAFE Standards for Passenger Cars and Light Trucks



d. What Mathematical Function is NHTSA Proposing to Use for New CAFE Standards, and Why?

In finalizing the MY 2011 standards, NHTSA noted that the agency is not required to use a constrained logistic function and indicated that the agency may consider defining future CAFE standards in terms of a different mathematical function. NHTSA has done so in preparation for the proposed CAFE standards.

In revisiting this question, NHTSA found that the final MY 2011 CAFE standard for passenger cars, though less

[552] *e* is the irrational *number* for which the slope of the function $y = number^x$ is equal to 1 when x is equal to zero. The first 8 digits of *e* are 2.7182818.

steep than the MY 2011 standard NHTSA proposed in 2008, continues to concentrate the sloped portion of the curve (from a compliance perspective, the area in which upsizing results in a slightly lower applicable target) within a relatively narrow footprint range (approximately 47–55 square feet). Further, most passenger car models have footprints smaller than the curve's 51.4 square foot inflection point, and many passenger car models have footprints at which the curve is relatively flat.

For both passenger cars and light trucks, a mathematical function that has some slope at most footprints where vehicles are produced is advantageous in terms of fairly balancing regulatory burdens among manufacturers, and in terms of providing a disincentive to respond to new standards by downsizing vehicles in ways that compromise vehicle safety. For example, a flat standard may be very difficult for a full-line manufacturer to meet, while requiring very little of a manufacturer concentrating on small vehicles, and a flat standard may provide an incentive to manufacturers to downsize certain vehicles, in order to ''balance out'' other vehicles subject to the same standard.

As a potential alternative to the constrained logistic function, NHTSA had, in proposing MY 2011 standards, presented information regarding a constrained linear function. As shown in the 2008 NPRM, a constrained linear function has the potential to avoid creating a localized region (in terms of vehicle footprint) over which the slope of the function is relatively steep. Although NHTSA did not receive public comments on this option, the agency indicated that it still believed a linear function constrained by upper (on a gpm basis) and possibly lower limits could merit reconsideration in future CAFE rulemakings.

Having re-examined a constrained linear function for purposes of the proposed standards, NHTSA tentatively concludes that for both passenger cars and light trucks, it remains meaningfully sloped over a wide footprint range, thereby providing a well-distributed disincentive to downsize vehicles in ways that could compromise highway safety. Further, the constrained linear function proposed today is not so steeply sloped that it would provide a strong incentive to increase vehicle size in order to obtain a lower CAFE requirement and higher CO_2 limit, thereby compromising energy and environmental benefits. Therefore, the CAFE standards proposed today are defined by constrained linear functions.

The constrained linear function is defined according to the following formula:

$$TARGET = \frac{1}{MIN\left[MAX\left(c \times FOOTPRINT + d, \frac{1}{a}\right), \frac{1}{b}\right]}$$

Here, *TARGET* is the fuel economy target (in mpg) applicable to vehicles of a given footprint (*FOOTPRINT,* in square feet), *b* and *a* are the function's lower and upper asymptotes (also in mpg), respectively, *c* is the slope (in gpm per square foot) of the sloped portion of the function, and *d* is the intercept (in gpm) of the sloped portion of the function (that is, the value the sloped portion would take if extended to a footprint of 0 square feet. The *MIN* and *MAX* functions take the minimum and maximum, respectively of the included values; for example, *MIN*(1,2) = 1, *MAX*(1,2) = 2, and *MIN*[*MAX*(1,2),3)]=2. The following chart shows an example of a linear target function, where *a* = 0.0241 gpm (41.6 mpg), *b* = 0.032 gpm (31.2 mpg), *c* = 0.000531 gpm per square foot, and *d* = 0.002292 gpm (436 mpg). Because the function is linear on a gpm basis, not an mpg basis, it is plotted on this basis.

e. How Did NHTSA Fit the Coefficients That Determine the Shape of the Proposed Curves?

For purposes of this NPRM, and for EPA's use in developing new CO_2 emissions standards, the basic curve shapes were developed using methods similar to those applied by NHTSA in fitting the curves defining the MY 2011 standards. We began with the market inputs discussed above, but because the baseline fleet is technologically heterogeneous, NHTSA used the CAFE model to develop a fleet to which nearly all the technologies discussed in Section V of the PRIA and Chapter 3 of the joint TSD [553] were applied, by taking the following steps: (1) Treating all manufacturers as unwilling to pay civil penalties rather than applying technology, (2) applying any technology at any time, irrespective of scheduled vehicle redesigns or freshening, and (3) ignoring ''phase-in caps'' that constrain the overall amount of technology that can be applied by the model to a given manufacturer's fleet. These steps helped to increase technological parity among vehicle models, thereby providing a better basis (than the baseline fleet) for estimating the statistical relationship between vehicle size and fuel economy.

More information on the process for fitting the passenger car and light truck curves for MYs 2012–2016 is available above in Section II.C, and NHTSA refers the reader to that section and to Chapter 2 of the joint TSD. NHTSA seeks comment on this approach to fitting the curves. We note that final decisions on this issue will play an important role in determining the form and stringency of the final CAFE and CO_2 standards, the incentives those standards will provide (*e.g.*, with respect to downsizing small vehicles), and the relative compliance burden faced by each manufacturer.

D. Statutory Requirements

1. EPCA, as Amended by EISA

a. Standard Setting

NHTSA must establish separate standards for MY 2011–2020 passenger cars and light trucks, subject to two principal requirements.[554] First, the standards are subject to a minimum requirement regarding stringency: They must be set at levels high enough to ensure that the combined U.S. passenger car and light truck fleet achieves an average fuel economy level of not less than 35 mpg not later than MY 2020.[555] Second, as discussed above and at length in the March 2009 final rule establishing the MY 2011 CAFE standards, EPCA requires that the

[553] The agencies excluded diesel engines and strong hybrid vehicle technologies from this exercise (and only this exercise) because the agencies expect that manufacturers would not need to rely heavily on these technologies in order to comply with the proposed standards. NHTSA and EPA did include diesel engines and strong hybrid vehicle technologies in all other portions of their analyses.

[554] EISA added the following additional requirements. Standards must be attribute-based and expressed in the form of a mathematical function. 49 U.S.C. 32902(b)(3)(A). Standards for MYs 2011–2020 must ''increase ratably'' in each model year. 49 U.S.C. 32902(b)(2)(C). NHTSA interprets this requirement, in combination with the requirement to set the standards for each model year at the level determined to be the maximum feasible level for that model year, to mean that the annual increases should not be disproportionately large or small in relation to each other.

[555] 49 U.S.C. 32902(b)(2)(A).

agency establish standards for all new passenger cars and light trucks at the maximum feasible average fuel economy level that the Secretary decides the manufacturers can achieve in that model year.[556] The implication of this second requirement is that it calls for exceeding the minimum requirement if the agency determines that the manufacturers can achieve a higher level. When determining the level achievable by the manufacturers, EPCA requires that the agency consider the four statutory factors of 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. In addition, the agency has the authority to and traditionally does consider other relevant factors, such as the effect of the CAFE standards on motor vehicle safety.

i. Statutory Factors Considered in Determining the Achievable Level of Average Fuel Economy

As none of the four factors is defined in EPCA and each remains interpreted only to a limited degree by case law, NHTSA has considerable latitude in interpreting them. NHTSA interprets the four statutory factors as set forth below.

(1) Technological Feasibility

''Technological feasibility'' refers to whether a particular technology for improving fuel economy is available or can become available for commercial application in the model year for which a standard is being established. Thus, the agency is not limited in determining the level of new standards to technology that is already being commercially applied at the time of the rulemaking. It can, instead, set technology-forcing standards, *i.e.,* ones that make it necessary for manufacturers to engage in research and development in order to bring a new technology to market.

(2) Economic Practicability

''Economic practicability'' refers to whether a standard is one ''within the financial capability of the industry, but not so stringent as to'' lead to ''adverse economic consequences, such as a significant loss of jobs or the unreasonable elimination of consumer choice.'' [557] In an attempt to ensure the economic practicability, the agency considers a variety of factors, including the annual rate at which manufacturers can increase the percentage of its fleet that has a particular type of fuel saving technology, and cost to consumers. Consumer acceptability is also an element of economic practicability.

At the same time, the law does not preclude a CAFE standard that poses considerable challenges to any individual manufacturer. The Conference Report for EPCA, as enacted in 1975, makes clear, and the case law affirms, ''(A) determination of maximum feasible average fuel economy should not be keyed to the single manufacturer which might have the most difficulty achieving a given level of average fuel economy.'' [558] Instead, the agency is compelled ''to weigh the benefits to the nation of a higher fuel economy standard against the difficulties of individual automobile manufacturers.'' *Id.* The law permits CAFE standards exceeding the projected capability of any particular manufacturer as long as the standard is economically practicable for the industry as a whole. Thus, while a particular CAFE standard may pose difficulties for one manufacturer, it may also present opportunities for another. The CAFE program is not necessarily intended to maintain the competitive positioning of each particular company. Rather, it is intended to enhance fuel economy of the vehicle fleet on American roads, while protecting motor vehicle safety and being mindful of the risk of harm to the overall United States economy.

Thus, NHTSA believes that this term must be applied in the context of the competing concerns associated with different levels of standards. Prior to switching to attribute-based standards in the MY 2008–2011 rulemaking, the agency sought to ensure the economy practicability of standards in part by setting them at or near the capability of the ''least capable manufacturer'' with a significant share of the market, *i.e.,* typically the manufacturer whose vehicles are, on average, the heaviest and largest. In the first several rulemakings to establish attribute based standards, the agency applied marginal cost benefit analysis. This ensured that the agency's application of technologies was limited to those that would pay for themselves and thus would have significant appeal to consumers. However, the agency can and has limited its application of technologies to those technologies, with or without the use of such analysis.

(3) The Effect of Other Motor Vehicle Standards of the Government on Fuel Economy

''The effect of other motor vehicle standards of the Government on fuel economy,'' involves an analysis of the effects of compliance with emission,[559] safety, noise, or damageability standards on fuel economy capability and thus on average fuel economy. In previous CAFE rulemakings, the agency has said that pursuant to this provision, it considers the adverse effects of other motor vehicle standards on fuel economy. It said so because, from the CAFE program's earliest years [560] until present, the effects of such compliance on fuel economy capability over the history of the CAFE program have been negative ones. In those instances in which the effects are negative, NHTSA is called upon to ''mak[e] a straightforward adjustment to the fuel economy improvement projections to account for the impacts of other Federal standards, principally those in the areas of emission control, occupant safety, vehicle damageability, and vehicle noise. However, only the unavoidable consequences should be accounted for. The automobile manufacturers must be expected to adopt those feasible methods of achieving compliance with other Federal standards which minimize any adverse fuel economy effects of those standards.'' [561] For example, safety standards that have the effect of increasing vehicle weight lower vehicle fuel economy capability and thus decrease the level of average fuel economy that the agency can determine to be feasible.

The ''other motor vehicle standards'' consideration has thus in practice functioned in a fashion similar to the provision in EPCA, as originally enacted, for adjusting the statutorily-specified CAFE standards for MY 1978–1980 passengers cars.[562] EPCA did not permit NHTSA to amend those standards based on a finding that the maximum feasible level of average fuel economy for any of those three years was greater or less than the standard specified for that year. Instead, it provided that the agency could only reduce the standards and only on one basis: if the agency found that there had been a *Federal* standards fuel economy reduction, *i.e.*, a reduction in fuel economy due to changes in the Federal vehicle standards, *e.g.*, emissions and safety, relative to the year of enactment, 1975.

[556] 49 U.S.C. 32902(a).

[557] 67 FR 77015, 77021 (Dec. 16, 2002).

[558] *CEI–I,* 793 F.2d 1322, 1352 (D.C. Cir. 1986).

[559] In the case of emission standards, this includes standards adopted by the Federal Government and can include standards adopted by the States as well, since in certain circumstances the Clean Air Act allows States to adopt and enforce State standards different from the Federal ones.

[560] 42 FR 63184, 63188 (Dec. 15, 1977). *See also* 42 FR 33534, 33537 (Jun. 30, 1977).

[561] 42 FR 33534, 33537 (Jun. 30, 1977).

[562] That provision was deleted as obsolete when EPCA was codified in 1994.

The ''other motor vehicle standards'' provision is broader than the *Federal* standards fuel economy reduction provision. Although the effects analyzed to date under the ''other motor vehicle standards'' provision have been negative, there could be circumstances in which the effects are positive. In the event that the agency encountered such circumstances, it would be required to consider those positive effects. For example, if changes in vehicle safety technology led to NHTSA's amending a safety standard in a way that permits manufacturers to reduce the weight added in complying with that standard, that weight reduction would increase vehicle fuel economy capability and thus increase the level of average fuel economy that could be determined to be feasible.

In the wake of *Massachusetts* v. *EPA* and of EPA's proposed endangerment finding, granting of a waiver to California for its motor vehicle GHG standards, and its own proposal of GHG standards, the agency is confronted with the issue of how to treat those standards under the ''other motor vehicle standards'' provision. To the extent the GHG standards result in increases in fuel economy, they would do so almost exclusively as a result of inducing manufacturers to install the same types of technologies used by manufacturers in complying with the CAFE standards. The primary exception would involve increases in the efficiency of air conditioners.

Thus, NHTSA tentatively concludes that the effects of the EPA and California standards are neither positive nor negative because the proposed rule results in consistent standards among all components of the National Program. Comment is requested on whether and in what way the effects of the California and EPA standards should be considered under the ''other motor vehicle standards'' provision or other provisions of EPCA in 49 U.S.C. 32902, consistent with NHTSA's independent obligation under EPCA/EISA to issue CAFE standards? The agency has already considered EPA's proposal and the harmonization benefits of the National Program in developing its own proposal.

(4) The Need of the United States To Conserve Energy

''The need of the United States to conserve energy'' means ''the consumer cost, national balance of payments, environmental, and foreign policy implications of our need for large quantities of petroleum, especially imported petroleum.'' [563] Environmental implications principally include those associated with reductions in emissions of criteria pollutants and CO_2. A prime example of foreign policy implications are energy independence and security concerns.

ii. Other Factors Considered by NHTSA

The agency historically has considered the potential for adverse safety consequences in setting CAFE standards. This practice is recognized approvingly in case law. As the courts have recognized, ''NHTSA has always examined the safety consequences of the CAFE standards in its overall consideration of relevant factors since its earliest rulemaking under the CAFE program.'' *Competitive Enterprise Institute* v. *NHTSA,* 901 F.2d 107, 120 n. 11 (DC Cir. 1990) (''*CEI I''*) (citing 42 Fed. Reg. 33534, 33551 (June 30, 1977)). The courts have consistently upheld NHTSA's implementation of EPCA in this manner. *See, e.g., Competitive Enterprise Institute* v. *NHTSA*, 956 F.2d 321, 322 (D.C. Cir. 1992) (''*CEI II''*) (in determining the maximum feasible fuel economy standard, ''NHTSA has always taken passenger safety into account.'') (citing *CEI I,* 901 F.2d at 120 n. 11); *Competitive Enterprise Institute* v. *NHTSA*, 45 F.3d 481, 482–83 (D.C. Cir. 1995) (''*CEI III''*) (same); *Center for Biological Diversity* v. *NHTSA,* 538 F.3d 1172, 1203–04 (9th Cir. 2008) (upholding NHTSA's analysis of vehicle safety issues associated with weight in connection with the MY 2008–11 light truck CAFE rule). Thus, in evaluating what levels of stringency would result in maximum feasible standards, NHTSA assesses the potential safety impacts and considers them in balancing the statutory considerations and to determine the appropriate level of the standards.

Under the universal or ''flat'' CAFE standards that NHTSA was previously authorized to establish, the primary risk to safety came from the possibility that manufacturers would respond to higher standards by building smaller, less safe vehicles in order to ''balance out'' the larger, safer vehicles that the public generally preferred to buy. Under the attribute-based standards being proposed today, that risk is reduced because building smaller vehicles would tend to raise a manufacturer's overall CAFE obligation, rather than only raising its fleet average CAFE. However, even if the manufacturers did not engage in any downsizing under attribute-based standards, there is still the possibility that manufacturers would rely on downweighting to improve their fuel economy (for a given vehicle at a given footprint target) in ways that may reduce safety to a greater or lesser extent. While NHTSA recognizes that manufacturers may nonetheless choose this option for raising their CAFE levels, in prior rulemakings we have limited the application of downweighting/material substitution in our modeling analysis to vehicles over 5,000 lbs GVWR.[564]

For purposes of today's proposed standards, however, NHTSA has revised its modeling analysis to allow some application of downweighting/material substitution for all vehicles, including those under 5,000 lbs GVWR, because we believe that this is more consistent with how manufacturers will actually respond to the standards. However, as discussed above, NHTSA does not mandate the use of any particular technology by manufacturers in meeting the standards. More information on the new approach to modeling manufacturer use of downweighting/material substitution is available in Chapter 3 of the draft joint TSD and in Section V of the PRIA; and the estimated safety impacts that may be due to the proposed standards are described below.

iii. Factors That NHTSA Is Prohibited From Considering

EPCA also provides that in determining the level at which it should set CAFE standards for a particular model year, NHTSA may not consider the ability of manufacturers to take advantage of several EPCA provisions that facilitate compliance with the CAFE standards and thereby reduce the costs of compliance.[565] As discussed further below, manufacturers can earn compliance credits by exceeding the CAFE standards and then use those credits to achieve compliance in years in which their measured average fuel economy falls below the standards. Manufacturers can also increase their CAFE levels through MY 2019 by producing alternative fuel vehicles. EPCA provides an incentive for producing these vehicles by specifying that their fuel economy is to be determined using a special calculation procedure that results in those vehicles being assigned a high fuel economy level.

The effect of the prohibitions against considering these flexibilities in setting the CAFE standards is that the flexibilities remain voluntarily-employed measures. If the agency were

[563] 42 FR 63184, 63188 (1977).

[564] *See* 74 FR 14396–14407 (Mar. 30, 2009).

[565] 49 U.S.C. 32902(h).

instead to assume manufacturer use of those flexibilities in setting new standards, that assumption would result in higher standards and thus tend to require manufacturers to use those flexibilities.

iv. Determining the Level of the Standards by Balancing the Factors

NHTSA has broad discretion in balancing the above factors in determining the appropriate levels of average fuel economy at which to set the CAFE standards for each model year. Congress "specifically delegated the process of setting * * * fuel economy standards with *broad* guidelines concerning the factors that the agency must consider." [566] The breadth of those guidelines, the absence of any statutorily prescribed formula for balancing the factors, the fact that the relative weight to be given to the various factors may change from rulemaking to rulemaking as the underlying facts change, and the fact that the factors may often be conflicting with respect to whether they militate toward higher or lower standards give NHTSA discretion to decide what weight to give each of the competing policies and concerns and then determine how to balance them. The exercise of that discretion is subject to the necessity of ensuring that NHTSA's balancing does not undermine the fundamental purpose of the EPCA: Energy conservation,[567] and as long as that balancing reasonably accommodates "conflicting policies that were committed to the agency's care by the statute." [568] The balancing of the factors in any given rulemaking is highly dependent on the factual and policy context of that rulemaking. Given the changes over time in facts bearing on assessment of the various factors, such as those relating to the economic conditions, fuel prices and the state of climate change science, the agency recognizes that what was a reasonable balancing of competing statutory priorities in one rulemaking may not be a reasonable balancing of those priorities in another rulemaking.[569] Nevertheless, the agency retains substantial discretion under EPCA to choose among reasonable alternatives.

EPCA neither requires nor precludes the use of any type of cost-benefit analysis as a tool to help inform the balancing process. While NHTSA used marginal cost-benefit analysis in the first two rulemakings to establish attribute-based CAFE standards, it was not required to do so and is not required to continue to do so. Regardless of what type of analysis is or is not used, considerations relating to costs and benefits remain an important part of CAFE standard setting.

Because the relevant considerations and factors can reasonably be balanced in a variety of ways under EPCA, and because of uncertainties associated with the many technological and cost inputs, NHTSA considers a wide variety of alternative sets of standards, each reflecting different balancing of those policies and concerns, to aid it in discerning reasonable outcomes. Among the alternatives providing for an increase in the standards in this rulemaking, the alternatives range in stringency from a set of standards that increase, on average, 3 percent annually to a set of standards that increase, on average, 7 percent annually.

2. Administrative Procedure Act

To be upheld under the "arbitrary and capricious" standard of judicial review in the APA, an agency rule must be rational, based on consideration of the relevant factors, and within the scope of the authority delegated to the agency by the statute. The agency must examine the relevant data and articulate a satisfactory explanation for its action including a "rational connection between the facts found and the choice made." *Burlington Truck Lines, Inc.* v. *United States,* 371 U.S. 156, 168 (1962).

Statutory interpretations included in an agency's rule are subjected to the two-step analysis of *Chevron, U.S.A., Inc.* v. *Natural Resources Defense Council,* 467 U.S. 837, 104 S.Ct. 2778, 81 L.Ed.2d 694 (1984). Under step one, where a statute "has directly spoken to the precise question at issue," *id.* at 842, 104 S.Ct. 2778, the court and the agency "must give effect to the unambiguously expressed intent of Congress," *id.* at 843, 104 S.Ct. 2778. If the statute is silent or ambiguous regarding the specific question, the court proceeds to step two and asks "whether the agency's answer is based on a permissible construction of the statute." *Id.*

If an agency's interpretation differs from the one that it has previously adopted, the agency need not demonstrate that the prior position was wrong or even less desirable. Rather, the agency would need only to demonstrate that its *new* position is consistent with the statute and supported by the record, and acknowledge that this is a departure from past positions. The Supreme Court emphasized this recently in *FCC* v. *Fox Television,* 129 S.Ct. 1800 (2009). When an agency changes course from earlier regulations, "the requirement that an agency provide reasoned explanation for its action would ordinarily demand that it display awareness that it *is* changing position," but "need not demonstrate to a court's satisfaction that the reasons for the new policy are *better* than the reasons for the old one; it suffices that the new policy is permissible under the statute, that there are good reasons for it, and that the agency *believes* it to be better, which the conscious change of course adequately indicates." [570]

3. National Environmental Policy Act

As discussed above, EPCA requires the agency to determine what level at which to set the CAFE standards for each model year by considering the four factors of 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. NEPA directs that environmental considerations be integrated into that process. To accomplish that purpose, NEPA requires an agency to compare the potential environmental impacts of its proposed action to those of a reasonable range of alternatives.

To explore the environmental consequences in depth, NHTSA has prepared a draft environmental impact statement. The purpose of an EIS is to "provide full and fair discussion of significant environmental impacts and [to] inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment." 40 CFR 1502.1.

NEPA is "a procedural statute that mandates a process rather than a particular result." *Stewart Park & Reserve Coal., Inc.* v. *Slater,* 352 F.3d at 557. The agency's overall EIS-related obligation is to "take a 'hard look' at the environmental consequences before taking a major action." *Baltimore Gas & Elec. Co.* v. *Natural Res. Def. Council, Inc.,* 462 U.S. 87, 97, 103 S.Ct. 2246, 76 L.Ed.2d 437 (1983). Significantly, "[i]f the adverse environmental effects of the proposed action are adequately identified and evaluated, the agency is not constrained by NEPA from deciding that other values outweigh the environmental costs." *Robertson* v. *Methow Valley Citizens Council,* 490 U.S. 332, 350, 109 S.Ct. 1835, 104 L.Ed.2d 351 (1989).

[566] *Center for Auto Safety* v. *NHTSA,* 793 F.2d 1322, 1341 (C.A.D.C. 1986).

[567] *Center for Biological Diversity* v. *NHTSA*, 538 F.3d 1172, 1195 (9th Cir. 2008).

[568] *CAS,* 1338 (quoting *Chevron U.S.A., Inc.* v. *Natural Resources Defense Council, Inc.*, 467 U.S. 837, 845).

[569] *CBD* v. *NHTSA*, 538 F.3d 1172, 1198 (9th Cir. 2008).

[570] *Ibid.,* 1181.

The agency must identify the "environmentally preferable" alternative, but need not adopt it. "Congress in enacting NEPA * * * did not require agencies to elevate environmental concerns over other appropriate considerations." *Baltimore Gas and Elec. Co.* v. *Natural Resources Defense Council, Inc.,* 462 U.S. 87, 97 (1983). Instead, NEPA requires an agency to develop alternatives to the proposed action in preparing an EIS. 42 U.S.C. 4332(2)(C)(iii). The statute does not command the agency to favor an environmentally preferable course of action, only that it make its decision to proceed with the action after taking a hard look at environmental consequences.

E. What Are the Proposed CAFE Standards?

1. Form of the Standards

Each of the CAFE standards that NHTSA is proposing today for passenger cars and light trucks is expressed as a mathematical function that defines a fuel economy target applicable to each vehicle model and, for each fleet, establishes a required CAFE level determined by computing the sales-weighted harmonic average of those targets.[571]

As discussed above in Section II.C, NHTSA is proposing to determine fuel economy targets using a constrained linear function defined according to the following formula:

$$TARGET = \frac{1}{MIN\left[MAX\left(c \times FOOTPRINT + d, \frac{1}{a}\right), \frac{1}{b}\right]}$$

Here, *TARGET* is the fuel economy target (in mpg) applicable to vehicles of a given footprint (*FOOTPRINT*, in square feet), *b* and *a* are the function's lower and upper asymptotes (also in mpg), respectively, *c* is the slope (in gpm per square foot) of the sloped portion of the function, and *d* is the intercept (in gpm) of the sloped portion of the function (that is, the value the sloped portion would take if extended to a footprint of 0 square feet). The *MIN* and *MAX* functions take the minimum and maximum, respectively of the included values.

As also discussed in Section II.C, under the proposed standards (as under the recently-promulgated MY 2011 standards), the CAFE level required of any given manufacturer will be determined by calculating the production-weighted harmonic average of the fuel economy targets applicable to each vehicle model:

$$CAFE_{required} = \frac{\sum_i SALES_i}{\sum_i \frac{SALES_i}{TARGET_i}}$$

Here, $CAFE_{required}$ is the required level for a given fleet, $SALES_i$ is the number of units of model *i* produced for sale in the United States, $TARGET_i$ is the fuel economy target applicable to model *i* (according to the equation shown in Chapter II and based on the footprint of model *i*), and the summations in the numerator and denominator are both performed over all models in the fleet in question.

The proposed standards are, therefore, specified by the four coefficients defining fuel economy targets:

a = upper limit (mpg)
b = lower limit (mpg)
c = slope (gpm per square foot)
d = intercept (gpm)

The values of the coefficients are different for the passenger car standards and the light truck standards.

2. Passenger Car Standards for MYs 2012–2016

For passenger cars, NHTSA is proposing CAFE standards defined by the following coefficients during MY 2012–2016:

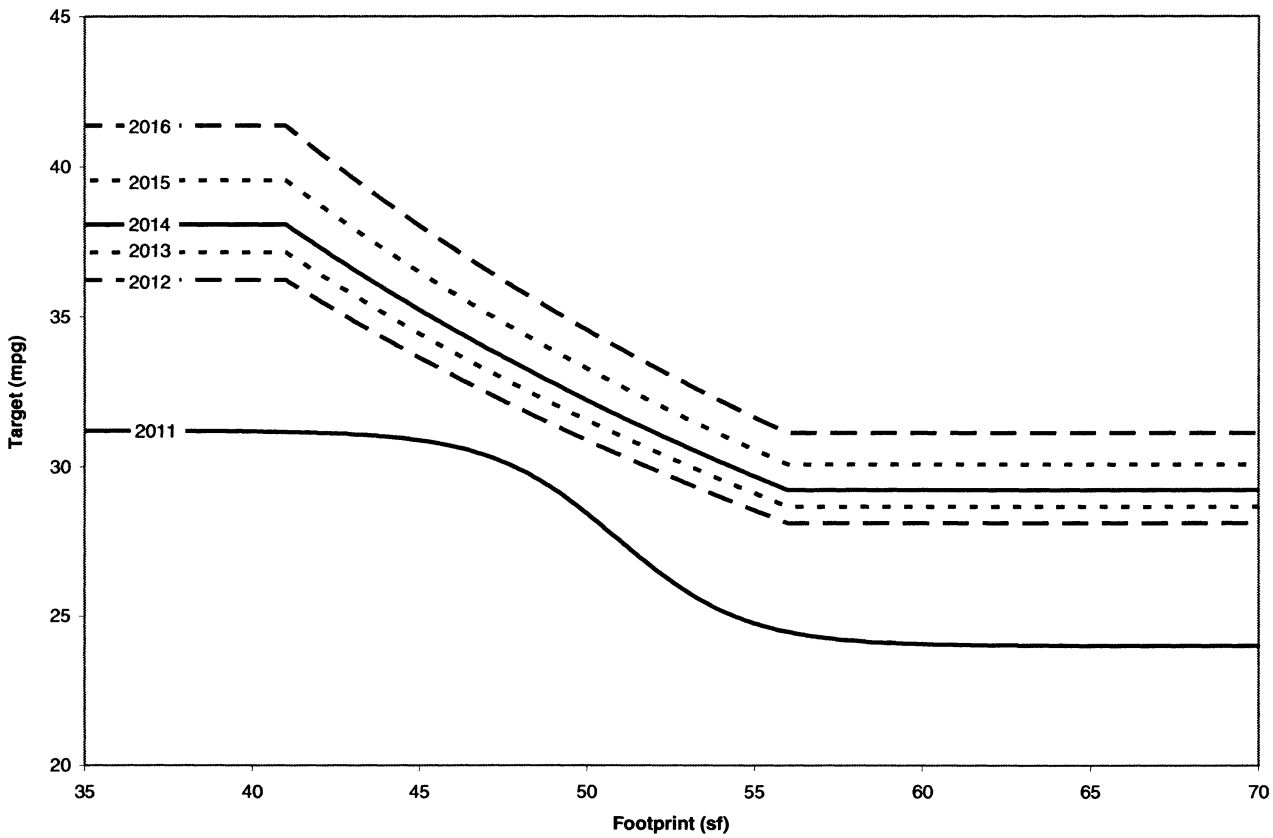
TABLE IV.E.2–1—COEFFICIENTS DEFINING PROPOSED MY 2012–2016 FUEL ECONOMY TARGETS FOR PASSENGER CARS

Coefficient	2012	2013	2014	2015	2016
a (mpg)	36.23	37.15	38.08	39.55	41.38
b (mpg)	28.12	28.67	29.22	30.08	31.12
c (gpm/sf)	0.0005308	0.0005308	0.0005308	0.0005308	0.0005308
d (gpm)	0.005842	0.005153	0.004498	0.003520	0.002406

These coefficients result in footprint-dependent target curves shown graphically below. The MY 2011 final standard, which is specified by a constrained logistic function rather than a constrained linear function, is shown for comparison.

[571] Required CAFE levels shown here are *estimated* required levels based on NHTSA's current projection of manufacturers' vehicle fleets in MYs 2012–2016. *Actual* required levels are not determined until the end of each model year, when all of the vehicles produced by a manufacturer in that model year are known and their compliance obligation can be determined with certainty. The target curves, as defined by the constrained linear function, and as embedded in the function for the sales-weighted harmonic average, are the real "standards" being proposed today.

Figure IV.E.2-1. Final MY 2011 and Proposed MY 2012-2016 Fuel Economy Target Curves for Passenger Cars



As discussed, the CAFE levels required of individual manufacturers will depend on the mix of vehicles they produce for sale in the United States. Based on the market forecast of future sales that NHTSA has used to examine today's proposed CAFE standards, the agency estimates that the targets shown above will result in the following average required fuel economy levels for individual manufacturers during MYs 2012–2016 (an updated estimate of the average required fuel economy level under the final MY 2011 standard is shown for comparison): [572]

TABLE IV.E.2–2—ESTIMATED AVERAGE FUEL ECONOMY REQUIRED UNDER FINAL MY 2011 AND PROPOSED MY 2012–2016 CAFE STANDARDS FOR PASSENGER CARS

Manufacturer	MY 2011	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	30.2	33.2	34.0	34.8	36.0	37.5
Chrysler	29.6	33.0	33.7	34.5	35.3	36.8
Daimler	29.4	32.6	33.1	33.8	35.0	36.4
Ford	29.8	33.0	33.7	34.5	35.8	37.3
General Motors	30.3	33.0	33.8	34.6	35.8	37.3
Honda	30.8	33.9	34.7	35.5	36.8	38.4
Hyundai	30.8	33.8	34.6	35.5	36.8	38.3
Kia	30.6	33.6	34.4	35.2	36.5	38.0
Mazda	30.7	34.1	34.8	35.7	37.0	38.6
Mitsubishi	31.0	34.4	35.3	36.1	37.4	39.2
Nissan	30.7	33.5	34.2	35.0	36.2	37.8
Porsche	31.2	36.2	37.2	38.1	39.6	41.4
Subaru	31.0	34.8	35.7	36.5	37.9	39.6
Suzuki	31.2	35.9	36.8	37.7	39.2	41.0
Tata	27.8	30.7	31.4	32.1	33.1	34.4
Toyota	30.8	34.1	34.9	35.7	37.0	38.6
Volkswagen	30.8	34.6	35.4	36.2	37.5	39.1
Average	30.5	33.6	34.4	35.2	36.4	38.0

[572] In the March 2009 final rule establishing MY 2011 standards for passenger cars and light trucks, NHTSA estimated that the required fuel economy levels for passenger cars would average 30.2 mpg under the MY 2011 passenger car standard. Based on the agency's current forecast of the MY 2011 passenger car market, which anticipates greater numbers of passenger cars than the forecast used in the MY 2011 final rule, NHTSA now estimates that the average required fuel economy level for passenger cars will be 30.5 mpg in MY 2011.

We note that a manufacturer's required average fuel economy level for a model year under the proposed standards would be based on its actual production numbers in that model year. Therefore, its official required fuel economy level would not be known until the end of that model year. However, because the targets for each vehicle footprint would be established in advance of the model year, a manufacturer should be able to estimate its required level accurately.

3. Minimum Domestic Passenger Car Standards

EISA expressly requires each manufacturer to meet a minimum fuel economy standard for domestically manufactured passenger cars in addition to meeting the standards set by NHTSA. According to the statute (49 U.S.C. 32902(b)(4)) the minimum standard shall be the greater of (A) 27.5 miles per gallon; or (B) 92 percent of the average fuel economy projected by the Secretary for the combined domestic and non-domestic passenger automobile fleets manufactured for sale in the United States by all manufacturers in the model year. The agency must publish the projected minimum standards in the **Federal Register** when the passenger car standards for the model year in question are promulgated.

Based on NHTSA's current market forecast, the agency's estimates of these minimum standards under the proposed MY 2012–2016 CAFE standards (and, for comparison, the final MY 2011 standard) are summarized below in Table IV.E.2–1.[573] For eventual compliance calculations, the final calculated minimum standards will be updated to reflect any changes in the average fuel economy level required under the final standards.

TABLE IV.E.3–1—ESTIMATED MINIMUM STANDARD FOR DOMESTICALLY MANUFACTURED PASSENGER CARS UNDER FINAL MY 2011 AND PROPOSED MY 2012–2016 CAFE STANDARDS FOR PASSENGER CARS

2011	2012	2013	2014	2015	2016
28.0	30.9	31.6	32.4	33.5	34.9

4. Light Truck Standards

For light trucks, NHTSA is proposing CAFE standards defined by the following coefficients during MYs 2012–2016:

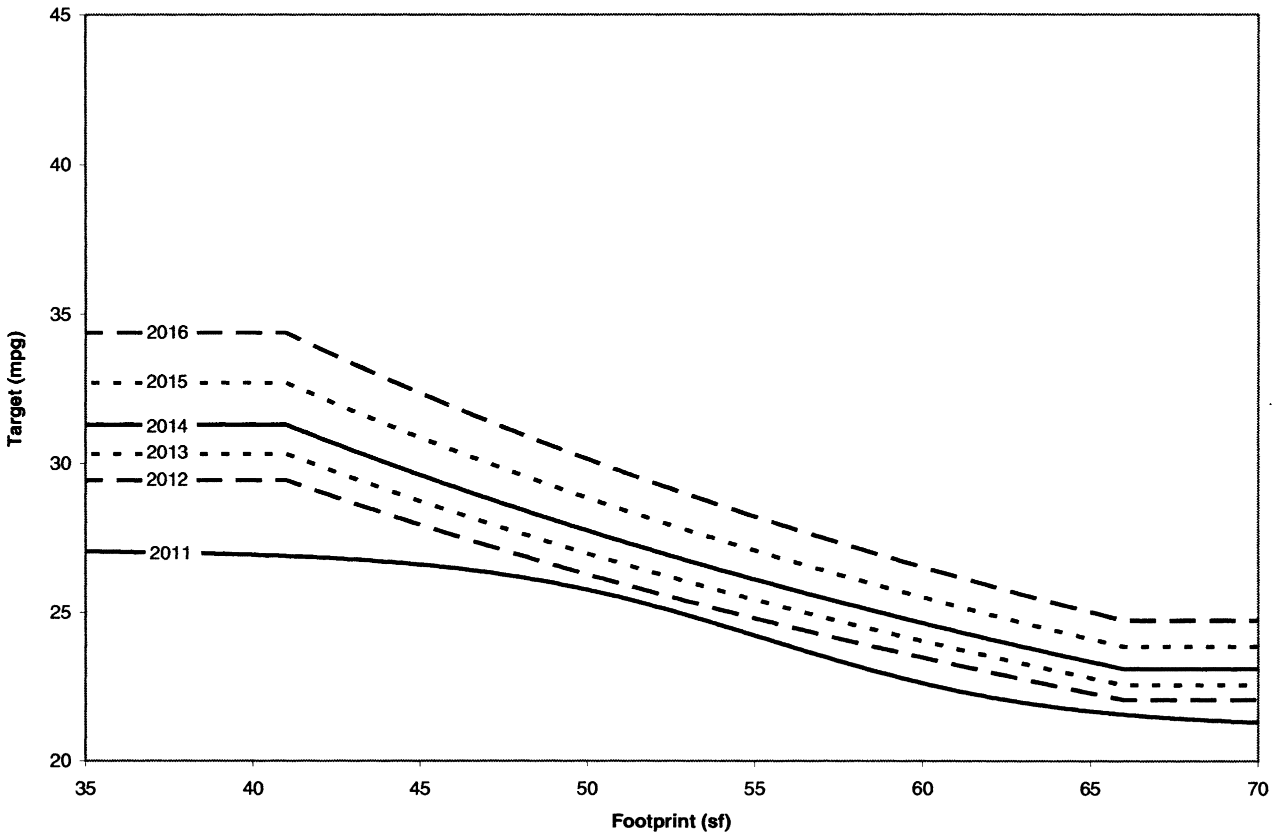
TABLE IV.E.4–1—COEFFICIENTS DEFINING PROPOSED MY 2012–2016 FUEL ECONOMY TARGETS FOR LIGHT TRUCKS

Coefficient	2012	2013	2014	2015	2016
a (mpg)	29.44	30.32	31.30	32.70	34.38
b (mpg)	22.06	22.55	23.09	23.84	24.72
c (gpm/sf)	0.0004546	0.0004546	0.0004546	0.0004546	0.0004546
d (gpm)	0.01533	0.01434	0.01331	0.01194	0.01045

These coefficients result in footprint-dependent targets shown graphically below. The MY 2011 final standard, which is specified by a constrained logistic function rather than a constrained linear function, is shown for comparison.

[573] In the March 2009 final rule establishing MY 2011 standards for passenger cars and light trucks, NHTSA estimated that the minimum required CAFE standard for domestically manufactured passenger cars would be 27.8 mpg under the MY 2011 passenger car standard. Based on the agency's current forecast of the MY 2011 passenger car market, NHTSA now estimates that the minimum required CAFE standard will be 28.0 mpg in MY 2011.

Figure IV.E.4-1. Final MY 2011 and Proposed MY 2012-2016 Fuel Economy Targets for Light Trucks



Given these targets, the CAFE levels required of individual manufacturers will depend on the mix of vehicles they produce for sale in the United States. Based on the market forecast NHTSA has used to examine today's proposed CAFE standards, the agency estimates that the targets shown above will result in the following average required fuel economy levels for individual manufacturers during MYs 2012–2016 (an updated estimate of the average required fuel economy level under the final MY 2011 standard is shown for comparison): [574]

TABLE IV.E.4–2—ESTIMATED AVERAGE FUEL ECONOMY REQUIRED UNDER FINAL MY 2011 AND PROPOSED MY 2012–2016 CAFE STANDARDS FOR LIGHT TRUCKS

Manufacturer	MY 2011	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	25.7	26.3	27.0	27.7	28.8	30.1
Chrysler	24.2	25.2	25.8	26.4	27.3	28.5
Daimler	24.7	25.4	26.1	26.9	27.9	29.1
Ford	23.3	24.3	24.9	25.3	26.2	27.3
General Motors	22.9	23.6	24.2	24.8	25.6	26.6
Honda	25.6	26.4	27.1	27.9	29.0	30.4
Hyundai	25.9	26.6	27.3	28.1	29.3	30.6
Kia	25.1	25.8	26.4	27.2	28.3	29.6
Mazda	26.3	27.4	28.1	28.8	29.9	31.4
Mitsubishi	26.4	27.4	28.1	28.9	30.1	31.6
Nissan	24.1	25.0	25.6	26.1	27.0	28.2
Porsche	25.5	26.0	26.7	27.4	28.5	29.8
Subaru	26.5	27.5	28.3	29.2	30.4	31.8
Suzuki	26.3	27.2	27.9	28.7	29.9	31.3
Tata	26.1	26.9	27.6	28.4	29.6	31.0
Toyota	25.2	25.7	26.3	27.1	28.1	29.3
Volkswagen	25.0	25.6	26.2	26.9	27.9	29.2
Average	24.2	25.0	25.6	26.2	27.1	28.3

[574] In the March 2009 final rule establishing MY 2011 standards for passenger cars and light trucks, NHTSA estimated that the required fuel economy levels for light trucks would average 24.1 mpg under the MY 2011 light truck standard. Based on the agency's current forecast of the MY 2011 light truck market, NHTSA now estimates that the required fuel economy levels will average 24.2 mpg in MY 2011. The increase in the estimate reflects a slight decrease in the size of the average light truck.

As discussed above with respect to the proposed passenger cars standards, we note that a manufacturer's required fuel economy level for a model year under the proposed standards would be based on its actual production numbers in that model year.

F. How Do the Proposed Standards Fulfill NHTSA's Statutory Obligations?

In developing the proposed MY 2012–16 standards, the agency developed and considered a wide variety of alternatives. NHTSA took a new approach to defining alternatives as compared to the most recent prior CAFE rulemaking. In response to comments received in the last round of rulemaking, in our March 2009 notice of intent to prepare an environmental impact statement, the agency selected a range of candidate stringencies that increased annually, on average, 3% to 7%.[575] That same approach has been carried over to this NPRM and to the accompanying DEIS and PRIA. The majority of the alternatives considered in this rulemaking are defined as average percentage increases in stringency—3 percent per year, 4 percent per year, 5 percent per year, and so on. NHTSA believes that this approach more clearly communicates the level of stringency of each alternative and is more intuitive than alternatives defined in terms of different cost-benefit ratios, and still allows us to identify alternatives that represent different ways to balance NHTSA's statutory requirements under EPCA/EISA.

In the notice of intent, we noted that each of the listed alternatives represents, in part, a different way in which NHTSA could conceivably balance conflicting policies and considerations in setting the standards. We were mindful that the agency would need to weigh and balance many factors, such as the technological feasibility, economic practicability, including leadtime considerations for the introduction of technologies and impacts on the auto industry, the impacts of the standards on fuel savings and CO_2 emissions, fuel savings by consumers; as well as other relevant factors such as safety. For example, the 7% Alternative, the most stringent alternative, weighs energy conservation and climate change considerations more heavily and technological feasibility and economic practicability less heavily. In contrast, the 3% Alternative, the least stringent alternative, places more weight on technological feasibility and economic practicability. We recognized that the "feasibility" of the alternatives also may reflect differences and uncertainties in the way in which key economic (*e.g.,* the price of fuel and the social cost of carbon) and technological inputs could be assessed and estimated or valued.

In subsequently developing the NPRM and the associated analytical documents, the agency expanded the list of alternatives to provide a degree of analytical continuity between the old and new approach to defining alternatives in an effort help the agency and the public understand the similarities and dissimilarities between the two approaches and to make the transition to the new approach. To that end, we included and analyzed two additional alternatives, one that sets standards at the point where net benefits are maximized, and another that sets standards at the point at which total costs are equal to total benefits.[576] With respect to the first of those alternatives, we note that Executive Order 12866 focuses attention on an approach that maximizes net benefits. Further, since NHTSA has thus far set attribute-based CAFE standards at the point at which net benefits are maximized, we believed it would be useful and informative to consider the potential impacts of that approach as compared to the new approach for MYs 2012–2016.

After working with EPA in thoroughly reviewing and in some cases reassessing the effectiveness and costs of technologies, most of which are already being incorporated in at least some vehicles, market forecasts and economic assumptions, we used the Volpe model extensively to assess the technologies that the manufacturers could apply in order to comply with each of the alternatives. This permitted us to assess the variety, amount and cost of the technologies that could be needed to enable the manufacturers to comply with each of the alternatives. NHTSA estimated how the application of these and other technologies could increase vehicle costs. The following five figures show industry-wide average incremental (*i.e.,* relative to the reference fleet) per-vehicle costs, for each model year, each fleet, and the combined fleet. Estimates specific to each manufacturer are shown in the accompanying PRIA.

[575] Notice of intent to prepare an EIS, 74 FR 14857, 14859–60, April 1, 2009.

[576] The stringency indicated by each of these alternatives depends on the value of inputs to NHTSA's analysis. Results presented here for these two alternatives are based on NHTSA's reference case inputs, which underlie the central analysis of the proposed standards. In the accompanying PRIA, the agency presents the results of that analysis to explore the sensitivity of results to changes in key economic inputs. Because of numerous changes in model inputs (*e.g.,* discount rate, rebound effect, CO_2 value, technology cost estimates), our analysis often exhausts all available technologies before reaching the point at which total costs equal total benefits. In these cases, the stringency that exhausts all available technologies is considered.

Figure IV.F.1. Average Incremental Per-Vehicle Costs (MY 2012)

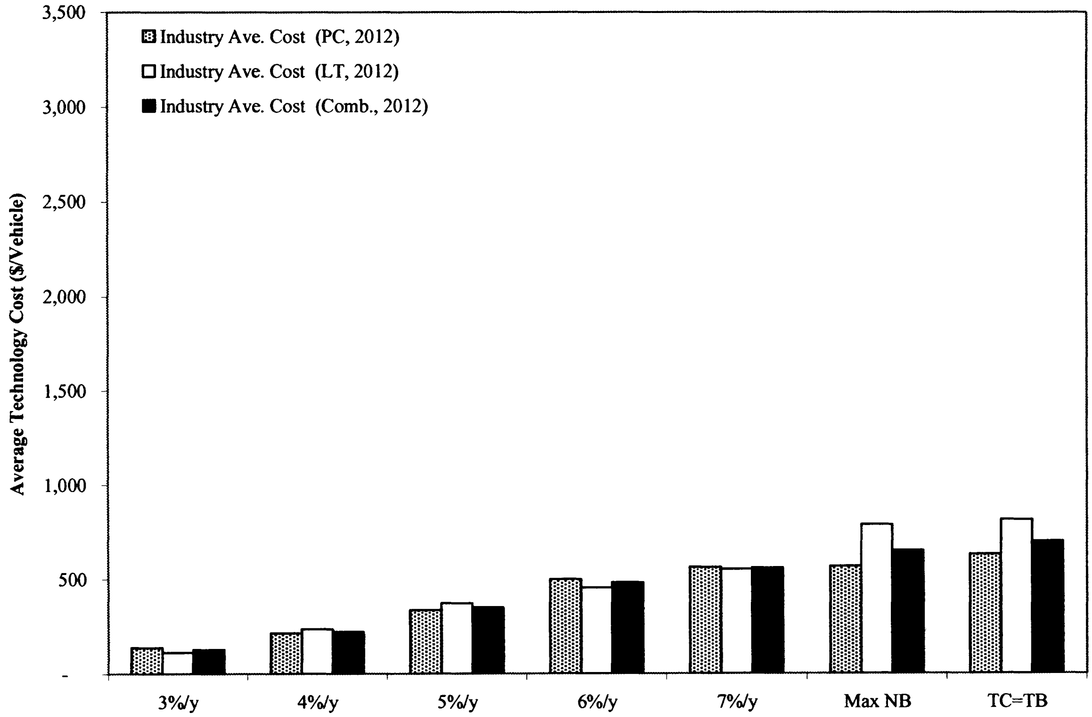


Figure IV.F.2. Average Incremental Per-Vehicle Costs (MY 2013)

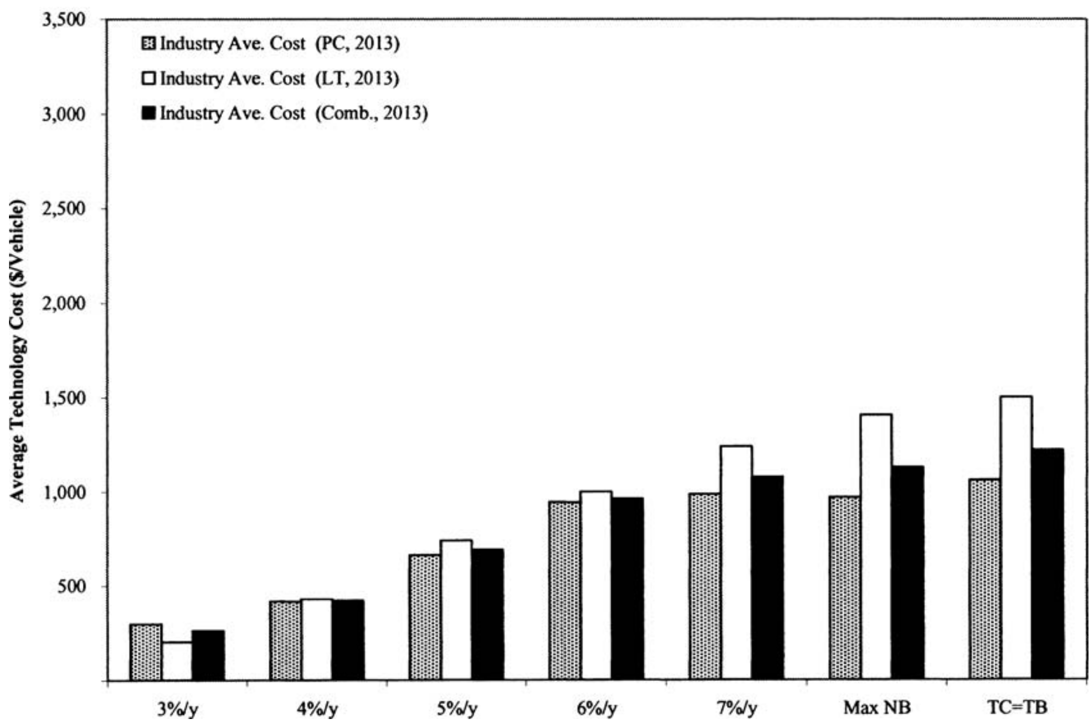


Figure IV.F.3. Average Incremental Per-Vehicle Costs (MY 2014)

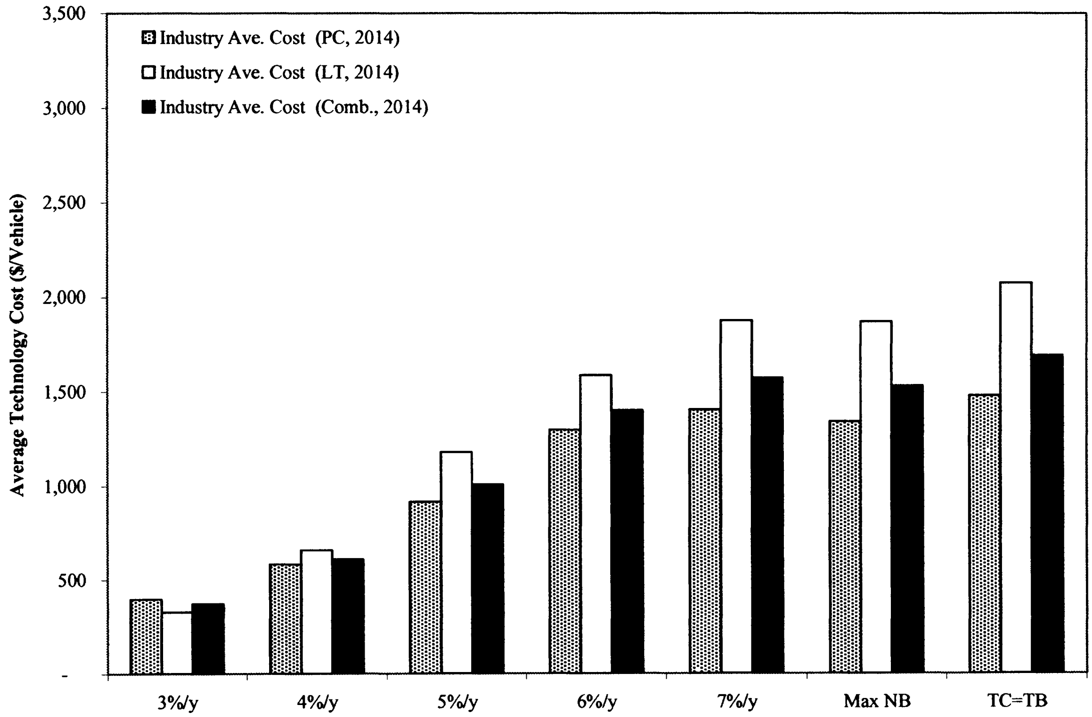


Figure IV.F.4. Average Incremental Per-Vehicle Costs (MY 2015)

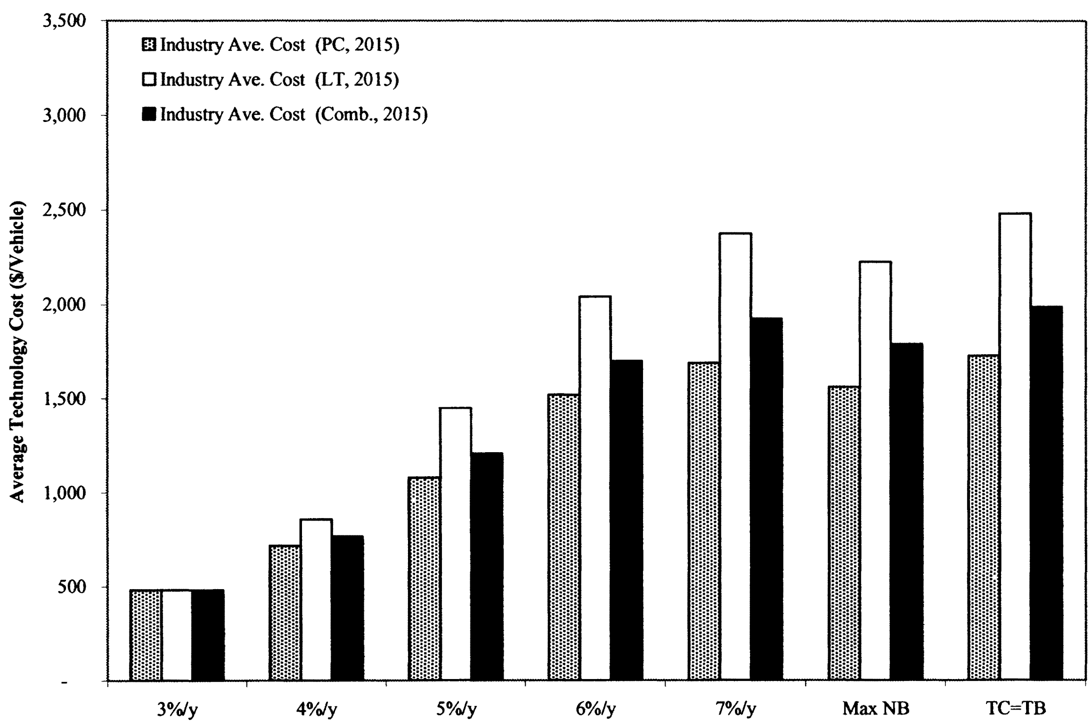
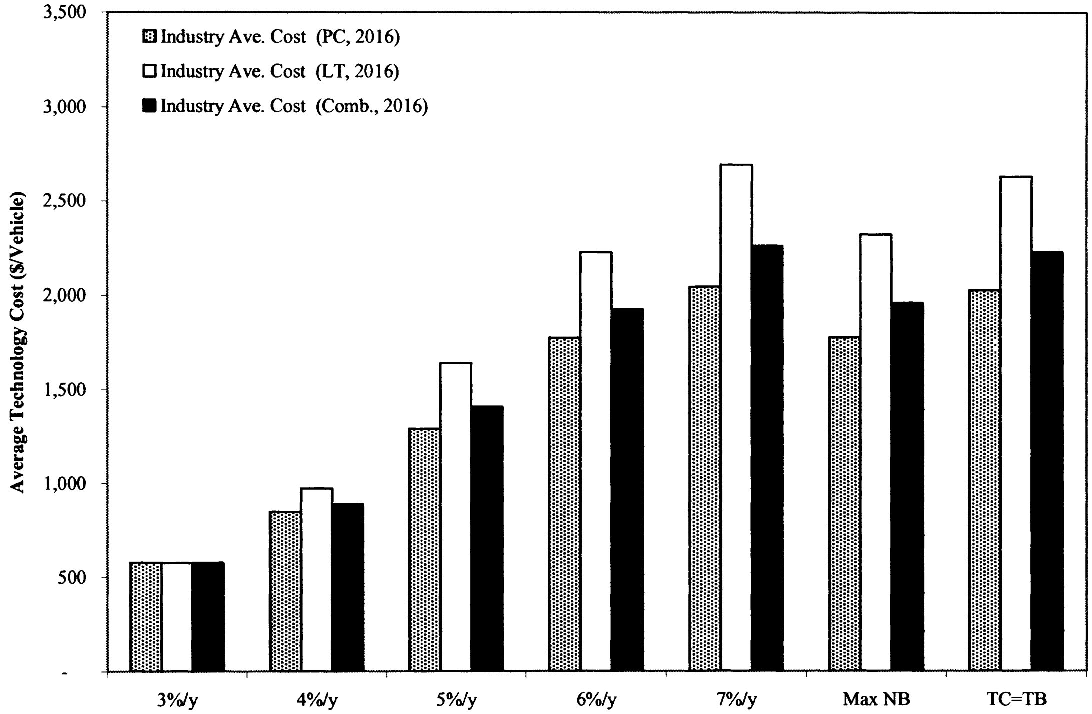
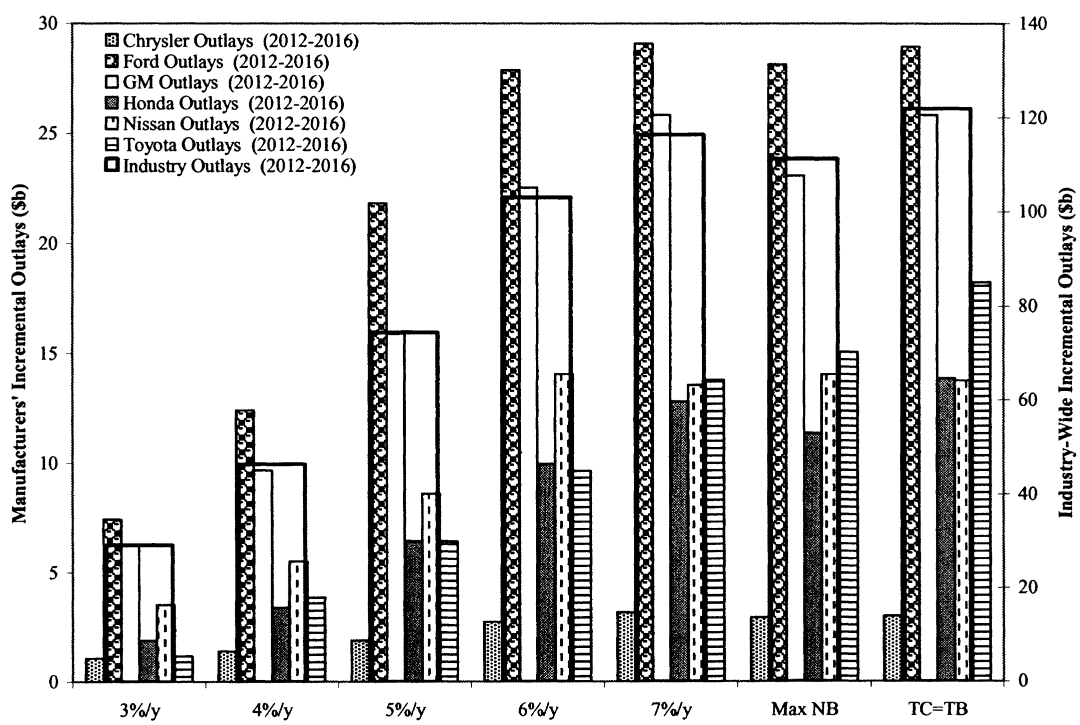


Figure IV.F.5. Average Incremental Per-Vehicle Costs (MY 2016)



Corresponding to these per-vehicle cost increases, NHTSA estimated total incremental outlays for additional technology in each model year. The following figure shows cumulative results for MY 2012–2016 for industry and Chrysler, Ford, General Motors, Honda, Nissan, and Toyota. This figure focuses on these manufacturers as they currently (in MY 2008) represent three large U.S.-headquartered and three large foreign-headquartered full-line manufacturers.

Figure IV.F.6. Incremental Technology Outlays (MY 2012-2016)



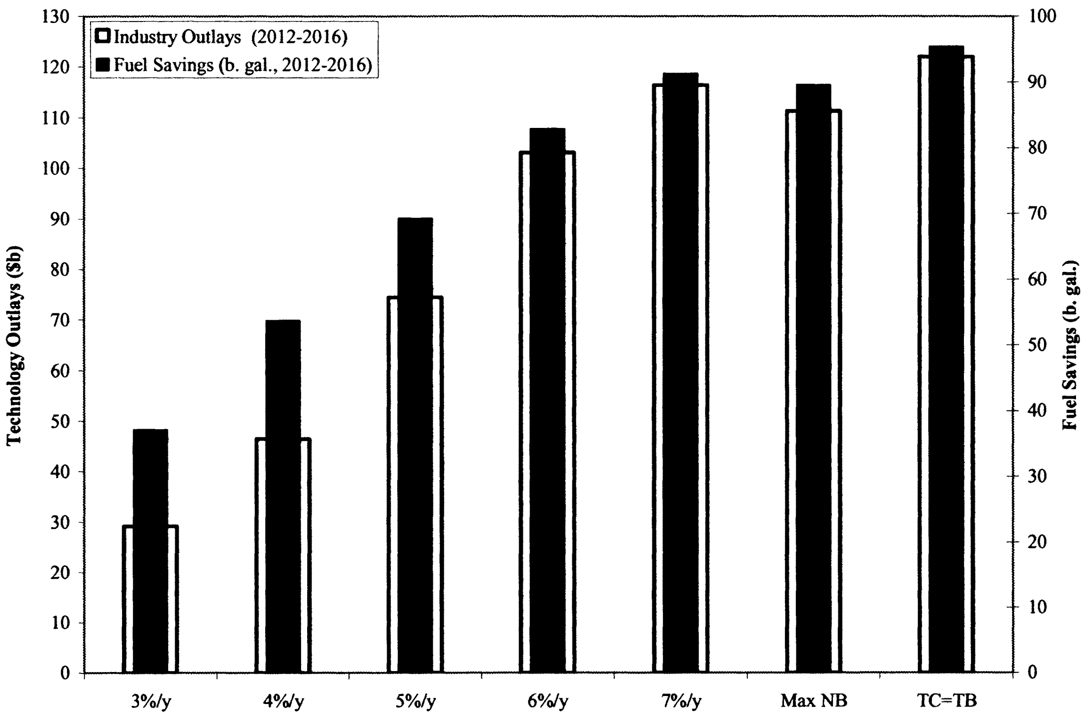
For each alternative, NHTSA has also estimated all corresponding effects for each model year, including fuel savings, CO_2 reductions, and other effects, as well as the estimated societal benefits of these effects.

TABLE IV.F.1—FUEL SAVINGS, CO_2 REDUCTIONS, AND TECHNOLOGY COSTS FOR REGULATORY ALTERNATIVES

Regulatory alternative	Fuel savings (b. gal)	CO_2 reductions (mmt)	Cost ($b)
3% per Year	37	404	29
4% per Year	54	582	46
5% per Year	69	718	74
6% per Year	83	846	103
Maximum Net Benefit	90	923	111
7% per Year	91	934	116
Total Cost = Total Benefit	95	977	122

The accompanying PRIA presents a detailed analysis of these results. Relevant to EPCA's requirement that NHTSA consider, among other factors, economic practicability and the need of the nation to conserve energy, the following figure compares the incremental technology outlays presented above to the corresponding cumulative fuel savings.

Figure IV.F.7. Incremental Technology Outlays and Fuel Savings (MY 2012-2016)



The agency then assessed which alternative would represent a reasonable balancing of the statutory criteria, given the difficulties confronting the industry and the economy, and the priorities and policy goals of the President. Those priorities and goals include achieving nationally harmonized and coordinated program for regulating fuel economy and GHG emissions.

Part of that assessment entailed an evaluation of the stringencies necessary to achieve both Federal and State GHG emission reduction goals, especially those of California and the States that have adopted its GHG emission standard for motor vehicles. Given that EPCA requires attribute-based standards, NHTSA and EPA determined the level at which an attribute-based GHG emissions standard would need to be set to achieve the goals of California. This was done by evaluating a nationwide CAA standard for MY 2016 that would require the levels of technology upgrade, across the country, which California standards would require for the subset of vehicles sold in California under the California standards for MY 2009–2016 (known as ''Pavley 1''). In essence, the stringency of the California Pavley 1 program was evaluated, but for a national standard. For a number of reasons discussed in section III.D, an assessment was developed of an equivalent national new vehicle fleet-wide CO_2 performance standards for model year 2016 which would result in the new vehicle fleet in the State of California having CO_2 performance equal to the performance from the California Pavley 1 standards. That level, 250 g/mi, is equivalent to 35.5 mpg if the GHG standard is met exclusively by fuel economy improvements.

To obtain the counterpart CAFE standard, we then adjusted that level downward to account for differences between the more prescriptive EPCA and the more flexible CAA. These differences give EPA greater ability under the CAA to provide compliance flexibilities that would enable manufacturers to achieve compliance with a given level of requirement under the CAA at less cost than with the same level of requirement under EPCA. Principal among those greater flexibilities are the credits that EPA can provide for improving the efficiency of air conditioners and reducing the leakage of refrigerants from them. The adjustments result in a figure of 34.1 mpg as the appropriate counterpart CAFE standard. This differential gives manufacturers the opportunity to reach 35.5 mpg under the CAA in ways that would significantly reduce their costs. Were NHTSA instead to establish its standard at the same level, manufacturers would need to make substantially greater expenditures on fuel-saving technologies to reach 35.5 mpg under EPCA.

Given the importance to this rulemaking of achieving a harmonized National Program, we created a new alternative whose annual percentage increases would achieve 34.1 mpg by MY 2016. That alternative is one which increases on average at 4.3% annually.

This new alternative, like the seven alternative presented above, represents a unique balancing of the statutory factors and other relevant considerations. We have added that alternative to the table below.

Regulatory alternative	Fuel savings (b. gal)	CO_2 reductions (mmt)	Cost ($b)
3% per Year	37	404	29
4% per Year	54	582	46
Proposed (4.3% per Year)	62	656	60
5% per Year	69	718	74
6% per Year	83	846	103
Maximum Net Benefit	90	923	111
7% per Year	91	934	116
Total Cost = Total Benefit	95	977	122

As noted earlier, NHTSA has used the Volpe model to analyze each of these alternatives based on analytical inputs determined jointly with EPA. For a given regulatory alternative, the Volpe model estimates how each manufacturer could apply technology in response to the MY 2012 standard (separately for cars and trucks), carries technologies applied in MY 2012 forward to MY 2013, and then estimates how each manufacturer could apply technology in response to the MY 2013 standard. When analyzing MY 2013, the model considers the potential to add ''extra'' technology in MY 2012 in order to carry that technology into MY 2013, thereby avoiding the use of more expensive technologies in MY 2013. The model continues in this fashion through MY 2016, and then performs calculations to estimate the costs, effects, and benefits of the applied technologies, and to estimate any civil penalties owed based on projected noncompliance. For each regulatory alternative, the model calculates incremental costs, effects, and benefits relative to the regulatory baseline (*i.e.,* the no-action alternative), under which the MY 2011 CAFE standards continue through MY 2016. The model calculates results for each model year, because EPCA requires that NHTSA set its standards for each model year at the ''maximum feasible average fuel economy level that the Secretary decides the manufacturers can achieve in that model year'' considering four statutory factors. Pursuant to EPCA's directive notice not to consider statutory credits in establishing CAFE standards, NHTSA did not FFV credits, credits carried forward and backward, and transferred credit.[577] [578] In addition, the analysis reflects the ability of manufacturers to pay fines in lieu of compliance.

Because it entails year-by-year examination of eight regulatory alternatives for, separately, passenger cars and light trucks, NHTSA's analysis involves a large amount of information. Detailed results of this analysis are presented separately in the PRIA accompanying today's notice. The remainder of this section discusses a combination of aggregated and illustrative results of this analysis.

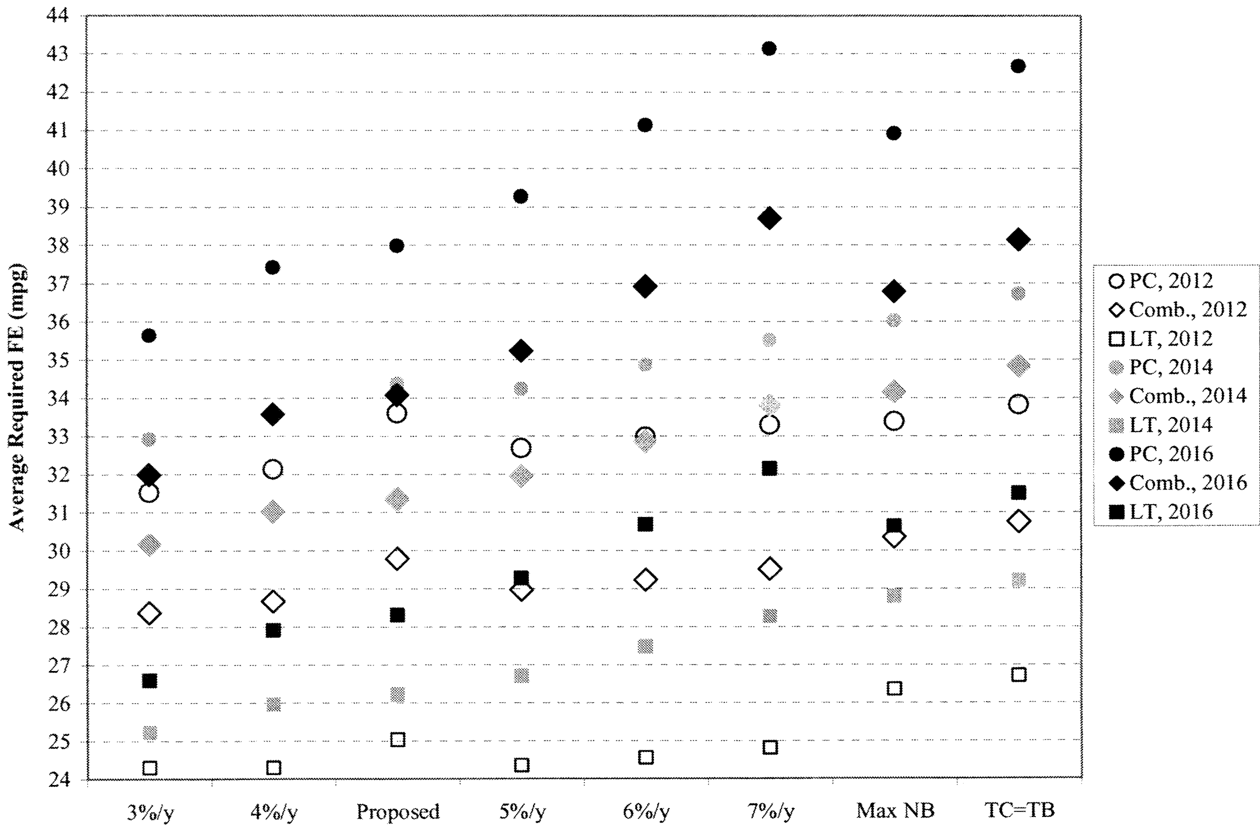
The following figure compares average fuel economy levels required of manufacturers under the eight regulatory alternatives in MYs 2012, 2014, and 2016. Required levels for MY 2013 and MY 2015 fall between those for MYs 2012 and 2014 and MYs 2014 and 2016, respectively. Although required levels for these interim years are not presented in the following figure to limit the complexity of the figure, they do appear in the accompanying PRIA.[579]

[577] Separately, NHTSA has conducted analysis that accounts for EPCA's provisions regarding FFVs.

[578] Because NHTSA's modeling represents every model year explicitly, accounts for estimates of when vehicle model redesigns will occur, and sets aside these compliance flexibilities, the agency's modeling produces results that differ varyingly from EPA's for specific manufacturers, fleets, and model years.

[579] Also, the ''Max NB'' and the ''TC = TB'' alternatives depend on the inputs to the agencies' analysis. The sensitivity analysis presented in the PRIA documents the response of these alternatives to changes in key economic inputs. For example, the combined average required fuel economy under the ''Max NB'' alternative is 36.8 mpg under the reference case economic inputs presented here, and ranges from 32.8 mpg to 37.2 mpg under the alternative economic inputs presented in the PRIA.

Figure IV.F.8. Average Required Fuel Economy (MYs 2012, 2014, and 2016)



As this figure illustrates, the proposed standards involve a ''faster start'' toward increased stringency than do any of the alternatives that increase steadily (*i.e.,* the 3%/y, 4%/y, 5%/y, 6%/y, and 7%/y alternatives). However, by MY 2016, the stringency of the proposed standards reflects an average annual increase of 4.3%/y. The proposed standards, therefore, represent an alternative that could be referred to as ''4.3% per year with a fast start'' or a ''front-loaded 4.3% average annual increase.''

In NHTSA's analysis, these achieved average fuel economy levels result from the application of technology rather than changes in the mix of vehicles produced for sale in the U.S. The accompanying PRIA presents detailed estimates of additional technology penetration into the NHTSA reference fleet associated with each regulatory alternative. The following four charts illustrate the results of this analysis, considering the application of four technologies by six manufacturers and the industry as a whole. Technologies include gasoline direct injection (GDI), engine turbocharging and downsizing, diesel engines, and strong HEV systems (including CISG systems). GDI and turbocharging are among the technologies that play an important role in achieving the fuel economy improvements shown in NHTSA's analysis, and diesels and strong HEVs represent technologies involving significant challenges for widespread use through MY 2016. These figures focus on Chrysler, Ford, General Motors, Honda, Nissan, and Toyota, as these manufacturers currently (in MY 2008) represent three large U.S.-headquartered and three large foreign-headquartered full-line manufacturers. For each alternative, the figures show additional application of technology by MY 2016. The PRIA presents results for all model years, technologies, and manufacturers, and NHTSA has considered these broader results when considering the eight regulatory alternatives.

Figure IV.F.9. Additional Application of GDI (MY 2016)

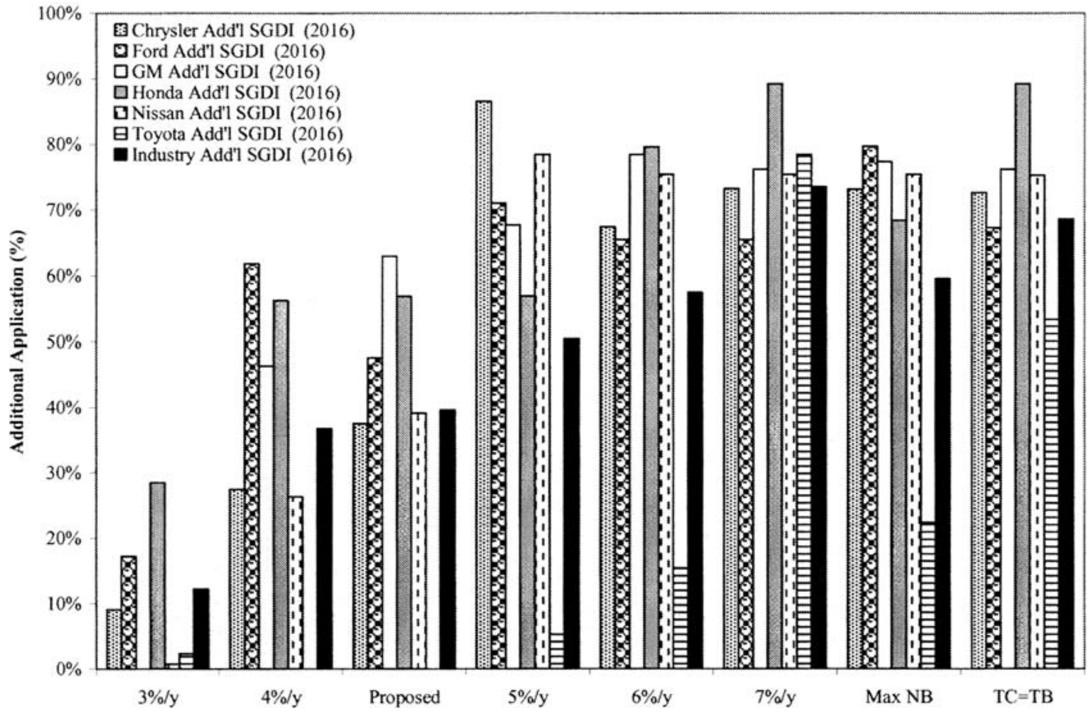


Figure IV.F.10. Additional Application of Engine Turbocharging & Downsizing (MY 2016)

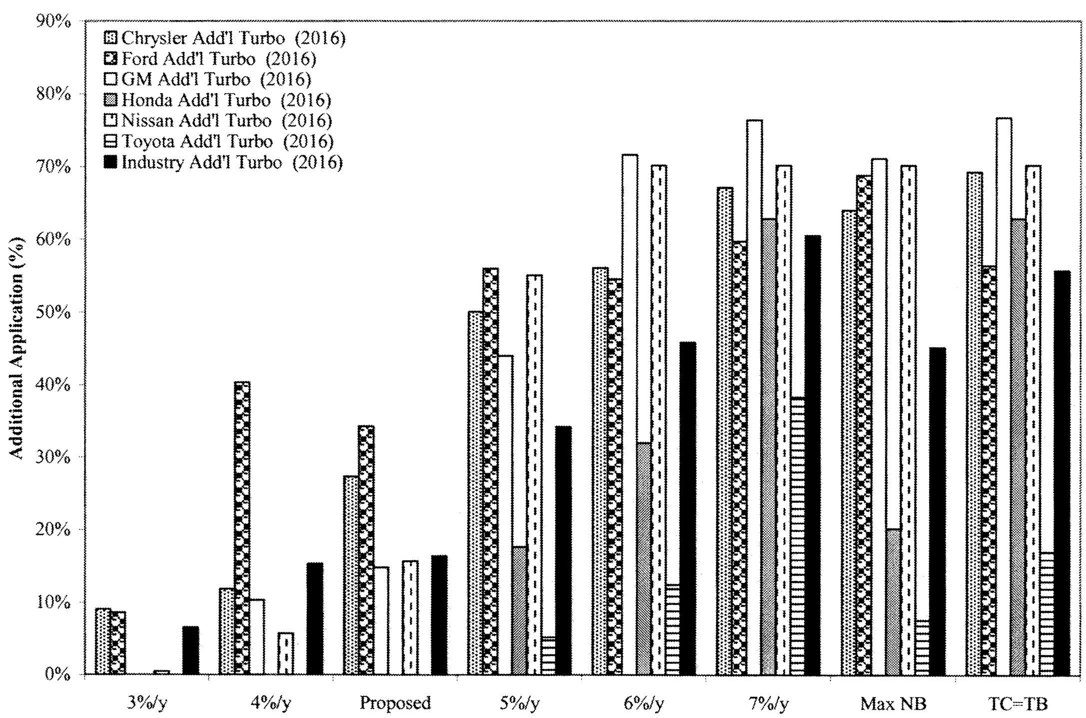


Figure IV.F.11. Additional Application of Diesel Engines (MY 2016)

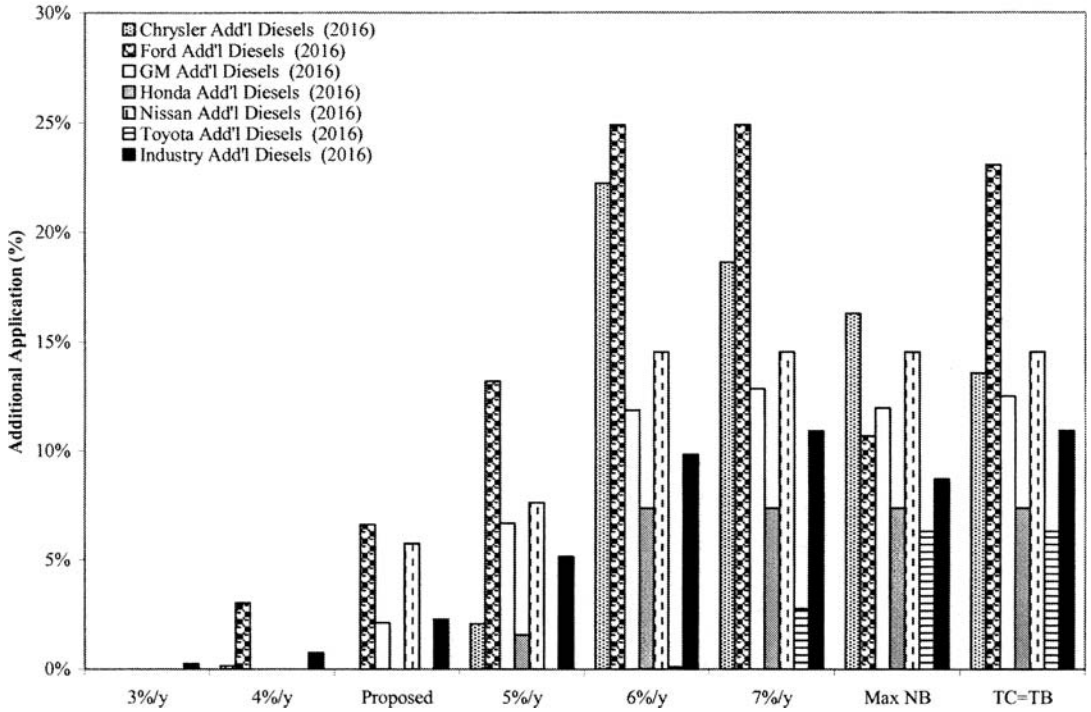
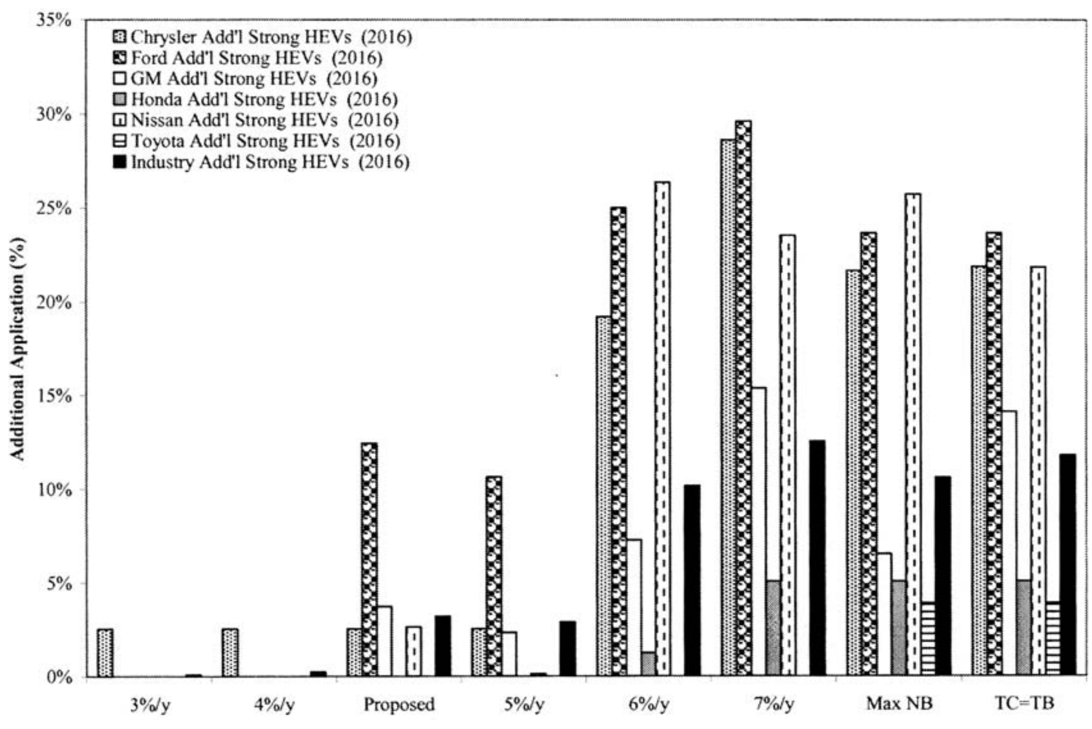


Figure IV.F.12. Additional Application of CISG and Strong HEV Systems (MY 2016)



The agency began the process of winnowing the alternatives by determining whether any of the lower stringency alternatives should be eliminated from consideration. To begin with, the agency needs to ensure that its standards are high enough to enable the combined fleet of passenger cars and light trucks to achieve at least 35 mpg not later than MY 2020, as required by EISA. Achieving that level makes it necessary for the chosen alternative to increase at over 3 percent annually.

NHTSA has concluded that it must reject the 3%/y and 4%/y alternatives. Given that CO_2 and fuel savings are very closely correlated, the above chart reveals that the 3%/y and 4%/y alternative would not produce the reductions in fuel savings and CO_2 emissions that the Nation needs at this time. Picking either of those alternatives would unnecessarily result in foregoing substantial benefits, in terms of fuel savings and reduced CO_2 emissions, which would be achievable at reasonable cost. Further, NHTSA has tentatively concluded that it must reject the 3%/y and 4%/y alternatives, as neither would lead to the regulatory harmonization that forms a vital core principle of the National Program that EPA and NHTSA are jointly striving to implement. In order to achieve a harmonized National Program, an average annual increase of 4.3% is necessary.

In contrast, at the upper end of the range of alternatives, the agency was concerned that the increased benefits offered by those alternatives were available only at excessive cost and might not be practicable in all cases within the available leadtime.

NHTSA first considered the environmentally-preferable alternative. Based on the information provided in the DEIS, the environmentally-preferable alternative would be that involving stringencies at which total costs most nearly equal total benefits. NHTSA notes that NEPA does not require that agencies choose the environmentally-preferable alternative if doing so would be contrary to the choice that the agency would otherwise make under its governing statute. Given the levels of stringency required by the environmentally-preferable alternative and the lack of lead time to achieve such levels between now and MY 2016, NHTSA tentatively concludes that the environmentally-preferable alternative would not be economically practicable or technologically feasible, and thus tentatively concludes that it would result in standards that would be beyond the level achievable for MYs 2012–2016.

NHTSA determined that it would be inappropriate to propose any of the other more stringent alternatives due to concerns over lead time and economic practicability. At a time when the entire industry remains in an economically critical state, the agencies believe that it would be unreasonable to propose more stringent standards. Even in a case where economic factors were not a consideration, there are real-world time constraints which must be considered due to the short lead time available for the early years of this program, in particular for MYs 2012 and 2013.

As revealed by the figures shown above, the proposed standards already require aggressive application of technologies, and more stringent standards which would require more widespread use (including more substantial implementation of advanced technologies such as stoichiometric gasoline direct injection engines and strong hybrids) raise serious issues of adequacy of lead time, not only to meet the standards but to coordinate such significant changes with manufacturers' redesign cycles.

NHTSA does not believe that more stringent standards would meet EPCA's requirement that CAFE standards be economically practicable. The figures presented above reveal that increasing stringency beyond the proposed standards would entail significant additional application of technology—technology that, though perhaps feasible for individual vehicle models, would not be economically practicable for the industry at the scales involved. Among the more stringent alternatives, the one closest in stringency to the standards proposed today is the alternative under which combined CAFE stringency increases at 5% annually. As indicated above, this alternative would yield fuel savings and CO_2 reductions about 12% and 9% higher, respectively, than the proposed standards. However, compared to the proposed standards, this alternative would increase outlays for new technologies during MY 2012–2016 by about 24%, or $14b. Average MY 2016 cost increases would, in turn, rise from $1,076 under the proposed standards to $1,409 when stringency increases at 5% annually. This represents a 30% increase in per-vehicle cost for only a 3% increase in average performance (on a gallon-per-mile basis to which fuel savings are proportional). The following three tables summarize estimated manufacturer-level average incremental costs for the 5%/y alternative and the average of the passenger and light truck fleets:

TABLE IV.F.3—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER THE 5%/Y ALTERNATIVE CAFE STANDARDS FOR PASSENGER CARS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	474	541	667	883	1,190
Chrysler	726	1,464	1,832	1,928	1,913
Daimler	132	209	814	1,094	1,467
Ford	979	1,556	1,572	1,918	2,181
General Motors	94	934	1,242	1,541	1,808
Honda	55	263	408	451	671
Hyundai	518	531	943	1,007	1,152
Kia	180	344	440	612	796
Mazda	603	919	1,294	1,569	1,863
Mitsubishi	1,106	1,141	2,594	2,962	2,913
Nissan	298	587	1,344	1,402	1,517
Porsche	209	240	350	465	581
Subaru	353	454	1,828	2,258	2,201
Suzuki	204	1,453	2,444	2,580	2,624
Tata	202	239	428	632	1,350
Toyota	133	127	194	285	446
Volkswagen	231	550	688	828	1,202
Average	337	664	916	1,079	1,291

TABLE IV.F.4—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER THE 5%/Y ALTERNATIVE CAFE STANDARDS FOR LIGHT TRUCKS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	297	306	403	753	935
Chrysler	113	475	1,058	1,271	1,538

TABLE IV.F.4—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER THE 5%/Y ALTERNATIVE CAFE STANDARDS FOR LIGHT TRUCKS—Continued

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Daimler	172	198	227	459	528
Ford	732	1,201	1,685	2,345	2,380
General Motors	....	786	1,121	1,275	1,457
Honda	646	614	1,139	1,265	1,624
Hyundai	990	1,009	2,106	2,206	2,148
Kia	....	309	713	1,181	1,692
Mazda	434	608	612	722	953
Mitsubishi	11	88	2,102	2,081	2,817
Nissan	793	891	1,419	1,535	1,907
Porsche	(17)	55	117	962	1,009
Subaru	1,398	1,370	1,501	1,441	1,486
Suzuki	6	2,169	2,093	2,028	2,155
Tata	....	77	160	242	695
Toyota	113	427	906	1,065	1,291
Volkswagen	(11)	55	127	209	286
Average	373	742	1,179	1,449	1,641

TABLE IV.F.5—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER THE 5%/Y ALTERNATIVE CAFE STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	415	469	590	848	1,123
Chrysler	351	888	1,392	1,632	1,747
Daimler	148	205	591	884	1,167
For^d	872	1,401	1,623	2,110	2,269
General Motors	52	868	1,189	1,426	1,660
Honda	272	386	638	701	955
Hyundai	610	625	1,167	1,228	1,330
Kia	143	337	489	707	942
Mazda	571	862	1,181	1,443	1,732
Mitsubishi	959	975	2,525	2,854	2,902
Nissan	462	683	1,367	1,441	1,627
Porsche	120	172	272	623	717
Subaru	743	787	1,709	1,964	1,942
Suzuki	152	1,637	2,349	2,434	2,504
Tata	71	144	267	420	1,001
Toyota	125	233	440	549	724
Volkswagen	182	460	586	716	1,043
Average	350	692	1,010	1,207	1,409

These cost increases derive from accelerated application of advanced technologies as stringency increases past the levels in the proposed standards. For example, under the proposed standards, additional diesel application rates average 2% for the industry and range from 0% to 7% among Chrysler, Ford, GM, Honda, Nissan, and Toyota. Under standards increasing in combined stringency at 5% annually, these rates more than double, averaging 5% for the industry and ranging from 2% to 13% for the same six manufacturers. The agency tentatively concludes that the levels of technology penetration required by the proposed standards are reasonable. Increasing the standards beyond those levels would lead to rapidly increasing dependence on advanced technologies with higher costs, particularly in the early years of the rulemaking time frame, according to the agency's analysis, and potentially pose too great an economic burden given the state of the industry.

In contrast, through analysis of the illustrative results shown above, as well as the more complete and detailed results presented in the accompanying PRIA, NHTSA has concluded that the proposed standards are technologically feasible and economically practicable. The proposed standards will require manufacturers to apply considerable additional technology. Although NHTSA cannot predict how manufacturers *will* respond to the proposed standards, the agency's analysis indicates that the standards could lead to significantly greater use of advanced engine and transmission technologies. As shown above, the agency's analysis shows considerable increases in the application of SGDI systems and engine turbocharging and downsizing. Though not presented above, the agency's analysis also shows similarly large increases in the use of dual-clutch automated manual transmissions (AMTs). However, the agency's analysis does not suggest that the additional application of these technologies in response to the proposed standards would extend beyond levels achievable by the industry. These technologies are likely to be applied to at least some extent even in the absence of new CAFE standards. In addition, the agency's analysis indicates that most manufacturers would rely only to a limited extent on the most expensive and advanced technologies, including diesel engines and strong HEVs.

As shown above, NHTSA estimates that the proposed standards could lead to average incremental costs ranging from $291 per vehicle (for light trucks in MY 2011) to $1,085 per vehicle (for passenger cars in MY 2016), increasing steadily from $421 per vehicle in for all light vehicles in MY 2011 $1,076 for all light vehicle in MY 2016. NHTSA estimates that these costs would vary considerably among manufacturers, but would rarely exceed $2,000 per vehicle. The following three tables summarize estimated manufacturer-level average incremental costs for the proposed standards and the average of the passenger and light truck fleets:

TABLE IV.F.6—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER PROPOSED PASSENGER CAR CAFE STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	524	552	634	828	1,124
Chrysler	775	1,304	1,473	1,583	1,582
Daimler	182	215	781	1,039	1,401
Ford	1,746	1,719	1,735	1,880	2,078
General Motors	143	990	1,189	1,387	1,553
Honda	31	122	205	287	494
Hyundai	418	452	643	726	868
Kia	319	359	387	473	647
Mazda	658	735	965	991	1,26
Mitsubishi	1,156	1,076	1,715	2,076	2,035
Nissan	653	712	1,155	1,153	1,275
Porsche	270	256	306	399	498
Subaru	408	465	1,493	1,877	1,838
Suzuki	259	1,001	1,445	1,494	1,675
Tata	246	244	395	577	1,284
Toyota	133	127	155	257	267
Volkswagen	286	561	650	767	1,125
Average	498	674	820	930	1,085

TABLE IV.F.7—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER PROPOSED LIGHT TRUCK CAFE STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	325	327	380	708	884
Chrysler	152	399	749	892	1,188
Daimler	322	289	316	420	478
Ford	471	629	693	1,323	1,365
General Motors	33	533	752	792	962
Honda	390	380	616	749	1,006
Hyundai	774	744	1,301	1,322	1,292
Kia	228	373	547	843	1,218
Mazda	340	608	610	679	776
Mitsubishi	55	94	1,546	1,732	2,123
Nissan	541	608	903	1,022	1,312
Porsche	28	46	84	913	954
Subaru	1,203	1,140	1,213	1,197	1,184
Suzuki	50	1,451	1,404	1,358	1,373
Tata	44	83	127	193	635
Toyota	172	309	665	764	877
Volkswagen	28	61	99	160	231
Average	291	485	701	911	1,058

TABLE IV.F.8—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER PROPOSED CAFE STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	457	483	560	796	1,061
Chrysler	393	777	1,061	1,271	1,408
Daimler	236	243	604	834	1,106
Ford	1,195	1,242	1,262	1,629	1,762
General Motors	94	785	997	1,131	1,304
Honda	162	212	335	429	647
Hyundai	488	509	769	835	944
Kia	300	362	416	535	740
Mazda	598	712	907	944	1,193
Mitsubishi	1,007	921	1,692	2,033	2,045
Nissan	616	679	1,078	1,115	1,286
Porsche	174	179	231	562	643
Subaru	705	711	1,392	1,632	1,602
Suzuki	204	1,117	1,434	1,458	1,598
Tata	115	150	234	368	938
Toyota	147	191	331	429	468

TABLE IV.F.8—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER PROPOSED CAFE STANDARDS—Continued

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Volkswagen	233	470	550	657	970
Average	421	605	777	924	1,076

In summary, NHTSA has considered eight regulatory alternatives, including the proposed standards, examining technologies that could be applied in response to each alternative, as well as corresponding costs, effects, and benefits. The agency has concluded that alternatives less stringent than the proposed standards would not produce the fuel savings and CO_2 reductions necessary at this time to achieve either the overarching purpose of EPCA, *i.e.*, energy conservation, or an important part of the regulatory harmonization underpinning the National Program. Conversely, the agency has concluded that more stringent standards would involve levels of additional technology and cost that, considering the fragile state of the automotive industry, would not be economically practicable. Therefore, having considered these eight regulatory alternatives, and the statutorily-relevant factors of 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, along with other relevant factors such as the safety impacts of the proposed standards,[580] NHTSA tentatively concludes that the proposed standards represent a reasonable balancing of all of these concerns, and are the maximum feasible average fuel economy levels that the manufacturers can achieve in MYs 2012–2016.

G. Impacts of the Proposed CAFE Standards

1. How Would These Proposed Standards Improve Fuel Economy and Reduce GHG Emissions for MY 2012–2016 Vehicles?

As discussed above, the CAFE level required under an attribute-based standard depends on the mix of vehicles produced for sale in the U.S. Based on the market forecast that NHTSA and EPA have used to develop and analyze new CAFE and CO_2 emissions standards, NHTSA estimates that the new CAFE standards will require CAFE levels to increase by an average of 4.3 percent annually through MY 2016, reaching a combined average fuel economy requirement of 34.1 mpg in that model year:

TABLE IV.G.1–1—AVERAGE REQUIRED FUEL ECONOMY (MPG) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016
Passenger Cars	33.6	34.4	35.2	36.4	38.0
Light Trucks	25.0	25.6	26.2	27.1	28.3
Combined	29.8	30.6	31.4	32.6	34.1

NHTSA estimates that average achieved fuel economy levels will correspondingly increase through MY 2016, but that manufacturers will, on average, undercomply[581] in some model years and overcomply[582] in others, reaching a combined average fuel economy of 33.7 mpg in MY 2016:[583]

TABLE IV.G.1–2—AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016
Passenger Cars	32.9	34.2	35.2	36.5	37.6
Light Trucks	24.9	25.7	26.5	27.4	28.1
Combined	29.3	30.5	31.5	32.7	33.7

NHTSA estimates that these fuel economy increases will lead to fuel savings totaling 61.6 billion gallons during the useful lives of vehicles sold in MYs 2012–2016:

[580] *See* Section IV.G.7 below.

[581] In NHTSA's analysis, ''undercompliance'' is mitigated either through use of FFV credits, use of existing or ''banked'' credits, or through fine payment. Because NHTSA cannot consider availability of credits in setting standards, the estimated achieved CAFE levels presented here do not account for their use. In contrast, because NHTSA is not prohibited from considering fine payment, the estimated achieved CAFE levels presented here include the assumption that BMW, Daimler (*i.e.*, Mercedes), Porsche, and Tata (*i.e.*, Jaguar and Rover) will only apply technology up to the point that it would be less expensive to pay civil penalties.

[582] In NHTSA's analysis, ''overcompliance'' occurs through multi-year planning: Manufacturers apply some ''extra'' technology in early model years (*e.g.*, MY 2014) in order to carry that technology forward and thereby facilitate compliance in later model years (*e.g.*, MY 2016)

[583] Consistent with EPCA, NHTSA has not accounted for manufacturers' ability to earn CAFE credits for selling FFVs, carry credits forward and back between model years, and transfer credits between the passenger car and light truck fleets.

TABLE IV.G.1–3—FUEL SAVED (BILLION GALLONS)
[Under proposed standards]

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.5	5.3	7.5	9.4	11.4	36.0
Light Trucks	1.8	3.7	5.4	6.8	7.8	25.6
Combined	4.3	9.1	12.9	16.1	19.2	61.6

The agency also estimates that these new CAFE standards will lead to corresponding reductions of CO_2 emissions totaling 656 million metric tons (mmt) during the useful lives of vehicles sold in MYs 2012–2016:

TABLE IV.G.1–4—AVOIDED CARBON DIOXIDE EMISSIONS (MMT) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	25	56	79	99	121	381
Light Trucks	19	40	58	73	85	275
Combined	44	96	137	173	206	656

2. How Would These Proposed Standards Improve Fleet-Wide Fuel Economy and Reduce GHG Emissions Beyond MY 2016?

Under the assumption that CAFE standards at least as stringent as those proposed for MY 2016 would be established for subsequent model years, the effects of the proposed standards on fuel consumption and GHG emissions will continue to increase for many years. This will occur because over time, a growing fraction of the U.S. light-duty vehicle fleet will be comprised of cars and light trucks that meet the MY 2016 standard. The impact of the proposed standards on fuel use and GHG emissions will continue to grow through approximately 2050, when virtually all cars and light trucks in service will have met the MY 2016 standard.

As Table IV.G.2–1 shows, NHTSA estimates that the fuel economy increases resulting from the proposed standards will lead to reductions in total fuel consumption by cars and light trucks of 9 billion gallons during 2020, increasing to 30 billion gallons by 2050. Over the period from 2012—when the proposed standards would begin to take effect—through 2050, cumulative fuel savings would total 693 billion gallons, as Table IV.G.2–1 also indicates.

TABLE IV.G.2–1—REDUCTION IN FLEET-WIDE FUEL USE (BILLION GALLONS) UNDER PROPOSED STANDARDS

Calendar year	2020	2030	2040	2050	Total, 2012–2050
Passenger Cars	5	12	16	19	431
Light Trucks	4	7	9	11	262
Combined	9	19	25	30	693

As a consequence of these reductions in fleet-wide fuel consumption, the agency also estimates that the proposed CAFE standards for MYs 2012–2016 will lead to corresponding reductions in CO_2 emissions from the U.S. light-duty vehicle fleet. Specifically, NHTSA estimates that total CO_2 emissions associated with passenger car and light truck use in the U.S. use will decline by 111 million metric tons (mmt) during 2020 as a consequence of the proposed standards, as Table IV.G.2–2 reports. The table also shows that the this reduction is estimated to grow to 355 million metric tons by the year 2050, and will total 8,247 million metric tons over the period from 2012, when the proposed standards would take effect, through 2050.

TABLE IV.G.2–2—REDUCTION IN FLEET-WIDE CARBON DIOXIDE EMISSIONS (MMT) FROM PASSENGER CAR AND LIGHT TRUCK USE UNDER PROPOSED STANDARDS

Calendar year	2020	2030	2040	2050	Total, 2012–2050
Passenger Cars	64	144	186	222	5,117
Light Trucks	47	87	110	132	3,130
Combined	111	231	295	355	8,247

These reductions in fleet-wide CO_2 emissions, together with corresponding reductions in other GHG emissions from fuel production and use, would lead to small but significant reductions in projected changes in the future global climate. These changes are summarized in Table IV.G.2–3 below.

TABLE IV.G.2–3—EFFECTS OF REDUCTIONS IN FLEET-WIDE CARBON DIOXIDE EMISSIONS (MMT) ON PROJECTED CHANGES IN GLOBAL CLIMATE

Measure	Units	Date	Projected change in measure		
			No action	With proposed standards	Difference
Atmospheric CO_2 Concentration	ppm	2100	783.0	780.3	−2.7
Increase in Global Mean Surface Temperature	°C	2100	3.136	3.126	−0.010
Sea Level Rise	cm	2100	38.00	37.91	−0.09
Global Mean Precipitation	% change from 1980–1999 avg.	2090	4.59%	4.57%	−0.02%

3. How Would These Proposed Standards Impact Non-GHG Emissions and Their Associated Effects?

Under the assumption that CAFE standards at least as stringent as those proposed for MY 2016 would be established for subsequent model years, the effects of the proposed standards on air quality and its associated health effects will continue to be felt over the foreseeable future. This will occur because over time a growing fraction of the U.S. light-duty vehicle fleet will be comprised of cars and light trucks that meet the MY 2016 standard, and this growth will continue until approximately 2050.

Increases in the fuel economy of light-duty vehicles required by the proposed CAFE standards will cause a slight increase in the number of miles they are driven, through the fuel economy ''rebound effect.'' In turn, this increase in vehicle use will lead to increases in emissions of criteria air pollutants and some airborne toxics, since these are products of the number of miles vehicles are driven.

At the same time, however, the projected reductions in fuel production and use reported in Table IV.G.2–1 above will lead to corresponding reductions in emissions of these pollutants that occur during fuel production and distribution (''upstream'' emissions). For most of these pollutants, the reduction in upstream emissions resulting from lower fuel production and distribution will outweigh the increase in emissions from vehicle use, resulting in a net decline in their total emissions.

Tables IV.G.3–1a and 3–1b report estimated reductions in emissions of selected criteria air pollutants (or their chemical precursors) and airborne toxics expected to result from the proposed standards during calendar year 2030. By that date, the majority of light-duty vehicles in use will have met the proposed MY 2016 CAFE standards, so these reductions provide a useful index of the long-term impact of the proposed standards on air pollution and its consequences for human health.

TABLE IV.G.3–1a—PROJECTED CHANGES IN EMISSIONS OF CRITERIA AIR POLLUTANTS FROM CAR AND LIGHT TRUCK USE

[Calendar year 2030; tons]

Vehicle class	Source of emissions	Criteria air pollutant			
		Nitrogen oxides (NO_X)	Particulate matter ($PM_{2.5}$)	Sulfur oxides (SO_X)	Volatile organic compounds (VOC)
Passenger Cars	Vehicle use	1,791	630	−2,375	2,157
	Fuel production and distribution	−19,022	−2,539	−11,363	−75,031
	All sources	−17,231	−1,909	−13,738	−72,874
Light Trucks	Vehicle use	1,137	257	−1,401	1,094
	Fuel production and distribution	−11,677	−1,569	−7,031	−43,667
	All sources	−10,540	−1,312	−8,432	−42,573
Total	Vehicle use	2,928	887	−3,776	3,251
	Fuel production and distribution	−30,699	−4,108	−18,394	−118,698
	All sources	−27,771	−3,221	−22,170	−115,447

TABLE IV.F.3–1b—PROJECTED CHANGES IN EMISSIONS OF AIRBORNE TOXICS FROM CAR AND LIGHT TRUCK USE

[Calendar year 2030; tons]

Vehicle class	Source of emissions	Toxic air pollutant		
		Benzene	1,3-Butadiene	Formaldehyde
Passenger Cars	Vehicle use	67	19	72

TABLE IV.F.3–1b—PROJECTED CHANGES IN EMISSIONS OF AIRBORNE TOXICS FROM CAR AND LIGHT TRUCK USE—Continued

[Calendar year 2030; tons]

Vehicle class	Source of emissions	Toxic air pollutant		
		Benzene	1,3-Butadiene	Formaldehyde
	Fuel production and distribution	−158	−1	−54
	All sources	−91	18	18
Light Trucks	Vehicle use	45	9	32
	Fuel production and distribution	−93	−1	−33
	All sources	−48	8	−1
Total	Vehicle use	112	28	104
	Fuel production and distribution	−251	−2	−87
	All sources	−139	26	17

Note: Positive values indicate increases in emissions; negative values indicate reductions.

In turn, the reductions in emissions reported in Tables IV.G.3–1a and 3–1b are projected to result in significant declines in the health effects that result from population exposure to these pollutants. Table IV.G.3–2 reports the estimated reductions in selected $PM_{2.5}$-related human health impacts that are expected to result from reduced population exposure to unhealthful atmospheric concentrations of $PM_{2.5}$. The estimates reported in Table IV.G.3–2 are derived from $PM_{2.5}$-related dollar-per-ton estimates that include only quantifiable reductions in health impacts likely to result from reduced population exposure to particular matter (PM). They do not include all health impacts related to reduced exposure to PM, nor do they include any reductions in health impacts resulting from lower population exposure to other criteria air pollutants (particularly ozone) and air toxics. NHTSA and EPA are using PM-related benefits-per-ton values as an interim approach to estimating the PM-related benefits of the proposal. To model the ozone and PM air quality benefit sof the final rule, the analysis will utilize ambient concentration data derived from full-scale photochemical air quality modeling.

TABLE IV.G.3–2—PROJECTED REDUCTIONS IN HEALTH IMPACTS OF EXPOSURE TO CRITERIA AIR POLLUTANTS FROM PROPOSED STANDARDS

[Calendar year 2030]

Health impact	Measure	Projected reduction (2030)
Mortality (ages 30 and older)	premature deaths per year	217 to 554
Chronic Bronchitis	cases per year	142
Emergency Room Visits for Asthma	number per year	198
Work Loss	workdays per year	25,522

4. What Are the Estimated Costs and Benefits of These Proposed Standards?

NHTSA estimates that the proposed standards could entail significant additional technology beyond the levels reflected in the baseline market forecast used by NHTSA. This additional technology will lead to increases in costs to manufacturers and vehicle buyers, as well as fuel savings to vehicle buyers. The following three tables summarize the extent to which the agency estimates technologies could be added to the passenger car, light truck, and overall fleets in each model year in response to the proposed standards. Percentages reflect the technology's additional application in the market, and are negative in cases where one technology is superseded (*i.e.,* displaced) by another. For example, the agency estimates that many automatic transmissions used in light trucks could be displaced by dual clutch transmissions.

BILLING CODE 6560–50–P

Table IV.G.4-1. Addition of Technologies to Passenger Car Fleet under Proposed Standards

Technology	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Low Friction Lubricants	21%	20%	21%	37%	36%
Engine Friction Reduction	10%	21%	24%	29%	40%
VVT - Coupled Cam Phasing (CCP) on SOHC	1%	1%	1%	4%	9%
Discrete Variable Valve Lift (DVVL) on SOHC	0%	1%	2%	2%	2%
Cylinder Deactivation on SOHC	0%	0%	0%	0%	1%
VVT - Intake Cam Phasing (ICP)	0%	0%	0%	0%	0%
VVT - Dual Cam Phasing (DCP)	13%	19%	26%	28%	29%
Discrete Variable Valve Lift (DVVL) on DOHC	13%	18%	21%	23%	29%
Continuously Variable Valve Lift (CVVL)	0%	0%	0%	0%	0%
Cylinder Deactivation on DOHC	0%	0%	0%	0%	0%
Cylinder Deactivation on OHV	0%	1%	1%	1%	1%
VVT - Coupled Cam Phasing (CCP) on OHV	0%	1%	1%	1%	1%
Discrete Variable Valve Lift (DVVL) on OHV	0%	2%	2%	3%	4%
Conversion to DOHC with DCP	0%	0%	0%	0%	0%
Stoichiometric Gasoline Direct Injection (GDI)	14%	22%	26%	30%	36%
Combustion Restart	0%	0%	2%	5%	9%
Turbocharging and Downsizing	10%	15%	16%	17%	20%
Exhaust Gas Recirculation (EGR) Boost	0%	7%	9%	10%	15%
Conversion to Diesel following TRBDS	1%	2%	2%	2%	2%
Conversion to Diesel following CBRST	0%	0%	0%	0%	1%
6-Speed Manual/Improved Internals	0%	0%	0%	0%	0%
Improved Auto. Trans. Controls/Externals	2%	8%	12%	10%	11%
Continuously Variable Transmission	0%	0%	0%	0%	0%
6/7/8-Speed Auto. Trans with Improved Internals	0%	0%	1%	1%	2%
Dual Clutch or Automated Manual Transmission	14%	24%	31%	41%	47%
Electric Power Steering	8%	24%	34%	42%	55%
Improved Accessories	14%	26%	31%	38%	50%
12V Micro-Hybrid	0%	0%	0%	0%	0%
Belt mounted Integrated Starter Generator	8%	18%	27%	30%	33%
Crank mounted Integrated Starter Generator	3%	3%	3%	3%	3%
Power Split Hybrid	1%	2%	2%	2%	2%
2-Mode Hybrid	0%	0%	0%	0%	0%
Plug-in Hybrid	0%	0%	0%	0%	0%
Material Substitution (1.5%)	18%	29%	32%	40%	62%
Material Substitution (5% to 10%)	0%	0%	14%	21%	32%
Material Substitution (NA)	0%	0%	0%	0%	0%
Low Rolling Resistance Tires	5%	26%	38%	45%	50%
Low Drag Brakes	2%	4%	5%	5%	9%
Secondary Axle Disconnect - Unibody	0%	0%	0%	0%	0%
Secondary Axle Disconnect - Ladder Frame	1%	2%	2%	2%	3%
Aero Drag Reduction	8%	21%	32%	37%	45%

Table IV.G.4-2. Addition of Technologies to Light Truck Fleet under Proposed Standards

Technology	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Low Friction Lubricants	19%	19%	19%	20%	21%
Engine Friction Reduction	2%	4%	12%	21%	21%
VVT - Coupled Cam Phasing (CCP) on SOHC	0%	0%	6%	8%	8%
Discrete Variable Valve Lift (DVVL) on SOHC	1%	1%	3%	12%	12%
Cylinder Deactivation on SOHC	0%	1%	1%	3%	6%
VVT - Intake Cam Phasing (ICP)	0%	0%	0%	0%	0%
VVT - Dual Cam Phasing (DCP)	2%	3%	7%	8%	10%
Discrete Variable Valve Lift (DVVL) on DOHC	12%	17%	21%	22%	27%
Continuously Variable Valve Lift (CVVL)	0%	0%	0%	0%	0%
Cylinder Deactivation on DOHC	-2%	-2%	-2%	1%	1%
Cylinder Deactivation on OHV	1%	6%	8%	7%	12%
VVT - Coupled Cam Phasing (CCP) on OHV	0%	1%	2%	4%	17%
Discrete Variable Valve Lift (DVVL) on OHV	0%	14%	17%	19%	19%
Conversion to DOHC with DCP	0%	0%	0%	0%	0%
Stoichiometric Gasoline Direct Injection (GDI)	17%	34%	41%	43%	47%
Combustion Restart	0%	0%	1%	6%	11%
Turbocharging and Downsizing	5%	8%	8%	8%	9%
Exhaust Gas Recirculation (EGR) Boost	0%	3%	3%	3%	6%
Conversion to Diesel following TRBDS	0%	0%	0%	0%	0%
Conversion to Diesel following CBRST	1%	1%	1%	1%	1%
6-Speed Manual/Improved Internals	0%	0%	0%	0%	0%
Improved Auto. Trans. Controls/Externals	-1%	-10%	-14%	-30%	-40%
Continuously Variable Transmission	0%	0%	0%	0%	0%
6/7/8-Speed Auto. Trans with Improved Internals	-3%	-4%	-4%	-4%	-3%
Dual Clutch or Automated Manual Transmission	19%	39%	54%	71%	80%
Electric Power Steering	9%	31%	39%	45%	50%
Improved Accessories	6%	13%	20%	27%	32%
12V Micro-Hybrid	0%	0%	0%	0%	0%
Belt mounted Integrated Starter Generator	8%	11%	20%	22%	24%
Crank mounted Integrated Starter Generator	0%	0%	0%	0%	0%
Power Split Hybrid	0%	0%	0%	0%	0%
2-Mode Hybrid	0%	0%	0%	0%	0%
Plug-in Hybrid	0%	0%	0%	0%	0%
Material Substitution (1.5%)	14%	15%	20%	31%	52%
Material Substitution (5% to 10%)	0%	0%	9%	22%	29%
Material Substitution (NA)	0%	0%	0%	0%	0%
Low Rolling Resistance Tires	15%	20%	22%	24%	24%
Low Drag Brakes	12%	15%	23%	30%	51%
Secondary Axle Disconnect - Unibody	0%	0%	0%	0%	0%
Secondary Axle Disconnect - Ladder Frame	8%	8%	12%	18%	19%
Aero Drag Reduction	10%	11%	16%	13%	16%

Table IV.G.4-3. Addition of Technologies to Overall Fleet under Proposed Standards

Technology	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Low Friction Lubricants	20%	19%	20%	31%	31%
Engine Friction Reduction	7%	15%	20%	26%	33%
VVT - Coupled Cam Phasing (CCP) on SOHC	1%	1%	3%	5%	9%
Discrete Variable Valve Lift (DVVL) on SOHC	1%	1%	2%	6%	6%
Cylinder Deactivation on SOHC	0%	0%	1%	1%	3%
VVT - Intake Cam Phasing (ICP)	0%	0%	0%	0%	0%
VVT - Dual Cam Phasing (DCP)	9%	13%	19%	21%	23%
Discrete Variable Valve Lift (DVVL) on DOHC	12%	17%	21%	22%	28%
Continuously Variable Valve Lift (CVVL)	0%	0%	0%	0%	0%
Cylinder Deactivation on DOHC	-1%	-1%	-1%	0%	0%
Cylinder Deactivation on OHV	0%	3%	3%	3%	4%
VVT - Coupled Cam Phasing (CCP) on OHV	0%	1%	2%	2%	7%
Discrete Variable Valve Lift (DVVL) on OHV	0%	7%	8%	9%	9%
Conversion to DOHC with DCP	0%	0%	0%	0%	0%
Stoichiometric Gasoline Direct Injection (GDI)	15%	27%	32%	34%	40%
Combustion Restart	0%	0%	2%	6%	10%
Turbocharging and Downsizing	8%	12%	13%	14%	16%
Exhaust Gas Recirculation (EGR) Boost	0%	5%	7%	8%	12%
Conversion to Diesel following TRBDS	1%	1%	1%	1%	1%
Conversion to Diesel following CBRST	0%	0%	0%	1%	1%
6-Speed Manual/Improved Internals	0%	0%	0%	0%	0%
Improved Auto. Trans. Controls/Externals	1%	1%	3%	-4%	-6%
Continuously Variable Transmission	0%	0%	0%	0%	0%
6/7/8-Speed Auto. Trans with Improved Internals	-1%	-1%	-1%	-1%	0%
Dual Clutch or Automated Manual Transmission	16%	29%	39%	52%	58%
Electric Power Steering	9%	27%	36%	43%	53%
Improved Accessories	11%	21%	27%	34%	44%
12V Micro-Hybrid	0%	0%	0%	0%	0%
Belt mounted Integrated Starter Generator	8%	16%	25%	27%	30%
Crank mounted Integrated Starter Generator	2%	2%	2%	2%	2%
Power Split Hybrid	1%	1%	1%	1%	1%
2-Mode Hybrid	0%	0%	0%	0%	0%
Plug-in Hybrid	0%	0%	0%	0%	0%
Material Substitution (1.5%)	17%	24%	28%	37%	59%
Material Substitution (5% to 10%)	0%	0%	12%	21%	31%
Material Substitution (NA)	0%	0%	0%	0%	0%
Low Rolling Resistance Tires	8%	23%	32%	38%	41%
Low Drag Brakes	5%	8%	11%	14%	23%
Secondary Axle Disconnect - Unibody	0%	0%	0%	0%	0%
Secondary Axle Disconnect - Ladder Frame	4%	4%	5%	7%	8%
Aero Drag Reduction	8%	17%	26%	29%	36%

BILLING CODE 6560–50–C

In order to pay for this additional technology (and, for some manufacturers, civil penalties), NHTSA estimates that average passenger car and light truck prices will, relative to levels resulting from compliance with baseline (MY 2011) standards, increase by $591-$1,127 and $283-$1,020, respectively, during MYs 2011–2016. The following tables summarize the agency's estimates of average price increases for each manufacturer's passenger car, light truck, and overall fleets (with corresponding averages for the industry):

TABLE IV.G.4–4—AVERAGE PASSENGER CAR INCREMENTAL PRICE INCREASES ($) UNDER PROPOSED STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	524	552	634	828	1,124
Chrysler	775	1,304	1,473	1,583	1,582
Daimler	182	215	781	1,039	1,401

TABLE IV.G.4–4—AVERAGE PASSENGER CAR INCREMENTAL PRICE INCREASES ($) UNDER PROPOSED STANDARDS—Continued

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Ford	1,746	1,719	1,735	1,880	2,078
General Motors	143	990	1,189	1,387	1,553
Honda	31	122	205	287	494
Hyundai	418	452	643	726	868
Kia	319	359	387	473	647
Mazda	658	735	965	991	1,263
Mitsubishi	1,156	1,076	1,715	2,076	2,035
Nissan	653	712	1,155	1,153	1,275
Porsche	270	256	306	399	498
Subaru	408	465	1,493	1,877	1,838
Suzuki	259	1,001	1,445	1,494	1,675
Tata	246	244	395	577	1,284
Toyota	133	127	155	257	267
Volkswagen	286	561	650	767	1,125
Total/Average	498	674	820	930	1,085

TABLE IV.G.4–5—AVERAGE LIGHT TRUCK INCREMENTAL PRICE INCREASES ($) UNDER PROPOSED STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	325	327	380	708	884
Chrysler	152	399	749	892	1,188
Daimler	322	289	316	420	478
Ford	471	629	693	1,323	1,365
General Motors	33	533	752	792	962
Honda	390	380	616	749	1,006
Hyundai	774	744	1,301	1,322	1,292
Kia	228	373	547	843	1,218
Mazda	340	608	610	679	776
Mitsubishi	55	94	1,546	1,732	2,123
Nissan	541	608	903	1,022	1,312
Porsche	28	46	84	913	954
Subaru	1,203	1,140	1,213	1,197	1,184
Suzuki	50	1,451	1,404	1,358	1,373
Tata	44	83	127	193	635
Toyota	172	309	665	764	877
Volkswagen	28	61	99	160	231
Total/Average	291	485	701	911	1,058

TABLE IV.G.4–6—AVERAGE INCREMENTAL PRICE INCREASES ($) BY MANUFACTURER UNDER PROPOSED STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	457	483	560	796	1,061
Chrysler	393	777	1,061	1,271	1,408
Daimler	236	243	604	834	1,106
Ford	1,195	1,242	1,262	1,629	1,762
General Motors	94	785	997	1,131	1,304
Honda	162	212	335	429	647
Hyundai	488	509	769	835	944
Kia	300	362	416	535	740
Mazda	598	712	907	944	1,193
Mitsubishi	1,007	921	1,692	2,033	2,045
Nissan	616	679	1,078	1,115	1,286
Porsche	174	179	231	562	643
Subaru	705	711	1,392	1,632	1,602
Suzuki	204	1,117	1,434	1,458	1,598
Tata	115	150	234	368	938
Toyota	147	191	331	429	468
Volkswagen	233	470	550	657	970
Total/Average	421	605	777	924	1,076

Based on the agencies' estimates of manufacturers' future sales volumes, these price increases will lead to a total of $60.2 billion in incremental outlays during MYs 2012–2016 for additional technology attributable to the proposed standards:

TABLE IV.G.4–7—INCREMENTAL TECHNOLOGY OUTLAYS ($B) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	4.1	6.5	8.4	9.9	11.8	40.8
Light Trucks	1.5	2.8	4.0	5.2	5.9	19.4
Combined	5.7	9.3	12.5	15.1	17.6	60.2

NHTSA notes that these estimates of the economic costs for meeting higher CAFE standards omit certain potentially important categories of costs, and may also reflect underestimation (or possibly overestimation) of some costs that are included. For example, although the agency's analysis attempts to hold vehicle performance, capacity, and utility constant in estimating the costs of applying fuel-saving technologies to vehicles, the analysis imputes no cost to any actual reductions in vehicle performance, capacity, and utility that may result from manufacturers' efforts to comply with the proposed CAFE standards. Although these costs are difficult to estimate accurately, they nonetheless represent a potentially significant category of omitted costs. Similarly, the agency's estimates of costs for meeting higher CAFE standards does not estimate the economic value of potential increases in motor vehicle fatalities and injuries that could result from reductions in the size or weight of vehicles. While NHTSA reports worst-case estimates of these increases in fatalities and injuries, no estimate of their economic value is included in the agency's estimates of the net benefits resulting from the proposed standards due to ongoing discussion regarding these potential impacts.

Finally, it is possible that the agency may have underestimated or overestimated manufacturers' direct costs for applying some fuel economy technologies, or the increases in manufacturer's indirect costs associated with higher vehicle manufacturing costs. In either case, the technology outlays reported here will not correctly represent the costs of meeting higher CAFE standards. Similarly, NHTSA's estimates of increased costs of congestion, accidents, and noise associated with added vehicle use are drawn from a 1997 study, and the correct magnitude of these values may have changed since they were developed.[584] If this is the case, the costs of increased vehicle use associated with the fuel economy rebound effect will differ from the agency's estimates in this analysis. Thus, like the agency's estimates of economic benefits, estimates of total compliance costs reported here may underestimate or overestimate the true economic costs of the proposed standards.

However, offsetting these costs, the achieved increases in fuel economy will also produce significant benefits to society. NHTSA estimates that, in present value terms (at a discount rate of 3 percent), these benefits will total $201.7 billion over the useful lives of light vehicles sold during MYs 2012–2016:

TABLE IV.G.4–8—PRESENT VALUE OF BENEFITS ($BILLION) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	7.6	17.0	24.4	31.2	38.7	119.1
Light Trucks	5.5	11.6	17.3	22.2	26.0	82.6
Combined	13.1	28.7	41.8	53.4	64.7	201.7

NHTSA attributes most of these benefits to reductions in fuel consumption, valuing fuel at future pretax prices in EIA's reference case forecast from AEO 2009. The total benefits shown in the above table also include other benefits and disbenefits, examples of which include the social values of reductions in CO_2 and criteria pollutant emissions, the value of additional travel (induced by the rebound effect), and the social cost of additional congestion, accidents, and noise attributable to that additional travel. The PRIA accompanying today's proposed rule presents a detailed analysis of specific benefits of the proposed rule.

For both the passenger car and light truck fleets, NHTSA estimates that the benefits of today's proposed standards will exceed the corresponding costs in every model year. Over the useful lives of the affected (MY 2012–2016) vehicles, the agency estimates that the benefits of the proposed standards will exceed the costs of the proposed standards by $141.5 billion:

TABLE IV.G.4–9—PRESENT VALUE OF NET BENEFITS ($BILLION) UNDER PROPOSED STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	3.5	10.5	16.0	21.3	26.9	78.3
Light Trucks	3.9	8.9	13.3	17.0	20.1	63.2

[584] The agency seeks comment above on appropriate values for these costs.

TABLE IV.G.4–9—PRESENT VALUE OF NET BENEFITS ($BILLION) UNDER PROPOSED STANDARDS—Continued

	2012	2013	2014	2015	2016	Total
Combined	7.4	19.4	29.3	38.3	47.1	141.5

NHTSA's estimates of economic benefits from establishing higher CAFE are also subject to considerable uncertainty. Most important, the agency's estimates of the fuel savings likely to result from adopting higher CAFE standards depend critically on the accuracy of the estimated fuel economy levels that will be achieved under both the baseline scenario, which assumes that manufacturers will continue to comply with the MY 2011 CAFE standards, and under alternative increases in the standards that apply to MY 2012–16 passenger cars and light trucks. Specifically, if the agency has underestimated the fuel economy levels that manufacturers will achieve under the baseline scenario, its estimates of fuel savings and the resulting economic benefits will be too large. As another example, the agency's estimate of benefits from reducing the threat of economic damages from disruptions in the supply of imported petroleum to the U.S. applies to calendar year 2015. If the magnitude of this estimate would be expected to grow after 2015 in response to increases in U.S. petroleum imports, growth in the level of U.S. economic activity, or increases in the likelihood of disruptions in the supply of imported petroleum, the agency may have underestimated the benefits from the reduction in petroleum imports expected to result from adopting higher CAFE standards.

However, it is also possible that NHTSA's estimates of economic benefits from establishing higher CAFE standards underestimate the true economic benefits of the fuel savings those standards would produce. This is partly because the agency has been unable to develop monetized estimates of the economic value of certain potentially significant categories of benefits from reducing fuel consumption. Specifically, the agency's estimate of the economic value of reduced damages to human health resulting from lower exposure to criteria air pollutants includes only the effects of reducing population exposure to $PM_{2.5}$ emissions. Although this is likely to be the most significant component of health benefits from reduced emissions of criteria air pollutants, it excludes the value of reduced damages to human health and other impacts resulting from lower emissions and reduced population exposure to other criteria air pollutants, including ozone and nitrous oxide (N_2O), as well as airborne toxics. The agency's analysis excludes these benefits because no reliable estimates of the health impacts of criteria pollutants other than $PM_{2.5}$ or of the health impacts of airborne toxics were available to use in developing estimates of these benefits.

In addition, the agency's estimate of the value of reduced climate-related economic damages from lower emissions of GHGs excludes many sources of potential benefits from reducing the pace and extent of global climate change. These include reductions in the risk of catastrophic changes in the global climate, lower costs for necessary adaptations to changes in climate, reduced water supply within specific global sub-regions, reductions in damages caused by severe storms, lower population exposure to harmful air pollution levels, reductions in ecosystem impacts and risks to natural resources of global significance, and reduced threats from widespread social or political unrest. Including monetized estimates of benefits from reducing the extent of climate change and these associated impacts would increase the agency's estimates of benefits from adopting higher CAFE standards.

The benefits, costs, and net benefits shown above are all based on a discount rate of 3 percent. As documented in the accompanying PRIA, the agency examined the sensitivity of results to changes in many economic inputs. With an alternative discount rate of 7 percent, incremental technology outlays were virtually identical to those estimated at a 3 percent discount rate:[585]

TABLE IV.G.4–10—INCREMENTAL TECHNOLOGY OUTLAYS ($B) UNDER PROPOSED STANDARDS (USING 7 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	4.1	6.5	8.4	9.9	11.8	40.8
Light Trucks	1.5	2.8	4.0	5.2	5.9	19.4
Combined	5.7	9.3	12.5	15.1	17.6	60.2

However, the present value of the benefits accrued over the lifetime of the vehicles covered by the proposal is about 20 percent smaller when discounted at a 7 percent annual rate than when discounted at a 3 percent annual rate:

TABLE IV.G.4–11—PRESENT VALUE OF BENEFITS ($BILLION) UNDER PROPOSED STANDARDS (USING 7 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	6.0	13.6	19.5	25.0	31.1	95.3
Light Trucks	4.3	9.1	13.5	17.4	20.4	64.6

[585] Because some economic inputs change the effective cost of some technologies, and NHTSA assumes some manufacturers will be willing to pay civil penalties based on economic considerations, this outcome is not assured.

TABLE IV.G.4–11—PRESENT VALUE OF BENEFITS ($BILLION) UNDER PROPOSED STANDARDS (USING 7 PERCENT DISCOUNT RATE)—Continued

	2012	2013	2014	2015	2016	Total
Combined	10.3	22.6	33.1	42.4	51.5	159.8

As a result, net benefits are 38 percent lower when total benefits are discounted at a 7 percent annual rate:

TABLE IV.G.4–12—PRESENT VALUE OF NET BENEFITS ($BILLION) UNDER PROPOSED STANDARDS (USING 7 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	1.9	7.0	11.1	15.1	19.3	54.5
Light Trucks	2.7	6.3	9.5	12.2	14.5	45.2
Combined	4.6	13.3	20.6	27.3	33.8	99.7

The following tables also present itemized costs and benefits for the combined fleet for each year of the proposed standards and for all the years combined, at 3 and 7 percent discount rates, respectively. Numbers in parentheses represent negative values.

TABLE IV.G.4–13—ITEMIZED COST AND BENEFIT ESTIMATES FOR THE COMBINED VEHICLE FLEET, 3% DISCOUNT RATE

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
Costs:						
Technology Costs	$5,695	$9,295	$12,454	$15,080	$17,633	$60,157
Benefits						
Lifetime Fuel Expenditures	10,197	22,396	32,715	41,880	50,823	158,012
Consumer Surplus from Additional Driving	751	1,643	2,389	3,029	3,639	11,451
Refueling Time Value	776	1,551	2,198	2,749	3,277	10,550
Petroleum Market Externalities	559	1,194	1,700	2,129	2,538	8,121
Congestion Costs	(460)	(934)	(1,332)	(1,657)	(1,991)	(6,376)
Noise Costs	(7)	(14)	(21)	(26)	(31)	(99)
Crash Costs	(217)	(437)	(625)	(776)	(930)	(2,985)
CO_2	1,028	2,287	3,382	4,376	5,372	16,446
CO	0	0	0	0	0	0
VOC	41	80	108	131	156	518
NO_X	82	132	155	174	200	744
PM	220	438	621	771	904	2,956
SO_X	161	345	490	613	731	2,341
Total	13,132	28,680	41,781	53,394	64,687	201,676
Net Benefits	7,044	18,759	27,090	34,710	41,386	128,992

TABLE IV.G.4–14—ITEMIZED COST AND BENEFIT ESTIMATES FOR THE COMBINED VEHICLE FLEET, 7% DISCOUNT RATE

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
Costs						
Technology Costs	$5,695	$9,295	$12,454	$15,080	$17,633	$60,157
Benefits:						
Lifetime Fuel Expenditures	7,991	17,671	25,900	33,264	40,478	125,305
Consumer Surplus from Additional Driving	590	1,301	1,896	2,412	2,904	9,102
Refueling Time Value	624	1,249	1,770	2,215	2,642	8,500
Petroleum Market Externalities	448	960	1,367	1,712	2,043	6,531
Congestion Costs	(371)	(753)	(1,074)	(1,335)	(1,606)	(5,138)
Noise Costs	(6)	(12)	(16)	(21)	(24)	(80)
Crash Costs	(173)	(352)	(503)	(626)	(749)	(2,403)
CO_2	797	1,781	2,634	3,410	4,189	12,813
CO	0	0	0	0	0	0
VOC	33	65	87	106	125	416
NO_X	60	99	120	135	156	570
PM	170	344	492	613	721	2,339

TABLE IV.G.4–14—ITEMIZED COST AND BENEFIT ESTIMATES FOR THE COMBINED VEHICLE FLEET, 7% DISCOUNT RATE—Continued

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
SO_X	129	278	394	493	588	1,882
Total	10,292	22,631	33,066	42,380	51,468	159,837
Net Benefits	4,281	12,832	18,818	24,414	29,293	89,638

The above benefit and cost estimates did not reflect the availability and use of flexibility mechanisms, such as compliance credits and credit trading, because EPCA prohibits NHTSA from considering the effects of those mechanisms in setting CAFE standards. However, the agency noted that, in reality, manufacturers were likely to rely to some extent on flexibility mechanisms provided by EPCA and would thereby reduce the cost of complying with the proposed standards to a meaningful extent.

As discussed in the PRIA, NHTSA has performed an analysis to estimate the costs and benefits if EPCA's provisions regarding FFVs are accounted for. The agency considered also attempting to account for other EPCA flexibility mechanisms, in particular credit transfers between the passenger and nonpassenger fleets, but has concluded that, at least within a context in which each model year is represented explicitly, technologies carry forward between model years, and multiyear planning effects are represented, there is no basis to reliably estimate how manufacturers might use these mechanisms. Accounting for the FFV provisions indicates that achieved fuel economies would be 0.6–1.1 mpg lower than when these provisions are not considered (for comparison *see* Table IV.G.1–2 above):

TABLE IV.G.4–15—AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER PROPOSED STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016
Passenger Cars	32.5	33.4	34.3	35.3	36.5
Light Trucks	24.1	24.6	25.3	26.3	27.0
Combined	28.7	29.6	30.4	31.6	32.7

As a result, NHTSA estimates that, when FFV credits are taken into account, fuel savings will total 58.8 billion gallons—about 4.5 percent less than the 61.6 billion gallons estimated when these credits are not considered:

TABLE IV.G.4–16—FUEL SAVED (BILLION GALLONS) UNDER PROPOSED STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.5	5.0	6.9	8.6	10.9	33.9
Light Trucks	2.0	3.3	5.0	6.8	7.9	24.9
Combined	4.5	8.2	11.8	15.4	18.8	58.8

The agency similarly estimates CO_2 emissions reductions would total 639 million metric tons (mmt), about 2.6 percent less than the 656 mmt estimated when these credits are not considered:[586]

TABLE IV.G.4–17—AVOIDED CARBON DIOXIDE EMISSIONS (MMT) UNDER PROPOSED STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	27	54	75	93	118	368
Light Trucks	22	36	54	74	86	272
Combined	49	90	129	167	204	639

This analysis further indicates significant reductions in outlays for additional technology when FFV provisions are taken into account—about $45b, or about 25 percent less than the $60b estimated when excluding these provisions:

[586] Differences in the application of diesel engines lead to differences in the incremental percentage changes in fuel consumption and carbon dioxide emissions.

TABLE IV.G.4–18—INCREMENTAL TECHNOLOGY OUTLAYS ($B) UNDER PROPOSED STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.5	4.4	6.1	7.4	9.3	29.6
Light Trucks	1.3	2.0	3.1	4.3	5.0	15.6
Combined	3.7	6.3	9.2	11.7	14.2	45.2

Because NHTSA's analysis indicated that FFV provisions would not significantly reduce fuel savings, the agency's estimate of discounted benefits when including these provisions, $192.5b, is only about 4.5 percent lower than the $201.7b shown above for the analysis that excluded these provisions:

TABLE IV.G.4–19—PRESENT VALUE OF BENEFITS ($BILLION) UNDER PROPOSED STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	7.8	15.9	22.5	28.6	37.1	111.9
Light Trucks	6.1	10.2	15.9	22.1	26.3	80.5
Combined	13.9	26.1	38.4	50.7	63.3	192.5

However, although the agency estimates lower discounted benefits when FFV provisions are taken into account, the agency estimates that these provisions slightly increase net benefits (by about 4 percent, from $141.5b to $147.2b) because costs decrease by more than discounted benefits:

TABLE IV.G.4–20—PRESENT VALUE OF NET BENEFITS ($BILLION) UNDER PROPOSED STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	5.3	11.5	16.4	21.2	27.8	82.3
Light Trucks	4.8	8.2	12.8	17.8	21.3	64.9
Combined	10.2	19.7	29.2	39.0	49.1	147.2

The agency has performed several sensitivity analyses to examine important assumptions. We examine sensitivity with respect to the following five economic parameters:

(1) *The price of gasoline:* The Reference Case uses the AEO 2009 reference case estimate for the price of gasoline. In this sensitivity analysis we examine the effect of using the AEO high or low forecast estimates instead.

(2) *The discount rate:* The Reference Case uses a discount rate of 3 percent to discount future benefits. In the sensitivity analysis, we equally examine the effect of using a 7 percent discount rate instead.

(3) *The rebound effect:* The Reference Case uses a rebound effect of 10 percent to project increased miles traveled as the cost per mile driven decreases. In the sensitivity analysis, we examine the effect of using a 5 percent or 15 percent rebound effect instead.

(4) *The values of CO_2 benefits and monopsony:* The Reference Case uses $20 per ton to quantify the benefits of reducing CO_2 emissions and $0.178 per gallon to quantify the benefits of reducing fuel consumption. In the sensitivity analysis, we examine the effect of using values of $5, $10, $34, or $56 per ton instead to value CO_2 benefits. These values can be translated into cents per gallon by multiplying by 0.0089,[587] giving the following values:

($5 per ton CO_2) x 0.0089 = $0.0445 per gallon

($10 per ton CO_2) x 0.0089 = $0.089 per gallon

($20 per ton CO_2) x 0.0089 = $0.178 per gallon

($34 per ton CO_2) x 0.0089 = $0.3026 per gallon

($56 per ton CO_2) x 0.0089 = $0.4984 per gallon

The $5 per ton value reflects the domestic impacts of CO_2 emissions and so we use a nonzero monopsony cost, namely $0.30 cents per gallon, when valuing CO_2 emissions at $5 per ton. The higher per-ton values of CO_2 emissions reflect the global impacts of CO_2 emissions and we so use $0 per gallon for monopsony in these cases.

(5) *Military security:* The Reference Case uses $0 per gallon to quantify the military security benefits of reducing fuel consumption. In the sensitivity analysis, we examine the impact of using a value of 5 cents per gallon instead.

Varying each of the above 5 parameters in isolation results in 10 economic scenarios, not including the Reference case. These are listed in Table IV.G.4–21 below, together with two additional scenarios that use values for these parameters that produce the lowest and highest valued benefits.

[587] The molecular weight of Carbon (C) is 12, the molecular weight of Oxygen (O) is 16, thus the molecular weight of CO_2 is 44. One ton of C = 44/12 tons CO_2 = 3.67 tons CO_2. 1 gallon of gas weighs 2,819 grams, of that 2,433 grams are carbon. $1.00 CO_2 = $3.67 C and $3.67/ton * ton/1000kg * kg/1000g * 2433g/gallon = (3.67 * 2433)/1000 * 1000 = $0.0089/gallon.

TABLE IV.G.4–21—SENSITIVITY ANALYSES EVALUATED IN NHTSA'S PRIA

Name	Fuel price	Discount rate	Rebound effect	SCC	Monopsony effect	Military security
Reference	Reference	3%	10%	$20	0¢/gal	0¢/gal
High Fuel Price	High	3%	10%	$20	0¢/gal	0¢/gal
Low Fuel Price	Low	3%	10%	$20	0¢/gal	0¢/gal
7% Discount Rate	Reference	7%	10%	$20	0¢/gal	0¢/gal
5% Rebound Effect	Reference	3%	5%	$20	0¢/gal	0¢/gal
15% Rebound Effect	Reference	3%	15%	$20	0¢/gal	0¢/gal
$56/ton CO_2 Value	Reference	3%	10%	$56	0¢/gal	0¢/gal
$34/ton CO_2	Reference	3%	10%	$34	0¢/gal	0¢/gal
$10/ton CO_2	Reference	3%	10%	$10	0¢/gal	0¢/gal
$5/ton CO_2	Reference	3%	10%	$5	30¢/gal	0¢/gal
5¢/gal Military Security Value	Reference	3%	10%	$20	0¢/gal	5¢/gal
Lowest Discounted Benefits	Low	7%	15%	$5	0¢/gal	0¢/gal
Highest Discounted Benefits	High	3%	5%	$56	0¢/gal	5¢/gal

The basic results of the sensitivity analyses were as follows:

(1) The various economic assumptions have similar effects on the passenger car and light truck standards.

(2) Varying the economic assumptions has virtually no impact on achieved fuel economy.

(3) The economic parameter with the greatest impact is fuel price. Changing the fuel price forecast to AEO's High or Low forecasts impacts benefits by about ±37 percent. However, the impact of fuel price on other quantities, such as cost, is much smaller, resulting in increases or decreases of 3–8 percent.

(4) Economic parameters other than fuel price and the rebound effect had no effect on per-vehicle cost, total cost, fuel savings, or CO_2 reductions. Their impacts on benefits were 6 percent or less, with the exception of the 7 percent discount rate, which decreased benefits by 20 percent, and the $56/ton CO_2 value, which raised benefits by 14 percent.

(5) Changing all economic parameters simultaneously (among the considered values) changes benefits by at most about 60 percent. However impacts to other quantities, such as cost, are much smaller, resulting in increases or decreases of 6 percent or less.

(6) Impacts other than those discussed in 1) through 5) were small (5 percent or less).

For more detailed information regarding NHTSA's sensitivity analyses for this NPRM, please see Chapter X of NHTSA's PRIA.

5. How Would These Proposed Standards Impact Vehicle Sales?

Higher fuel economy standards are expected to increase the price of passenger cars and light trucks, because manufacturers will have to add technology to vehicles to increase their fuel economy, the cost for which they will likely pass on in some fashion to consumers. NHTSA examined the potential impact of higher vehicle prices on sales on an industry-wide basis for passenger cars and light trucks separately. We note that the analysis conducted for this rule does not have the precision to examine effects on individual manufacturers or different vehicle classes.

There is a broad consensus in the economic literature that the price elasticity for demand for automobiles is approximately –1.0.[588] Thus, every one percent increase in the price of the vehicle would reduce sales by one percent. Elasticity estimates assume no perceived change in the quality of the product. However, in this case, vehicle price increases result from adding technologies that improve fuel economy. If consumers did not value improved fuel economy at all, and considered nothing but the increase in price in their purchase decisions, then the estimated impact on sales from price elasticity could be applied directly. However, NHTSA believes that consumers do value improved fuel economy, because it reduces the operating cost of the vehicles. NHTSA also believes that consumers consider other factors that affect their costs and have included these in the analysis.

The main question, however, is how much of the retail price needed to cover the technology investments to meet higher fuel economy standards will manufacturers be able to pass on to consumers. The ability of manufacturers to pass the compliance costs on to consumers depends upon how consumers value the fuel economy improvements.[589] Consumer valuation of fuel economy improvements often depends upon the price of gasoline, which has recently been very volatile. The estimates reported below as part of NHTSA's analysis on sales impacts assume that manufacturers will be able to pass all of their costs to improve fuel economy on to consumers. To the extent that NHTSA has accurately predicted the price of gasoline and consumers' reactions, and manufacturers can pass on all of the costs to consumers, then the sales and employment impact analyses are reasonable. On the other hand, if manufacturers only increase retail prices to the extent that consumers value these fuel economy improvements (*i.e.,* to the extent that they value fuel savings), then there would be no impact on sales, although manufacturers' profit levels would fall. Sales losses are predicted to occur only if consumers fail to value fuel economy improvements at least as much as they pay in higher vehicle prices. Likewise, if fuel prices rise beyond levels used in this analysis, consumer valuation of improved fuel economy could increase to match or exceed their initial investment, resulting in no impact or even an increase in sales levels.

To estimate the average value consumers place on fuel savings at the time of purchase, NHTSA assumes that the average purchaser considers the fuel savings they would receive over a 5-year time frame. NHTSA chose 5 years because this is the average length of time of a financing agreement.[590] The

[588] Kleit, A.N. (1990). ''The Effect of Annual Changes in Automobile Fuel Economy Standards,'' *Journal of Regulatory Economics,* vol. 2, pp. 151–172; Bordley, R. (1994). ''An Overlapping Choice Set Model of Automotive Price Elasticities,'' *Transportation Research B,* vol. 28B, no. 6, pp. 401–408; McCarthy, P.S. (1996). ''Market Price and Income Elasticities of New Vehicle Demands,'' *The Review of Economics and Statistics,* vol. LXXVII, no. 3, pp. 543–547.

[589] Gron, Ann and Swenson, Deborah, 2000, ''Cost Pass-Through in the U.S. Automobile Market,'' *The Review of Economics and Statistics,* 82: 316–324.

[590] National average financing terms for automobile loans are available from the Board of Governors of the Federal Reserve System G.19 ''Consumer Finance'' release. *See http://www.federalreserve.gov/releases/g19/* (last accessed August 9, 2009).

present values of these savings were calculated using a 3 percent discount rate. NHTSA used a fuel price forecast that included taxes, because this is what consumers must pay. Fuel savings were calculated over the first 5 years and discounted back to a present value.

NHTSA believes that consumers may consider several other factors over the 5-year horizon when contemplating the purchase of a new vehicle. NHTSA added these factors into the calculation to represent how an increase in technology costs might affect consumers' buying considerations.

First, consumers might consider the sales taxes they have to pay at the time of purchasing the vehicle. NHTSA took sales taxes in 2007 by State and weighted them by population by State to determine a national weighted-average sales tax of 5.5 percent.

Second, NHTSA considered insurance costs over the 5-year period. More expensive vehicles will require more expensive collision and comprehensive (*e.g.,* theft) car insurance. The increase in insurance costs is estimated from the average value of collision plus comprehensive insurance as a proportion of average new vehicle price. Collision plus comprehensive insurance is the portion of insurance costs that depends on vehicle value. The Insurance Information Institute provides the average value of collision plus comprehensive insurance in 2006 as $448.[591] This is compared to an average price for light vehicles of $24,033 for 2006.[592] Average prices and estimated sales volumes are needed because price elasticity is an estimate of how a percent increase in price affects the percent decrease in sales.

Dividing the insurance cost by the average price of a new vehicle gives the proportion of comprehensive plus collision insurance as 1.86 percent of the price of a vehicle. If we assume that this premium is proportional to the new vehicle price, it represents about 1.86 percent of the new vehicle price, and insurance is paid each year for the five-year period we are considering for payback. Discounting that stream of insurance costs back to present value indicates that the present value of the component of insurance costs that vary with vehicle price is equal to 8.5 percent of the vehicle's price at a 3 percent discount rate.

Third, NHTSA considered that 70 percent of new vehicle purchasers take out loans to finance their purchase. The average new vehicle loan is for 5 years at a 6 percent rate.[593] At these terms, the average person taking a loan will pay 16 percent more for their vehicle over the 5 years than a consumer paying cash for the vehicle at the time of purchase.[594] Discounting the additional 3.2 percent (16 percent/5 years) per year over the 5 years using a 3 percent mid-year discount rate [595] results in a discounted present value of 14.87 percent higher for those taking a loan. Multiplying that by the 70 percent of consumers who take out a loan means that the average consumer would pay 10.2 percent more than the retail price for loans the consumer discounted at a 3 percent discount rate.

Fourth, NHTSA considered the residual value (or resale value) of the vehicle after 5 years and expressed this as a percentage of the new vehicle price. In other words, if the price of the vehicle increases due to fuel economy technologies, the resale value of the vehicle will go up proportionately. The average resale price of a vehicle after 5 years is about 35 percent of the original purchase price.[596] Discounting the residual value back 5 years using a 3 percent discount rate (35 percent * .8755) gives an effective residual value at new of 30.6 percent.

NHTSA then adds these four factors together. At a 3 percent discount rate, the consumer considers she could get 30.6 percent back upon resale in 5 years, but will pay 5.5 percent more for taxes, 8.5 percent more in insurance, and 10.2 percent more for loans, resulting in a 6.48 percent return on the increase in price for fuel economy technology. Thus, the increase in price per vehicle is multiplied by 0.9352 (1 − 0.0648) before subtracting the fuel savings to determine the overall net consumer valuation of the increase of costs on her purchase decision.

The following table shows the estimated impact on sales for passenger cars and light trucks combined for the proposed alternative. For all model years except MY 2012, NHTSA anticipates an increase in sales, based on consumers valuing the improvement in fuel economy more than the increase in price.

TABLE IV.G.5–1—POTENTIAL IMPACT ON SALES, PASSENGER CARS AND LIGHT TRUCKS COMBINED

MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
−58,058	52,719	178,470	342,628	454,520

6. What Are the Consumer Welfare Impacts of These Proposed Standards?

There are two viewpoints for evaluating the costs and benefits of the proposed increase in CAFE standards: The private perspective of vehicle buyers themselves on the higher fuel economy levels the proposed rule would require, and the economy-wide or "social" perspective on the costs and benefits of requiring higher fuel economy. From the perspective of vehicle buyers, raising CAFE standards would impose significant costs in the form of higher prices for new vehicles, as manufacturers attempt to recover their added costs for producing vehicles with higher fuel efficiency. If vehicle manufacturers are unable to fully recover their higher costs for producing more fuel-efficient cars and light trucks through higher sales prices, they will bear part of these costs in the form of reduced "producer surplus" or short-term profits.

Other private costs from requiring higher fuel economy also result from changes in the welfare of potential vehicle buyers, as they respond to

[591] Insurance Information Institute, 2008, "Average Expenditures for Auto Insurance By State, 2005–2006." *Available at http://www.iii.org/media/facts/statsbyissue/auto/* (last accessed August 9, 2009).

[592] $29,678/$26,201 = 1.1327 * $22,651 = $25,657 average price for light trucks. In 2006, passenger cars were 54 percent of the on-road fleet, and light trucks were 46 percent of the on-road fleet, resulting in an average light vehicle price for 2006 of $24,033.

[593] New car loan rates in 2007 averaged about 7.8 percent at commercial banks and 4.5 percent at auto finance companies, so their average is close to 7 percent.

[594] Based on *www.bankrate.com* auto loan calculator for a 5-year loan at 6 percent.

[595] For a 3 percent discount rate, the summation of 3.2 percent × 0.9853 in year one, 3.2 × 0.9566 in year two, 3.2 × 0.9288 in year three, 3.2 × 0.9017 in year 4, and 3.2 × 0.8755 in year five.

[596] Consumer Reports, August 2008, "What That Car Really Costs to Own." *Available at http://www.consumerreports.org/cro/cars/pricing/what-that-car-really-costs-to-own-4-08/overview/what-that-car-really-costs-to-own-ov.htm* (last accessed August 9, 2009).

higher vehicle prices by purchasing different models or postponing their purchases of new vehicles. The effects of requiring higher fuel economy on consumer welfare also depend on whether manufacturers elect to make other changes in vehicle attributes as they comply with stricter CAFE standards, such as performance, passenger- and cargo-carrying capacity, comfort, or occupant safety. Although NHTSA believes it has employed estimates of costs for improving fuel economy that include adequate allowances for any accompanying modifications necessary to maintain new vehicles' current levels of other attributes, any changes in these attributes that manufacturers elect to make will represent additional private costs to vehicle buyers from requiring increased fuel economy.

At the same time, raising CAFE standards also provides important private benefits to vehicle buyers, mainly in the form of the values buyers assign to the future savings in fuel costs they believe are likely to result from purchasing more fuel-efficient vehicles. Although these values are likely to vary significantly among buyers depending on their expectations about future fuel prices, how long they anticipate owning their vehicles, and how much they expect to drive, fuel savings are the primary source of private benefits from increased fuel economy. In addition, requiring new cars and light trucks to attain higher fuel economy will also provide benefits to their buyers through the increase in vehicle use associated with the fuel economy rebound effect, as well as from increases in vehicles' driving range, which allow drivers to refuel less frequently.

From the social perspective, the economic benefits and costs of establishing higher CAFE standards include not only these private benefits and costs, but also changes in the value of environmental and economic externalities that result from fuel consumption and vehicle use.[597] These include the reduction in potential climate-related economic damages resulting from lower CO_2 emissions, reduced damages to human health from lower emissions of criteria air pollutants, reductions in economic externalities associated with U.S. petroleum imports, and increases in traffic congestion, vehicle noise, and accidents caused by the increased driving that results through the fuel economy rebound effect.

NHTSA has estimated most elements of the private and social benefits and costs that will result from its proposal to establish higher CAFE standards for model years 2012 through 2016, and the agency reports detailed empirical estimates of these impacts in this document and its Preliminary Regulatory Impact Analysis for the proposed rule. However, the agency is unable to provide a definitive accounting of the private costs and benefits from establishing higher CAFE standards, because we are unable to estimate the losses in consumer welfare that are likely to result from the effects of higher prices for on the number of new vehicles sold or on the mix of specific vehicle models that buyers decide to purchase. Assuming that the agency has correctly estimated each of the other costs and benefits that will result from the proposed rule, its estimates of the net private and total (private plus social) benefits represent their maximum possible values, and considering the rule's impacts on consumer welfare would invariably *reduce* the agency's reported estimates of the proposed rule's net private and total benefits.

If the agency's estimates of technology costs are indeed adequate to maintain vehicles' current levels of these other attributes constant, the only changes in vehicles' characteristics resulting from higher CAFE standards will be improvements in the fuel economy and increases in sales prices for some (or perhaps even all) models. In this case, the welfare effects of requiring higher fuel economy depend on exactly how potential vehicle buyers value the future savings in fuel costs that they anticipate will result from purchasing vehicles with higher fuel economy.

If the market for new vehicles is perfectly competitive and consumers have reliable information to estimate the likely magnitude and value of future fuel savings from buying more efficient models, economic theory suggests that they will make correct trade-offs between higher initial costs for purchasing more fuel-efficient vehicles and subsequent reductions in their operating costs. These include lower fuel expenditures, savings in the time they spend refueling, and the benefits from any additional driving they do in response to its lower per-mile cost. The assumption that consumers have adequate information, foresight, and capability to make such trade-offs has been challenged on both theoretical and empirical grounds. If this assumption is accurate, however, no net private benefits can result from requiring higher fuel economy, since doing so will alter both the purchase prices of new cars and their lifetime streams of operating costs in ways that will inevitably reduce consumers' well-being.

The essence of this view is that in the absence of the regulation, consumers fully understand their current and future costs for owning and using vehicles, and make tradeoffs between these that maximize their individual welfare. From this viewpoint, CAFE standards—or any other regulation that alters this trade-off—will reduce their private well being. The intuition behind this conclusion is probably best captured by recognizing that automobile manufacturers currently sell a wide range of vehicle models, including many that already comply with the CAFE standards proposed in this rule. Yet sufficiently few buyers elect to purchase these vehicles that the average fuel economy of new vehicles sold today remains well below the levels this rule would require.

On the other hand, a great deal of recent evidence suggests that many consumers do not accurately trade off current and future costs of owning and operating cars. For example, it appears that some buyers do not know how to estimate future savings in fuel costs from purchasing a higher-mpg vehicle, or that they incorrectly estimate the increased expense of purchasing a more fuel-efficient new car. In this situation, higher CAFE standards—which will increase purchase prices for new cars, but reduce their lifetime operating costs—can indeed improve consumers' financial well-being. If these circumstances are widespread, then it is likely that requiring manufacturers to achieve higher fuel economy can increase private well-being, and thus that potentially significant savings in private costs can result from the proposed rule.

Whether these circumstances are indeed typical is largely a question of the values that consumers place on additional fuel economy. NHTSA is not currently in a position to reach a conclusive judgment on this issue, and is thus unable to determine how requiring higher fuel economy levels is likely to affect consumer welfare, even if the only impacts of the proposed rule are to change the sales prices and fuel

[597] Vehicle buyers are likely to value fuel savings using retail fuel prices, which include taxes levied by *Federal,* State, and some local governments. Because the reduction in these tax payments resulting from lower fuel purchases is exactly offset by lower tax revenues to government agencies (and reduced spending on the transportation infrastructure and other investments financed by fuel taxes), it does not represent a net benefit from the perspective of the U.S. economy as a whole. Thus the social costs of requiring higher fuel efficiency also include an adjustment to reflect the reduction in fuel tax revenues that results from reduced fuel purchases by new-car buyers.

economy levels of new cars and light trucks, as the agency assumes.

Even if these are the only changes that result from the proposed rule, however, changes in the sales prices and fuel economy levels of some new vehicle models are likely to affect some potential buyers' decisions about whether to purchase a car and what type or model to purchase. Research has demonstrated that previous CAFE rules and market-based changes in operating costs (for example, resulting from changes in gasoline prices) lead consumers to alter the number and types of cars they purchase, and that these changes can lead to losses in consumer well-being. However, NHTSA is not currently able to provide empirical estimates of the magnitude of potential losses in vehicle buyers' welfare resulting from postponement of their decisions to purchase new vehicles or changes in the specific models they elect to buy.

For both of these reasons, the likely impacts of adopting higher CAFE standards on consumer welfare remain unknown. Because changes in consumer welfare are an important component of the total private costs and benefits resulting from higher standards, the magnitude and even the direction of the net private economic impact of adopting stricter CAFE standards also remains unknown.

How Do Consumers Value Fuel Economy?

For this proposed rule, NHTSA estimates several sources of private benefits to vehicle buyers, including savings in future fuel costs, the value of time saved due to less frequent refueling, and utility gained from additional travel that results from the rebound effect. In combination, the agency's estimates suggest that these private savings greatly outweigh its estimates of the costs to consumers for providing higher fuel economy, even without accounting for the additional social benefits from higher fuel economy. This is due primarily to the very large estimated value of future fuel savings from higher fuel economy, which in turn partly reflects the agency's use of modest discount rates (3 percent and 7 percent).

Even without considering the unmeasured welfare losses likely to result from changes in the number of new cars sold and the specific models purchased, however, this finding presents a conundrum. On the one hand, requiring higher fuel economy levels appears likely to produce large net benefits, primarily because the increased cost of producing more fuel-efficient cars and light trucks appears to be far outweighed by the value of the future fuel savings projected to result from higher fuel economy (assuming modest discount rates). At the same time, however, vehicle manufacturers currently produce many models that would allow them to meet the proposed higher CAFE standards, yet at least on average, buyers reveal a preference for lower fuel economy than the proposed rule would require.

In this situation, often referred to as the Energy Efficiency Paradox, consumers appear not to purchase products that are in their economic self-interest. There are theoretical reasons that could explain such behavior: consumers may be myopic, and thus undervalue the long term; they might lack information or be unable to use it properly even when it is presented to them; they may be particularly averse to potential short-term losses associated with purchasing energy-efficient products (the behavioral phenomenon of ''loss aversion''); or even if consumers have relevant knowledge, the benefits of energy efficient vehicles might not seem sufficiently important to them at the time they decide to purchase a new car. A great deal of work in behavioral economics has suggested the possibility that factors of this sort help account for the Energy Efficiency Paradox.

Another possible explanation for the paradox between the apparently large private benefits to vehicle buyers from requiring higher fuel economy and the reluctance of many buyers to purchase new vehicles with higher fuel economy is that consumers may apply much higher discount rates than the agency has used when they evaluate future cost savings from purchasing more fuel-efficient vehicles or other capital goods offering gains in energy efficiency. For example, the Energy Information Agency (1996) has used discount rates as high as 111 percent for water heaters and 120 percent for electric clothes dryers.[598]

Some evidence also suggests directly that vehicle buyers employ high discount rates: consumers surveyed by Kubik (2006) reported that fuel savings would have to be adequate to pay back the additional purchase price of a more fuel-efficient vehicle in less than 3 years to persuade a typical buyer to purchase it.[599] In short, there appears to be no consensus in the literature on what the private discount rate should be in the context of vehicle purchase decisions.

Another possible reconciliation of the Energy Efficiency Paradox, which poses a significant complication for evaluating the private benefits resulting from higher CAFE standards, is that the values consumers place on the future savings from higher fuel economy may vary sufficiently widely that it is unclear whether on average this value exceeds the costs of providing higher fuel economy. A 1988 review of consumers' willingness to pay for improved fuel economy found estimates that varied by more than an order of magnitude: For a $1 per year reduction in vehicle operating costs, consumers would be willing to spend between $0.74 and $25.97 in increased vehicle price.[600] (For comparison, the present value of saving $1 per year on fuel for 15 years at a 3 percent discount rate is $11.94, while a 7 percent discount rate produces a present value of $8.78.) Thus, this study finds that some consumers appear to be willing to pay far too much to obtain future fuel savings, while others may be willing to pay far too little.

Although NHTSA has not found an updated survey of these values, a few examples suggest that vehicle choice models also imply wide variation in estimates of how much people are willing to pay for fuel savings. For instance, Espey and Nair (2005) and McManus (2006) find that consumers are willing to pay nearly $600 extra to purchase a vehicle that achieves one additional mile per gallon.[601] In contrast, Gramlich (2008) finds that consumers' willingness to pay for an increase from 25 mpg to 30 mpg varies between $4,100 (for luxury cars when gasoline costs $2/gallon) to $20,560 (for SUVs when gasoline costs $3.50/gallon).[602] Thus, some buyers appear

[598] Energy Information Administration, U.S. Department of Energy (1996). Issues in Midterm Analysis and Forecasting 1996, DOE/EIA–0607(96), Washington, D.C. *Available at http://www.osti.gov/bridge/purl.cover.jsp?purl=/366567–BvCFp0/webviewable/* (last accessed Jul. 7, 2009).

[599] Kubik, M. (2006). Consumer Views on Transportation and Energy. Second Edition. Technical Report: National Renewable Energy Laboratory.

[600] Greene, David L., and Jin-Tan Liu (1988). ''Automotive Fuel Economy Improvements and Consumers' Surplus.'' Transportation Research Part A 22A(3): 203–218. The study actually calculated the willingness to pay for reduced vehicle operating costs, of which vehicle fuel economy is a major component.

[601] Espey, Molly, and Santosh Nair (2005). ''Automobile Fuel Economy: What is it Worth?'' Contemporary Economic Policy 23(3): 317–323; McManus, Walter M. (2006). ''Can Proactive Fuel Economy Strategies Help Automakers Mitigate Fuel-Price Risks?'' University of Michigan Transportation Research Institute.

[602] Gramlich, Jacob (2008). ''Gas Prices and Endogenous Product Selection in the U.S.

Continued

not to make accurate trade-offs between higher initial purchase prices and subsequent fuel savings. At the same time, however, these results may simply reflect the fact that the expected savings from purchasing higher fuel economy vary widely among individuals, because they travel different amounts or have different driving styles.

Finally, it is possible that the apparent Energy Efficiency Paradox is in fact not a paradox at all when one considers the uncertainty surrounding future fuel prices and a vehicle's expected lifetime and usage. As Metcalf and Rosenthal (1995) indicate, purchasing higher fuel economy requires buyers to weigh known, up-front costs that are essentially irreversible (that is, they have a relatively low salvage value if the return never materializes) against an unknown future stream of fuel savings.[603] They find some evidence that this accounts for a large portion of the seeming inconsistency between low cost opportunities to invest in energy efficiency and the current lack of investment in them. This would not imply failure on the part of consumers in making decisions, but rather that the rate of return buyers require on their vehicle purchases (or other energy efficiency investments) is much higher than that implied by a 3 percent discount rate that does not include a provision for uncertainty.

Greene *et al.* (2009) find additional support for this conclusion in the context of fuel economy decisions: They find that the expected net present value of increasing the fuel economy of a passenger car from 28 to 35 miles per gallon falls from $405 when calculated using standard net present value calculations to nearly zero when uncertainty regarding future cost savings is taken into account.[604] In contrast to Metcalf and Rosenthal, Greene et al. find that uncertainty regarding the future price of gasoline is less important than uncertainty surrounding the expected lifetimes of new vehicles. 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 leasing provides them with the option to return it before those costs become too high.[605]

In contrast, other research suggests that the Energy Efficiency Paradox is real and significant, and owes to consumers' inability to value future fuel savings appropriately. For example, Sanstad and Howarth (1994) argue that consumers optimize behavior without full information by resorting to imprecise but convenient rules of thumb. Larrick and Soll (2008) find evidence that consumers do not understand how to translate changes in miles per gallon into fuel savings.[606] If the behavior identified in these studies is indeed widespread, then significant gains to consumers can result from requiring higher fuel economy.

How NHTSA Proposes To Treat the Issue of Welfare Losses

In the course of future rulemakings, the agency intends to explore methods that would allow it to present a more comprehensive accounting of private costs and benefits from requiring higher fuel economy, including more detailed estimates of changes in the welfare of new vehicle buyers that are likely to result from higher CAFE standards. One promising approach to estimating the full welfare loss associated with CAFE's impact on vehicle purchasing decisions is using consumer vehicle choice models to evaluate the simultaneous effects of increases in sales prices, improvements in fuel economy, and changes in other attributes of specific vehicle models, rather than in the average values of these variables. NHTSA invites comments on the state of the art of consumer vehicle choice modeling, as well as on the prospects for these models to yield reliable estimates of changes in consumer welfare from requiring higher fuel economy.

7. What Are the Estimated Safety Impacts of These Proposed Standards?

As discussed above, in evaluating the appropriate levels at which to establish new CAFE standards, NHTSA must assess any potential safety trade-offs. Safety trade-offs associated with fuel economy increases have occurred in the past and the possibility of future ones remains a concern. In the congressionally-mandated report entitled ''Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards,'' a committee of the National Academy of Sciences (NAS) (''2002 NAS Report'')[607] concluded that the then-existing form of passenger car and light truck CAFE standards, together with market forces, created an incentive for vehicle manufacturers to comply in part by downweighting and even downsizing their vehicles and that these actions led to additional fatalities. Given the cost advantages of downsizing instead of substituting lighter, higher strength materials, NAS urged that the CAFE program be restructured to reduce the regulatory incentive to downsize. As NAS observed, the ability to reduce weight without reducing size does not mean they will exclusively rely on those means of weight reduction. Responding to NAS' concern, Congress mandated in EISA that CAFE standards be based on an attribute related to fuel economy, like footprint or weight.

Given the relative cost-effectiveness of at least some approaches to weight reduction, it is reasonable to assume that the vehicle manufacturers will choose weight reduction as one means of achieving compliance with the proposed standards. In fact, informal statements by the vehicle manufacturers themselves indicate that they intend to engage in some weight reduction, as appropriate for certain vehicle models, during the rulemaking time frame. While the manufacturers generally indicate that they plan to reduce weight without reducing size, their adherence to those plans would not remove all bases for any safety concerns.

The question of the effect of changes in vehicle weight on safety in the context of fuel economy is a complex question that poses serious analytic challenges and has been a contentious issue for many years. This contentiousness arises, at least in part, from the difficulty of isolating vehicle weight from other confounding factors (*e.g.,* driver behavior, or vehicle factors such as engine size and wheelbase). In addition, at least in the past, several vehicle factors have been closely related, such as vehicle mass, wheelbase, track width, and structural integrity. The issue has been addressed in the literature for more than two decades. For the reader's reference, much more information about safety in

Automobile Industry.'' *Available at http://www.econ.yale.edu/seminars/apmicro/am08/gramlich-081216.pdf* (last accessed May 1, 2009).

[603] 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.

[604] 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.

[605] 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.

[606] Sanstad, A., and R. Howarth (1994). '' 'Normal' Markets, Market Imperfections, and Energy Efficiency.'' Energy Policy 22(10): 811–818; Larrick, R.P., and J.B. Soll (2008). ''The MPG illusion.'' *Science* 320: 1593–1594.

[607] National Research Council, ''Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards,'' National Academy Press, Washington, DC (2002). *Available at http://www.nap.edu/openbook.php?isbn=0309076013* (last accessed September 11, 2009).

the CAFE context is available in the MY 2011 final rule [608] and in Section IX of the PRIA.

Conducting the safety assessment for this rulemaking is thus difficult since, in general, it is unclear to what extent the higher fatality risk of smaller and lighter vehicles is associated with their reduced mass as compared to their reduced physical dimensions. That is because, historically, the safest vehicles have been heavy and large, while the vehicles with the highest fatal-crash rates have been light and small, both because the crash rate is higher for small/light vehicles and because the fatality rate is higher for small/light vehicle crashes.[609] Intuitively, a reduction in mass while maintaining physical dimensions is likely to be less harmful than a reduction in both mass and physical dimensions.

As noted above, the manufacturers have generally informally stated that they plan to use weight reduction methods that do not involve size reduction. That is plausible since the selection of footprint as the attribute in setting CAFE standards helps to minimize the incentive to reduce a vehicle's physical dimensions. This is because as footprint decreases, the corresponding fuel economy target decreases.[610]

However, NHTSA cautions that vehicle footprint is not synonymous with vehicle size. Since the footprint is only that portion of the vehicle bounded by the front and rear axles and by the wheels, footprint based standards do not discourage downsizing the portions of a vehicle in front of the front axle and to the rear of the rear axle (front and rear overhand). Similarly, they do not discourage downsizing the portions of a vehicle outside its wheels (side overhang). The crush space provided by those portions of a vehicle can make important contributions to managing crash energy. We note that at least one manufacturer has confidentially indicated plans to reduce overhang as a way of reducing weight on some vehicles during the rulemaking time frame.

Neither the CAFE standards nor our analysis of the feasibility of fuel economy improvements mandates mass reduction or any other specific technology application. In addition, considering NHTSA's analysis of the observed relationship between vehicle mass and the prevalence of fatalities, NHTSA has, except for vehicles with baseline curb weight over 5,000 pounds, excluded weight reduction from its analysis of potential CAFE standards in past rulemakings. The agency followed this analytical approach in order to ensure that its consideration of new standards was not dependent on weight reduction that could potentially compromise highway safety, recognizing, though, that the structure of CAFE standards does not prohibit manufacturers from making such responses to new CAFE standards. The agency implemented this approach by setting the Volpe model to apply this exclusion when estimating how manufacturers could apply technology in response to new CAFE standards.

In its rulemakings on MY 2008–2011 light truck CAFE standards and MY 2011 car and light truck CAFE standards, NHTSA received comments suggesting that NHTSA expand the applicability of weight reduction technologies in its modeling to vehicles under 5,000 pounds, because, according to the commenters, weight reduction can be accompanied by proper vehicle design to assure that vehicle safety is not compromised. In the final rules in those rulemakings, the agency said that there may be great possibilities in the use of material substitution and other processes to minimize the safety effects of reducing weight. The agency further noted that this should be explored as data become available.

After reviewing its assumptions and methodologies per the President's January 26 memorandum and working with EPA in this rulemaking, NHTSA revised its approach to include weight reduction of up to 5–10 percent of baseline curb weight, depending on vehicle type. Recently-submitted manufacturer product plans as well as public statements from a number of the manufacturers suggest some of them expect that by MY 2016, they will be able to reduce the weight of some specific vehicle models by similar levels. However, NHTSA does not believe that, except where already planned, such significant weight reductions can be achieved in MY 2012 or MY 2013, because there is not enough lead time for the necessary design, engineering, and tooling. NHTSA estimates that weight reductions of 1.5 percent can be achieved during redesigns occurring prior to MY 2014, and that weight reductions of 5–10 percent can be achieved in redesigns occurring in MY 2014 or later. For purposes of analyzing CAFE standards, NHTSA has further assumed that weight reductions would be limited to 5 percent for small vehicles (*e.g.,* subcompact passenger cars), and that reductions of 10 percent would only be applied to the larger vehicle types (*e.g.,* large light trucks).

NHTSA's modeling approach is similar to EPA's in terms of maximum available weight reduction for any vehicle model, sensitive to vehicle safety in terms of when and to which vehicle types significant weight reduction can be achieved safely, and supported by information in some manufacturers' product plans. Some manufacturers have indicated that, in later model years, they plan to reduce significantly the weight of some specific vehicle models, and that they plan to do so without reducing vehicle size. NHTSA's analysis results in similar degrees of weight reduction, applied more widely to some manufacturers. NHTSA notes, though, that some manufacturers are also planning considerable changes in product mix, and some of these changes could mean reduced average size along with reduced average weight. In NHTSA's (and EPA's) analysis, such changes in product mix are not counted, because they are either in the baseline market forecast, or are not estimated.

As stated above, neither the CAFE standards nor our analysis mandates mass reduction, or mandates that if mass reduction occurs, it be done in any specific manner. However, mass reduction is one of the technology applications available to the manufacturers and has been used by them in the past. A degree of mass reduction is used by the Volpe model in determining the capabilities of manufacturers and in predicting both cost and fuel consumption impacts of improved CAFE standards.

In this section, we briefly summarize our analysis of the potential impacts of these mass reductions on vehicle safety. NHTSA's quantified analysis is based on the 2003 Kahane study,[611] which estimates the effect of 100-pound reductions in MYs 1991–1999 heavy light trucks and vans (LTVs), light LTVs, heavy passenger cars, and light passenger cars. The study compares the fatality rates of LTVs and cars to quantify differences between vehicle

[608] 74 FR 14396–14407 (Mar. 30, 2009).

[609] Kahane, Charles J., Ph.D., ''Vehicle Weight, Fatality Risk and Crash Compatibility of Model Year 1991–99 Passenger Cars and Light Trucks,'' DOT HS 809 662, October 2003, Executive Summary. *Available at http://www.nhtsa.dot.gov/cars/rules/regrev/evaluate/809662.html* (last accessed August 12, 2009).

[610] Vehicle footprint is not synonymous with vehicle size. Since the footprint is only that portion of the vehicle between the front and rear axles, footprint based standards do not discourage downsizing the portions of a vehicle in front of the front axle and to the rear of the rear axle. The crush space provided by those portions of a vehicle can make important contributions to managing crash energy.

[611] *Id.*

types, given drivers of the same age/gender, etc. In this analysis, the effect of ''weight reduction'' is not limited to the effect of mass *per se,* but includes all the factors, such as length, width, structural strength, and size of the occupant compartment, that were naturally or historically confounded with mass in MYs 1991–1999 vehicles. The rationale is that adding length, width, or strength to a vehicle will also make it heavier.

The agency utilized the relationships between weight and safety from Kahane (2003), expressed as percentage increases in fatalities per 100-pound weight reduction, and examined the weight impacts assumed in this CAFE analysis. However, there are several identifiable safety trends that are already in place or expected to occur in the foreseeable future and that are not accounted for in the study. For example, two important new safety standards that have already been issued and will be phasing in during the rulemaking time frame. Federal Motor Vehicle Safety Standard No. 126 (49 CFR 571.126) will require electronic stability control in all new vehicles by MY 2012, and the upgrade to Federal Motor Vehicle Safety Standard No. 214 (Side Impact Protection, 49 CFR 571.214) will likely result in all new vehicles being equipped with head-curtain air bags by MY 2014.[612] Additionally, we anticipate continued improvements in driver (and passenger) behavior, such as higher safety belt use rates. All of these will tend to reduce the absolute number of fatalities resulting from weight reductions. Thus, while the percentage increases in Kahane (2003) was applied, the reduced base has resulted in smaller absolute increases than those that were predicted in the 2003 report.

The agency examined the impacts of the identifiable safety trends over the lifetime of the vehicles produced in each model year. An estimate of these impacts was contained in a previous agency report.[613] The impacts were estimated on a year-by-year basis, but could be examined in a combined fashion. The agency assumed that the safety trends will result in a reduction in the target population of fatalities from which the weight impacts are derived. Using this method, we found a 12.6 percent reduction in fatality levels between 2007 and 2020. The estimates derived from applying Kahane's percentages to a baseline of 2007 fatalities were thus multiplied by 0.874 to account for changes that the agency believes will take place in passenger car and light truck safety between the 2007 baseline on-road fleet used for this particular analysis and year 2020.

We note that because these new analyses are based on the method shown in Kahane (2003), which predicts the safety effect of 100-pound mass reductions in MY 1991–1999 light trucks and vans (LTVs) and passenger cars, the new analyses need to be understood in the context of that study. Specifically, the numbers in the new analyses represent an upper bound (or worst case) fatality estimate—that is, the estimate would only apply if all weight reductions come from reducing both weight and footprint. Kahane's conclusions are based upon a cross-sectional analysis of the actual on-road safety experience of 1991–1999 vehicles. For those vehicles, heavier usually also meant larger-footprint. Hence, the numbers in the new analyses predict the safety-related fatalities that would occur in the unlikely event that weight reduction for MYs 2012–2016 is accomplished entirely by reducing mass *and* reducing footprint.

Exclusive reliance on downsizing for the model years covered by this rulemaking is unlikely for the following reasons. As noted above, the manufacturers have generally indicated that they plan reduce weight without reducing size. Further, the flat CAFE standards in effect when those MY 1991–1999 vehicles were produced had no penalty for such a strategy for improving fuel economy. In contrast, as discussed above, the current attribute-based CAFE standards do not encourage vehicle downsizing by reducing footprint. This structural change to the CAFE program means that the CAFE standards now favor the use of weight reduction strategies that do not involve simply making that portion of the vehicle smaller. These other strategies include downsizing the engine and adding turbocharging, as well as materials substitution.

Given this structural change to the CAFE program, it is likely that a significant portion of the weight reduction in the MY 2012–2016 vehicles will be accomplished by strategies that have a lesser safety impact than the prevalent 1990s strategy of simply making the vehicles smaller, although NHTSA is unable to predict how large a portion. For example, a manufacturer could conceivably add length, width, or strength to a vehicle by replacing existing materials with light, high-strength components.

To the extent that future weight reductions could be achieved by substituting light, high-strength materials for existing materials—without any accompanying reduction in the size or structural strength of the vehicle—then NHTSA believes that the fatality increases associated with the weight reductions anticipated by the model as a result of the proposed standards could be significantly smaller than those in the worst-case scenario. However, NHTSA does not currently have information (on-road data) to calibrate and predict how much smaller those increases would be for any given mixture of material substitution and downsizing, since the data on the safety effects of mass reduction alone is not available due to the low numbers of vehicles in the current on-road fleet that have utilized this technology extensively. Further, to the extent that weight reductions were accomplished through use of light, high-strength materials, there would be significant additional costs that would need to be determined and accounted for. Those higher costs are not reflected in NHTSA's cost-benefit analysis for this proposal.

Nevertheless, even though NHTSA cannot quantify these safety effects, we can project that they could be significantly less than those that would result from simple downsizing. However, we are also convinced that the safety effects are larger than zero for the following reasons:

• The effects of mass *per se* (laws of physics) will persist regardless whether mass is reduced by material substitution, downsizing, or any other method. There are a variety of crash types that could be impacted in various ways by changes in vehicle weight and at times by the way in which the vehicle's weight is changed. The following discussion examines weight reduction by either engine size reductions or material substitution and its impact on each of the different crash types.[614]

Let us assume that *Car A weighs X pounds and that Car B weighs X − 100*

[612] We note that the Volpe model currently does not account for the weight of safety standards that will be added compared to the MY 2008 baseline, nor does it account for the societal cost of reductions in weight. However, both of these items will be added to the model for the final rule; doing so will raise the weight of every vehicle by roughly 17 pounds in MY 2016 (slightly less in earlier years), which will likely require manufacturers to add slightly more technology to reach the final standards than they were estimated to need to reach the proposed standards. However, NHTSA does not expect the impact of these roughly 17 pounds per vehicle to have a significant impact on the safety analysis.

[613] Blincoe, L. and Shankar, U, ''The Impact of Safety Standards and Behavioral Trends on Motor Vehicle Fatality Rates,'' DOT HS 810 777, January 2007. *See* Table 4 comparing 2020 to 2007 (37,906/43,363 = 12.6% reduction (1 − .126 = .874).

[614] For a similar discussion of effect of weight reduction on different crash modes, see Effectiveness and Impact of Corporate Average Fuel Economy Standards, NAS 1972, pp 74–75.

pounds and that Cars A and B have the same footprint, overhang and structural strength.

○ *Single-vehicle crashes*

Hitting an immovable object (like a big tree or bridge abutment).

In most cases, there would be little impact on vehicle safety if Car A and Car B each hit a different immovable object at the same speed because the change in velocity (delta-V) would be the same for both vehicles.

Hitting a partially movable object (like a small tree, parked car, storefront, or dwelling).

Heavier vehicles will impart more force to movable objects than lighter vehicles. This will increase the chance that the movable objects will break, crush, or otherwise give way and increase the distance over which the striking vehicle can decelerate, which will reduce the delta-V for the vehicle's occupants.

Single-vehicle rollovers.

Smaller vehicles end up in more rollover crashes than larger vehicles. Part of the reason for this is the static stability factor, since smaller vehicles have less track width. Part of the reason for this is the way smaller vehicles are driven. Given the same track width for Car A and Car B, the impact on rollovers is hard to determine since the weight helps build up momentum and the influence of momentum versus weight for tripped rollovers is hard to discern.

○ *Multi-vehicle crashes*

Frontal impact—two light vehicles.

While a collision of Car B with Car B is likely to have the same risk as a similar collision of Car A with Car A, the final answer on safety will depend upon what vehicle sizes receive overall weight reductions. As NHTSA's study shows, if weight is taken out of the larger light trucks, overall safety is improved. If weight is taken out of passenger cars or smaller light trucks, overall safety decreases. Overall, we can't determine whether there will be an overall difference in safety.

Side impact—struck vehicle.

As a struck vehicle, Car B is at a disadvantage because its delta V would be increased. Car B would be less safe.

Side impact—striking vehicle.

NHTSA analyses have shown that for a striking vehicle in a side impact, weight is not as important as striking height. Weight does have an impact, because of imparting a lower delta V on the struck vehicle. When struck by Car B, the struck vehicle would be somewhat safer.

Side impact—overall.

Overall, there will be a minimal difference in safety.

Collision with an older light vehicle.

Car B would experience a higher delta V and a higher fatality risk than Car A, if either were struck by the same pre-2012 vehicle. But the occupants of the older vehicle would experience a lower delta V and a lower risk if struck by Car B.

Collision with a medium-sized truck (somewhat over 10,000 GVWR).

Medium-size trucks are not affected by CAFE and do not need to decrease their weight. Car B would experience a higher delta V and a higher risk than Car A. (The risk to the occupants of the medium-size truck would be minimally higher with Car A.) Overall, Car B would be less safe.

Collision with a fully-loaded tractor trailer (significantly over 10,000 GVWR).

Car B would experience a higher delta V than Car A, but in this case, the difference in delta V would be minimal. Risk would be similar in both cars.

○ *Pedestrian/bicyclist impacts*

In general, Car A would impose a slightly higher delta V on the pedestrian than Car B, but the difference would be so small that risk for the pedestrian would essentially be the same either way.

• Our attribute-based standards have the excellent feature that they can avoid encouraging reductions in footprint. However, weight can be removed by downsizing, rather than material substitution, even *while maintaining footprint:*

○ By reducing the overhang in front of the front wheels and behind the rear wheels. These are protective structures whose removal would increase risk to occupants by reducing vehicle crush space.

○ By thinning or removing structures within the vehicle.

• NHTSA has found that lighter vehicles are driven in a manner that results in a higher involvement rate in fatal crashes, even after controlling for the driver's age, gender, urbanization, and region of the country. However, in our response in the MY 2011 final rule to the DRI analyses, we were unable to attribute this effect to any obvious ''size'' parameter such as track width or wheelbase. In non-rollover crashes, weight continued to be the most important parameter, even when track width and wheelbase were included as independent variables. Until we understand the phenomenon better, we assume that weight reduction is likely to be associated with higher fatal-crash rates, no matter how the weight reduction is achieved.

Table IV.G.7–1 below shows the results of NHTSA's worst case analysis of safety-related fatalities separately for each model year. Additionally, the societal impacts of increasing fatalities can be monetized using DOT's estimated comprehensive cost per life of $6.1 million. This consists of a value of a statistical life of $5.8 million plus external economic costs associated with fatalities such as medical care, insurance administration costs and legal costs.[615]

NHTSA has also calculated an assumed impact on injuries and added that to the societal costs of fatalities. This assumed impact is based on past studies indicating that fatalities account for roughly 44 percent of total comprehensive costs due to injury.[616] If weight impacts non-fatal injuries roughly proportional to its impact on fatalities, then total costs would be roughly 2.3 times those noted in Table IV.G.7–2. The potential societal costs for just fatalities are shown in Table IV.G.7–2. The combined potential social costs are shown in Table IV.G.7–4.

Looking at the results on a calendar year basis, we also note that the safety impacts of the Kahane analysis based weight reduction have a slow onset. Passenger cars typically have a 10–25 year lifetime, and light trucks somewhat longer. Thus, some of the fatalities for MY 2016 light trucks will not occur until after 2050. Moreover, the weight reductions are small in the early model years 2012 and 2013. The vehicles with reduced weight will only be a small proportion of the entire on-road fleet in the initial calendar years of these proposed CAFE standards. The influence of these factors is illustrated in Table IV.G.7–3 below.

Additionally, there will be significant fuel-saving benefits from these proposed standards, up to 61.6 billion gallons during the lifetime of MYs 2012–2016 vehicles. There will also be significant reductions in CO_2 emissions, up to 656 million metric tons during that same time period.

Improved fuel economy will also result in a decrease in harmful criteria pollutants, which will decrease premature deaths due to a number of diseases related to environmental pollution. The literature strongly supports the causal relationship between health and exposure to criteria pollutants. However, as with vehicle safety impacts, there is much

[615] Blincoe *et al.*, The Economic Impact of Motor Vehicle Crashes 2000, May 2002, DOT HS 809 446. Data from this report were updated for inflation and combined with the current DOT guidance on value of a statistical life to estimate the comprehensive value of a statistical life.

[616] Based on data in Blincoe *et al.*, updated for inflation and reflecting the Department's current VSL of $5.8 million.

uncertainty regarding the exact level of health impacts that might be achieved with this rule. Thus, there are potentially both positive and negative impacts that could result from this rulemaking. We have not attempted to quantify other beneficial health impacts that are expected to result from the proposed standards, including the results of a decrease in the rate of global warming, and increased energy security resulting from a lesser dependence on oil imported volatile regions of the world, but they, too, could be significant.

In summary, the agency recognizes the balancing inherent in achieving higher levels of fuel economy through reduction of vehicle weight. We emphasize that these safety-related fatality estimates represent a worst case scenario for the potential effects of this rulemaking, and that actual fatalities will be less than these estimates, possibly significantly less, based on the qualitative discussion above of the various factors that could reduce the estimates. At the same time, however, the agency cannot specify a reasonable lower-bound estimate. It is possible that the impact could be fairly small, but the agency is unable to specify a lower-bound at this time due to a lack of studies that address the safety risk associated with weight reduction that is not also accompanied by size reduction. Additionally, the estimates presented here do not include estimates for injuries. Nevertheless, we believe that the balancing is reasonable.

In the absence of data that permit examining the fatality impact of reductions in weight and footprint independently, we considered whether it would be appropriate to use the industry-sponsored DRI study to estimate a lower-bound value. However, as noted below, the agency's inability to reproduce DRI's results raises questions whether the DRI reports sufficiently satisfy reproducibility criteria and thus have the quality, objectivity, utility, and integrity needed for information relied upon and disseminated by the Federal Government to the public. Reliance upon non-reproducible studies undermines the credibility of the Government's scientific information. Further, the DRI reports raise a significant additional data quality concern. They have not been subjected to a rigorous form of peer review.

DRI produced several studies between 2000 and 2005, funded by a manufacturer of small vehicles and purporting to analyze mass, track width, and wheelbase as independent variables. DRI's 2002 paper indicated that reducing mass would be beneficial, while reducing track width and wheelbase would be harmful. If true, this meant that weight reduction would benefit safety if track width and wheelbase were maintained. However, NHTSA has concluded that the 2002 DRI study inadvertently introduced significant biases in the analysis, as a result of including 2-door cars in the analysis. Dr. Kahane's analyses have excluded 2-door passenger cars on the grounds that in the data reviewed in those analyses (and by DRI in its analysis), 2-door cars consisted in considerable part of sports and muscle cars. Including sports and muscle cars in a regression analysis of vehicle weight and safety biases the results for two primary reasons: first, because sports and muscle cars tend to have short wheelbases but be relatively heavy for their size, they function as outliers in the regression analysis and thus distort the derived relationships and second, because sports and muscle cars as a group tend to be disproportionately involved in crashes. NHTSA provided this response to DRI publicly in 2004.[617] In response, DRI submitted a new study in 2005 with a sensitivity analysis limited to 4-door cars, excluding police cars. DRI further stated that it could mimic NHTSA's logistic regression approach for an analysis of model year 1991–98 4-door cars in calendar year 1995–1999 crashes. DRI stated that its updated 2005 analysis still showed results directionally similar to its earlier work—increased risk for lower track width and wheelbase, reduced risk for lower mass—although DRI acknowledged that the wheelbase and mass effects were no longer statistically significant after removing the 2-door cars from the analysis.

Since receiving it, NHTSA has disagreed with the results of DRI's 2005 analysis, most recently on record in the MY 2011 CAFE final rule, for two primary reasons. First, even using the same (NHTSA) data and methodology as DRI used, NHTSA has been unable to reproduce DRI's 2005 results. And second, to our knowledge, unlike Dr. Kahane's 2003 study, DRI's 2005 study has not been rigorously peer-reviewed.

The following provides an example of how NHTSA has tried to reproduce DRI's results, unsuccessfully. In MY 1991–1998, the average car weighing x + 100 pounds had a track width that was 0.34 inches larger and a wheelbase that was 1.01 inches longer. Thus, one could say that a ''historical'' 100-pound weight reduction would have been accompanied by a 0.34 inch track width reduction and a 1.01 inch wheelbase reduction. However, using a reasonable check, if one dissociates weight, track width, and wheelbase and treats them as independent parameters, DRI's logistic regression of model year 1991–1998 4-door cars excluding police cars attributes the following effects:

[617] Docket No. NHTSA–2003–16318–0016.

DRI – Parameter	Effect on Fatalities
Reduce mass by 100 pounds	379 fewer deaths
Reduce track width by 0.34 inches	1,000 more deaths
Reduce wheelbase by 1.01 inches	207 more deaths
Reduce mass by 100 lb., track by 0.34, and WB by 1.01 inches	828 more deaths

However, applying NHTSA's logistic regression analyses [618] to NHTSA's database, exactly as described in the agency's response to comments on its 2003 report, except for limiting the data to model years 1991–98, instead of 1991–99, produces results that are not at all like DRI's. Mass still has the largest effect, exceeding track width, and it moves in the expected direction.

NHTSA – Parameter	Effect on Fatalities
Reduce mass by 100 pounds	485 more deaths
Reduce track width by 0.34 inches	334 more deaths
Reduce wheelbase by 1.01 inches	9 more deaths
Reduce mass by 100 lb., track by 0.34, and WB by 1.01 inches	828 more deaths

NHTSA obtained its estimates by adding the results from 12 individual logistic regressions: Six types of crashes multiplied by two car-weight groups (less than 2,950 pounds; 2,950 pounds or more).[619] DRI does not appear to have followed the same procedures, based on the widely differing results.

Based on our review, NHTSA is not persuaded by the DRI analysis. NHTSA's analyses do not corroborate the 2005 DRI study that suggested mass could be reduced without safety harm and perhaps with safety benefit. Moreover, even though NHTSA's analyses continue to attribute a much larger effect for mass than for track width or wheelbase in small cars, NHTSA has never said that mass *alone* is the single factor that increases or decreases fatality risk. There may not be a single factor, but rather it may be that mass and some of the other factors that are historically correlated with mass, such as wheelbase and track width, together are the factors.

We note that comparatively it *would seem* the least harmful way to reduce mass would be from material substitution, where one replaces a heavy material with a lighter one that delivers the same performance, or other designs that reduce mass while maintaining wheelbase and track width. While this may seem intuitively to be the case, there is an absence of supporting data for the thrust of the 2005 DRI analysis, because those changes have not happened to any substantial number of vehicles in the real world. NHTSA thus has no way, yet, of proving the intuitive conclusion. We do know that mass has historically been correlated with wheelbase and track width, and that reductions in mass have also reduced those other factors. Until there is an analysis that clearly demonstrates that mass does not matter for safety, NHTSA concludes it should be guided by the decades' worth of studies suggesting

[618] Regression analysis involves modeling and analyzing several variables, when the focus is on the relationship between a *dependent variable* and one or more *independent variables*. Logistic regression analysis involves three variables.

[619] *See, e.g.*, Kahane (2003), Table 2 on p. xi.

that mass is the most important of the related factors.

The tables below contain NHTSA's estimates of the safety-related fatality impacts of the proposed standards, the costs associated with those impacts, and the overall change in impacts given other anticipated mitigating effects during the next several years. Again, we emphasize that the safety-related fatality impacts presented below represent a worst case scenario, and that NHTSA believes that the fatality increases associated with the anticipated weight reductions could be significantly smaller than those shown, because manufacturers are unlikely to respond to this rulemaking by decreasing the footprint or reducing the structural integrity of their vehicles.

In addition, we note that the implementation of new Federal Motor Vehicle Safety Standards, combined with behavioral changes (*e.g.*, further increases in safety belt use), will produce important reductions in the number of deaths and injuries that would otherwise occur in the vehicles subject to this rulemaking over their lifetime.

NHTSA seeks comments on its analysis of the safety impacts of the proposed standards. To aid the agency in refining its analysis for the final rule, including its attempts to assess reasonable upper and lower ends of the potential range of estimated fatalities, NHTSA requests that each vehicle manufacturer provide, for inclusion in the record of this rulemaking, detailed information concerning the extent to which and manner in which it plans to reduce the weight of each of its models for the period covered by this rulemaking, and the cost of each method used. Manufacturers should include in those plans whether there will be any footprint or other size reduction, whether through reducing the size of an existing model, mix shifting or other means. Please also submit the analysis, including engineering or computer simulation analysis, performed to assess the possible safety impacts of such planned weight reduction. In addition, please submit the results of any vehicle crash or component tests that would aid in assessing those impacts.

TABLE IV.G.7–1—COMPARISON OF THE CALCULATED WORST CASE WEIGHT SAFETY-RELATED FATALITY IMPACTS OF THE PENDING PROPOSED STANDARDS OVER THE LIFETIME OF THE VEHICLES PRODUCED IN EACH MODEL YEAR

[Increase in fatalities compared to the Calendar Year 2007 fatality level]

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Baseline MY 2011 standards continued for lifetime of vehicles					
Passenger cars	13	15	18	18	19
Light trucks	13	15	17	17	18
Combined	26	30	35	35	37
Proposed standards					
Passenger cars	42	64	165	242	379
Light trucks	18	20	64	106	150
Combined	60	84	229	348	530
Difference between proposed standards and baseline continued					
Passenger cars	29	49	147	224	360
Light trucks	5	5	47	89	132
Combined	34	54	194	313	493

NOTE—all estimates in this table are worst-case. Actual values could be significantly less.

TABLE IV.G.7–2—CALCULATED WORST CASE WEIGHT SAFETY-RELATED FATALITY IMPACTS ON SOCIETAL COSTS FOR THE PROPOSED STANDARDS OVER THE LIFETIME OF THE VEHICLES PRODUCED IN EACH MODEL YEAR

[$ millions]

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
Passenger cars	177	299	897	1,366	2,916	4,935
Light trucks	31	31	287	543	805	1,696
Combined	207	329	1,183	1,909	3,001	6,637

NOTE—all estimates in this table are worst-case. Actual values could be significantly less.

TABLE IV.G.7–3—ESTIMATED WORST CASE IMPACT OF WEIGHT ON CALCULATED FATALITIES BY CALENDAR YEAR

[Additional fatalities by model year and calendar year]

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018	MY 2019	MY 2020	Totals
2012	3									3
2013	3	5								8
2014	3	5	19							27
2015	3	5	19	30						57
2016	3	5	18	29	47					102

TABLE IV.G.7–3—ESTIMATED WORST CASE IMPACT OF WEIGHT ON CALCULATED FATALITIES BY CALENDAR YEAR—Continued

[Additional fatalities by model year and calendar year]

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	MY 2017	MY 2018	MY 2019	MY 2020	Totals
2017	3	5	17	28	46	47	....	....	....	146
2018	3	5	16	27	44	46	47	....	....	187
2019	3	4	16	26	42	44	46	47	....	226
2020	2	4	15	24	40	42	44	46	47	264

NOTE—all estimates in this table are worst-case. Actual values could be significantly less.

The following table is based on the worst-case scenario estimate for fatalities.

TABLE IV.G.7–4—CALCULATED WORST CASE WEIGHT SAFETY IMPACTS ON SOCIETAL COSTS FOR THE PROPOSED STANDARDS OVER THE LIFETIME OF THE VEHICLES PRODUCED IN EACH MODEL YEAR, ESTIMATED FATALITIES AND ASSUMED INJURIES

[$ millions]

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
Undiscounted:						
Passenger Cars	$406	$686	$2,058	$3,136	$5,040	$11,326
Light Trucks	70	70	658	1,246	1,848	3,892
Combined	476	756	2,716	4,382	6,888	15,218
Discounted 3%:						
Passenger Cars	337	570	1,709	2,604	4,185	9,405
Light Trucks	56	56	528	1,000	1,482	3,122
Combined	393	626	2,237	3,604	5,668	12,527
Discounted 7%:						
Passenger Cars	272	460	1,379	2,101	3,377	7,588
Light Trucks	44	44	415	785	1,165	2,453
Combined	316	504	1,794	2,886	4,542	10,042

NOTE—all estimates in this table are worst-case. Actual values could be significantly less.
Discount factors: passenger cars, 3% = 0.8304, 7% = 0.67; light trucks, 3% = 0.8022, 7% = 0.6303.

8. What Other Impacts (Quantitative and Unquantifiable) Will These Proposed Standards Have?

In addition to the quantified benefits and costs of fuel economy standards, the standards we are proposing will have other impacts that we have not quantified in monetary terms. The decision on whether or not to quantify a particular impact depends on several considerations:

- Does the impact exist, and can the magnitude of the impact reasonably be attributed to the outcome of this rulemaking?
- Would quantification help NHTSA and the public evaluate standards that may be set in rulemaking?
- Is the impact readily quantifiable in monetary terms? Do we know how to quantify a particular impact?
- If quantified, would the monetary impact likely be material?
- Can a quantification be derived with a sufficiently narrow range of uncertainty so that the estimate is useful?

NHTSA expects that this rulemaking will have a number of genuine, material impacts that have not been quantified due to one or more of the considerations listed above. In some cases, further research may yield estimates for future rulemakings.

Technology Forcing

The proposed rule will improve the fuel economy of the U.S. new vehicle fleet, but it will also increase the cost (and presumably, the price) of new passenger cars and light trucks built during MYs 2012–2016. We anticipate that the cost, scope, and duration of this rule, as well as the steadily rising standards it requires, will cause automakers and suppliers to devote increased attention to methods of improving vehicle fuel economy.

This increased attention will stimulate additional research and engineering, and we anticipate that, over time, innovative approaches to reducing the fuel consumption of light duty vehicles will emerge. These innovative approaches may reduce the cost of the proposed rule in its later years, and also increase the set of feasible technologies in future years.

We have attempted to estimate the effect of learning on known technologies within the period of the proposed rulemaking. We have not attempted to estimate the extent to which not-yet-invented technologies will appear, either within the time period of the current rulemaking or that might be available after MY 2016.

Effects on Vehicle Maintenance, Operation, and Insurance Costs

Any action that increases the cost of new vehicles will subsequently make such vehicles more costly to maintain, repair, and insure. In general, this effect can be expected to be a positive linear function of vehicle costs. The proposed rulemaking, however, raises vehicle costs by only a few percent at most, and hence the change in maintenance and operation costs, distributed over the expected life of regulated vehicles and discounted back to the present, is probably de minimus in terms of the full analysis.

One of the common consequences of using more complex or innovative technologies is a decline in vehicle reliability and an increase in maintenance costs, borne, in part, by the manufacturer (through warranty costs, which are included in the indirect costs of production) and, in part by the vehicle owner. NHTSA believes that this effect is difficult to quantify, but likely to be de minimus as well.

Effects on Vehicle Miles Traveled (VMT)

While NHTSA has estimated the impact of the rebound effect on VMT, we have not estimated how a change in vehicle sales could impact VMT. Since the value of the fuel savings to consumers outweighs the technology costs, new vehicle sales are predicted to increase. A change in vehicle sales will have complicated and a hard-to-quantify effect on vehicle miles traveled given the rebound effect, the trade-in of older vehicles, etc. In general, overall VMT should not be significantly affected.

Effect on Composition of Passenger Car and Light Truck Sales

In addition, manufacturers, to the extent that they pass on costs to customers, may distribute these costs across their motor vehicle fleets in ways that affect the composition of sales by model. To the extent that changes in the composition of sales occur, this could affect fuel savings to some degree. However, NHTSA's view is that the scope for compositional effects is relatively small, since the total effect of the regulation itself will be to increase costs by only a few percent. Compositional effects might be important with respect to compliance costs for individual manufacturers, but are unlikely to be material for the rule as a whole.

NHTSA is continuing to study methods of estimating compositional effects and may be able to develop methods for use in future rulemakings.

Effects on the Used Vehicle Market

The effect of this rule on the use and scrappage of older vehicles will be related to its effects on new vehicle prices, the fuel efficiency of new vehicle models, and the total sales of new vehicles. If the value of fuel savings resulting from improved fuel efficiency to the typical potential buyer of a new vehicle outweighs the average increase in new models' prices, sales of new vehicles will rise, while scrappage rates of used vehicles will increase slightly. This will cause the ''turnover'' of the vehicle fleet—that is, the retirement of used vehicles and their replacement by new models—to accelerate slightly, thus accentuating the anticipated effect of the rule on fleet-wide fuel consumption and CO_2 emissions. However, if potential buyers value future fuel savings resulting from the increased fuel efficiency of new models at less than the increase in their average selling price, sales of new vehicles will decline, as will the rate at which used vehicles are retired from service. This effect will slow the replacement of used vehicles by new models, and thus partly offset the anticipated effects of the proposed rules on fuel use and emissions.

Because the agencies are uncertain about how the value of projected fuel savings from the proposed rules to potential buyers will compare to their estimates of increases in new vehicle prices, we have not attempted to estimate explicitly the effects of the rule on scrappage of older vehicles and the turnover of the vehicle fleet. We seek comment on the methods that might be used to estimate the effect of the proposed rule on the scrappage and use of older vehicles as part of the analysis to be conducted for the final rule.

Impacts of Changing Fuel Composition on Costs, Benefits, and Emissions

EPAct, as amended by EISA, creates a Renewable Fuels Standard that sets targets for greatly increased usage of renewable fuels over the next decade. The law requires fixed volumes of renewable fuels to be used—volumes that are not linked to actual usage of transportation fuels.

Ethanol and biodiesel (in the required volumes) may increase the cost of gasoline and diesel depending on crude oil prices and tax subsidies. The extra cost of renewable fuels will be borne through a cross-subsidy: The price of every gallon of gasoline will rise sufficiently to pay for the extra cost of renewable fuels. The proposed CAFE rule, by reducing total fuel consumption, would tend to increase any necessary cross-subsidy per gallon of fuel, and hence raise the market price of transportation fuels, while there would be no change in the volume or cost of renewable fuels used.

Some of these effects are indirectly incorporated in NHTSA's analysis of the proposed CAFE rule because they are directly incorporated in EIA's projections of future gasoline and diesel prices in the *Annual Energy Outlook*, which incorporates in its baseline both a Renewable Fuel Standard and an increasing CAFE standard.

The net effect of incorporating an RFS then might be to slightly reduce the benefits of the rule because affected vehicles might be driven slightly less, and because they emit slightly fewer greenhouse gas emissions per gallon. In addition there might be deadweight losses from the induced reduction in VMT. All of these effects are difficult to estimate, because of uncertainty in future crude oil prices, uncertainty in future tax policy, and uncertainty about how petroleum marketers will actually comply with the RFS, but they are likely to be small, because the cumulative deviation from baseline fuel consumption induced by the proposed rule will itself be small.

Macroeconomic Impacts of This Rule

The proposed rule will have a number of consequences that may have short-run and longer-run macroeconomic effects. It is important to recognize, however, that these effects do *not* represent benefits in addition to those resulting directly from reduced fuel consumption and emissions. Instead, they represent the economic effects that occur as these direct impacts filter through the interconnected markets comprising the U.S. economy.

- Increasing the cost and quality (in the form of better fuel economy) of new light duty vehicles will have ripple effects through the rest of the economy. Depending on the assumptions made, the rule could generate very small increases or declines in output.
- Reducing consumption of imported petroleum should induce an increase in long-run output.
- Decreasing the world price of oil should induce an increase in long-run output.

NHTSA has not studied the macroeconomic effects of the proposal, however a discussion of the economy-wide impacts of this rule conducted by EPA is included in Section III.H.5. Although economy-wide models do not capture all of the potential impacts of this rule (*e.g.*, improvements in product quality), these models can provide valuable insights on how this proposal would impact the U.S. economy in ways that extend beyond the transportation sector.

Military Expenditures

This analysis contains quantified estimates for the social cost of petroleum imports based on monopsony effects and the risk of oil market disruption. We have not included estimates of the cost of military expenditures associated with petroleum imports.

H. Vehicle Classification

Vehicle classification, for purposes of the CAFE program, refers to whether NHTSA considers a vehicle to be a passenger automobile or a light truck, and thus subject to either the passenger automobile or the light truck standards. As NHTSA explained in the MY 2011 rulemaking, EPCA categorizes some light 4-wheeled vehicles as passenger automobiles (cars) and the balance as non-passenger automobiles (light trucks). EPCA defines passenger automobiles as any automobile (other than an automobile capable of off-highway operation) which NHTSA decides by rule is manufactured primarily for use in the transportation of not more than 10 individuals. EPCA 501(2), 89 Stat. 901. NHTSA created regulatory definitions for passenger automobiles and light trucks, found at 49 CFR part 523, to guide the agency and manufacturers in classifying vehicles.

Under EPCA, there are two general groups of automobiles that qualify as non-passenger automobiles or light trucks: (1) Those defined by NHTSA in its regulations as other than passenger automobiles due to their having design features that indicate they were not manufactured "primarily" for transporting up to ten individuals; and (2) those expressly excluded from the passenger category by statute due to their capability for off-highway operation, regardless of whether they might have been manufactured primarily for passenger transportation. NHTSA's classification rule directly tracks those two broad groups of non-passenger automobiles in subsections (a) and (b), respectively, of 49 CFR 523.5.

For the purpose of this NPRM for the MYs 2012–2016 standards, EPA agreed to use NHTSA's regulatory definitions for determining which vehicles would be subject to which CO_2 standards.

In the MY 2011 rulemaking, NHTSA took a fresh look at the regulatory definitions in light of several factors and developments: its desire to ensure clarity in how vehicles are classified, the passage of EISA, and the Ninth Circuit's decision in *CBD* v. *NHTSA*.[620] NHTSA explained the origin of the current definitions of passenger automobiles and light trucks by tracing them back through the history of the CAFE program, and did not propose to change the definitions themselves at that time, because the agency concluded that the definitions were largely consistent with Congress' intent in separating passenger automobiles and light trucks, but also in part because the agency tentatively concluded that doing so would not lead to increased fuel savings. However, the agency tightened the definitions in § 523.5 to ensure that only vehicles that actually have 4WD will be classified as off-highway vehicles by reason of having 4WD (to prevent 2WD SUVs that also come in a 4WD "version" from qualifying automatically as "off-road capable" simply by reason of the existence of the 4WD version). It also took this action to ensure that manufacturers may only use the "greater cargo-carrying capacity" criterion of 523.5(a)(4) for cargo van-type vehicles, rather than for SUVs with removable second-row seats unless they truly have greater cargo-carrying than passenger-carrying capacity "as sold" to the first retail purchaser. NHTSA concluded that these changes increased clarity, were consistent with EPCA and EISA, and responded to the Ninth Circuit's decision with regard to vehicle classification.

However, manufacturers currently have an incentive to classify vehicles as light trucks because, generally speaking, the fuel economy target for light trucks with a given footprint is less stringent than the target for passenger cars with the same footprint. This is due to the fact that the curves are based on actual fuel economy capabilities of the vehicles to which they apply. Because of characteristics like 4WD, towing and hauling capacity, and heavy weight, the vehicles in the current light truck fleet are generally less capable of achieving higher fuel economy levels as compared to the vehicles in the passenger car fleet. 2WD SUVs are the vehicles that could be most readily redesigned so that they can be "moved" from the passenger car to the light truck fleet. A manufacturer could do this by adding a third row of seats, for example, or boosting GVWR over 6,000 lbs for a 2WD SUV that already meets the ground clearance requirements for "off-road capability." A change like this may only be possible during a vehicle redesign, but since vehicles are redesigned, on average, every 5 years, at least some manufacturers may make such changes before or during the model years covered by this rulemaking.

In looking forward to model years beyond 2011 and considering how CAFE should operate in the context of the National Program and previously-received comments as requested by President Obama, NHTSA seeks comment on the following potential changes to NHTSA's vehicle classification system. We request comment also on whether, if any of the changes were to be adopted, they should be applied to any of the model years covered by this rulemaking or whether, due to lead time concerns, they should apply only to MY 2017 and thereafter.

Reclassifying Minivans and other "3-row" light trucks as passenger cars (i.e., removing 49 CFR 523.5(a)(5)):

NHTSA has received repeated comments over the course of the last several rulemakings from environmental and consumer groups regarding the classification of minivans as light trucks instead of as passenger cars. Commenters have argued that because minivans generally have three rows of seats, are built on unibody chassis, and are used primarily for transporting passengers, they should be classified as passenger cars. NHTSA did not accept these arguments in the MY 2011 final rule, due to concerns that moving minivans to the passenger car fleet would lower the fuel economy targets for those passenger cars having essentially the same footprint as the minivans, and thus lower the overall fuel average fuel economy level that the manufacturers would need to meet. However, due to the new methodology for setting standards, the as-yet-unknown fuel-economy capabilities of future minivans and 3-row 2WD SUVs, and the unknown state of the vehicle market (particularly for MYs 2017 and beyond), NHTSA can no longer say with certainty that moving these vehicles could negatively affect potential stringency levels for either passenger cars or light trucks.

Although such a change would not be made applicable during the MY 2012–2016 time frame, we seek comment on why NHTSA should or should not consider, as part of this rulemaking, reclassifying minivans (and other current light trucks that qualify as such because they have three rows of designated seating positions as standard equipment) for MYs 2017 and after.

Classifying "like" vehicles together:

Many commenters objected in the rulemaking for the MY 2011 standards to NHTSA's regulatory separation of "like" vehicles. Industry commenters argued that it was technologically inappropriate for NHTSA to place 4WD and 2WD versions of the same SUV in separate classes. They argued that the vehicles are the same, except for their drivetrain features, thus giving them similar fuel economy improvement potential. They further argued that all SUVs should be classified as light trucks. Environmental and consumer group commenters, on the other hand, argued that 4WD SUVs and 2WD SUVs that are "off-highway capable" by virtue of a GVWR above 6,000 pounds should be classified as passenger cars, since they are primarily used to transport passengers. In the MY 2011 rulemaking, NHTSA rejected both of these sets of arguments. NHTSA concluded that 2WD SUVs that were neither "off-highway capable" nor possessed "truck-like" functional characteristics were appropriately classified as passenger cars. At the same time, NHTSA also

[620] 538 F.3d 1172 (9th Cir. 2008).

concluded that because Congress explicitly designated vehicles with GVWRs over 6,000 pounds as ''off-highway capable'' (if they meet the ground clearance requirements established by the agency), NHTSA did not have authority to move these vehicles to the passenger car fleet.

With regard to the first argument, that ''like'' vehicles should be classified similarly (*i.e.*, that 2WD SUVs should be classified as light trucks because, besides their drivetrain, they are ''like'' the 4WD version that qualifies as a light truck), NHTSA continues to believe that 2WD SUVs that do not meet any part of the existing regulatory definition for light trucks should be classified as passenger cars. However, NHTSA recognizes the additional point raised by industry commenters in the MY 2011 rulemaking that manufacturers may respond to this tighter classification by ceasing to build 2WD versions of SUVs, which could reduce fuel savings. In response to that point, NHTSA stated in the MY 2011 final rule that it expects that manufacturer decisions about whether to continue building 2WD SUVs will be driven in much greater measure by consumer demand than by NHTSA's regulatory definitions. If it appears, in the course of the next several model years, that manufacturers are indeed responding to the CAFE regulatory definitions in a way that reduces overall fuel savings from expected levels, it may be appropriate for NHTSA to review this question again. NHTSA seeks comment on how the agency might go about reviewing this question as more information about manufacturer behavior is accumulated.

With regard to the second argument, that NHTSA should move vehicles that qualify as ''off-highway capable'' from the light truck to the passenger car fleet because they are primarily used to transport passengers, NHTSA reiterates that EPCA is clear that certain vehicles are non-passenger automobiles (*i.e.*, light trucks) because of their off-highway capabilities, regardless of how they may be used day-to-day.

However, NHTSA could explore additional approaches, although not all could be pursued on current law. Possible alternative legal regimes might include: (a) classifying vehicles as passenger cars or light trucks based on use alone (rather than characteristics); (b) removing the regulatory distinction altogether and setting standards for the entire fleet of vehicles instead of for separate passenger car and light truck fleets; or (c) dividing the fleet into multiple categories more consistent with current vehicle fleets (*i.e.*, sedans, minivans, SUVs, pickup trucks, etc.). NHTSA seeks comment on whether and why it should pursue any of these courses of action.

I. Compliance and Enforcement

1. Overview

NHTSA's CAFE enforcement program and the compliance flexibilities available to manufacturers are largely established by statute—unlike the CAA, EPCA and EISA are very prescriptive and leave the agency limited authority to increase the flexibilities available to manufacturers. This was intentional, however. Congress balanced the energy saving purposes of the statute against the benefits of the various flexibilities and incentives it provided and placed precise limits on those flexibilities and incentives. For example, while the Department sought authority for unlimited transfer of credits between a manufacturer's car and light truck fleets, Congress limited the extent to which a manufacturer could raise its average fuel economy for one of its classes of vehicles through credit transfer in lieu of adding more fuel saving technologies. It did not want these provisions to slow progress toward achieving greater energy conservation or other policy goals. In keeping with EPCA's focus on energy conservation, NHTSA has done its best, for example, in crafting the credit transfer and trading regulations authorized by EISA, to ensure that total fuel savings are preserved when manufacturers exercise their compliance flexibilities.

The following sections explain how NHTSA determines whether manufacturers are in compliance with the CAFE standards for each model year, and how manufacturers may address potential non-compliance situations through the use of compliance flexibilities or fine payment.

2. How Does NHTSA Determine Compliance?

a. Manufacturer Submission of Data and CAFE Testing by EPA

NHTSA begins to determine CAFE compliance by considering pre- and mid-model year reports submitted by manufacturers pursuant to 49 CFR part 537, Automotive Fuel Economy Reports.[621] The reports for the current model year are submitted to NHTSA every December and July. As of the time of this NPRM, NHTSA has received mid-model year reports from manufacturers for MY 2009, and anticipates receiving pre-model year reports for MY 2010 at the end of this year. Although the reports are used for NHTSA's reference only, they help the agency, and the manufacturers who prepare them, anticipate potential compliance issues as early as possible, and help manufacturers plan compliance strategies. Currently, NHTSA receives these reports in paper form. In order to facilitate submission by manufacturers and consistent with the President's electronic government initiatives, NHTSA proposes to amend Part 537 to allow for electronic submission of the pre- and mid-model year CAFE reports.

NHTSA makes its ultimate determination of manufacturers' CAFE compliance upon receiving EPA's official certified and reported CAFE data. The EPA certified data is based on vehicle testing and on final model year data submitted by manufacturers to EPA pursuant to 40 CFR 600.512, Model Year Report, no later than 90 days after the end of the calendar year. Pursuant to 49 U.S.C. 32904(e), EPA is responsible for calculating automobile manufacturers' CAFE values so that NHTSA can determine compliance with the CAFE standards. In measuring the fuel economy of passenger cars, EPA is required by EPCA[622] to use the EPA test procedures in place as of 1975 (or procedures that give comparable results), which are the city and highway tests of today, with adjustments for procedural changes that have occurred since 1975. EPA uses similar procedures for light trucks, although, as noted above, EPCA does not require it to do so. One notable shortcoming of the 1975 test procedure is that it does not include a provision for air conditioner usage during the test cycle. As discussed in Section III above of the preamble, air conditioner usage increases the load on a vehicle's engine, reducing fuel efficiency and increasing CO_2 emissions. Since the air conditioner is not turned on during testing, equipping a vehicle model with a relatively inefficient air conditioner will not adversely affect that model's measured fuel economy, while quipping a vehicle model with a relatively efficient air conditioner will not raise that model's measured fuel economy. The fuel economy test procedures for light trucks could be amended through rulemaking to provide for air conditioner operation during testing and to take other steps for improving the accuracy and representativeness of fuel economy measurements. Comment is sought in section I.D.2 regarding implementing such amendments beginning in MY 2017 and also on the more immediate

[621] 49 CFR Part 537 is authorized by 49 U.S.C. 32907.

[622] 49 U.S.C. 32904(c).

interim step of providing credits under 49 U.S.C. 32904(c) for light trucks equipped with relatively efficient air conditioners for MYs 2012–2016. Modernizing the passenger car test procedures as well would not be possible under EPCA as currently written.

b. NHTSA Then Analyzes EPA–Certified CAFE Values for Compliance

Determining CAFE compliance is fairly straightforward. After testing, EPA verifies the data submitted by manufacturers and issues final CAFE reports to manufacturers and to NHTSA between April and October of each year (for the previous model year). NHTSA then identifies the manufacturers' compliance categories (fleets) that do not meet the applicable CAFE fleet standards.

To determine if manufacturers have earned credits that would offset those shortfalls, NHTSA calculates a cumulative credit status for each of a manufacturer's vehicle compliance categories according to 49 U.S.C. 32903. If a manufacturer's compliance category exceeds the applicable fuel economy standard, NHTSA adds credits to the account for that compliance category. If a manufacturer's vehicles in a particular compliance category fall below the standard fuel economy value, NHTSA will provide written notification to the manufacturer that it has not met a particular fleet standard. The manufacturer will be required to confirm the shortfall and must either: Submit a plan indicating it will allocate existing credits, and/or for MY 2011 and later, how it will earn, transfer and/or acquire credits; or pay the appropriate civil penalty. The manufacturer must submit a plan or payment within 60 days of receiving agency notification. The amount of credits are determined by multiplying the number of tenths of a mpg by which a manufacturer exceeds, or falls short of, a standard for a particular category of automobiles by the total volume of automobiles of that category manufactured by the manufacturer for a given model year. Credits used to offset shortfalls are subject to the three and five year limitations as described in 49 U.S.C. 32903(a). Transferred credits are subject to the limitations specified by 49 U.S.C. 32903(g)(3). The value of each credit, when used for compliance, received via trade or transfer is adjusted, using the adjustment factor described in 49 CFR part 536.4, pursuant to 49 U.S.C. 32903(f)(1). Credit allocation plans received from the manufacturer will be reviewed and approved by NHTSA. NHTSA will approve a credit allocation plan unless it finds 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. If a plan is rejected, NHTSA will notify the respective manufacturer and request a revised plan or payment of the appropriate fine.

In the event that a manufacturer does not comply with a CAFE standard, even after the consideration of credits, EPCA provides for the assessing of civil penalties. The Act specifies a precise formula for determining the amount of civil penalties for such a noncompliance. The penalty, as adjusted for inflation by law, is $5.50 for each tenth of a mpg that a manufacturer's average fuel economy falls short of the standard for a given model year multiplied by the total volume of those vehicles in the affected fleet (*i.e.,* import or domestic passenger car, or light truck), manufactured for that model year. The amount of the penalty may not be reduced except under the unusual or extreme circumstances specified in the statute. All penalties are paid to the U.S. Treasury and not to NHTSA itself.

Unlike the National Traffic and Motor Vehicle Safety Act, EPCA does not provide for recall and remedy in the event of a noncompliance. The presence of recall and remedy provisions [623] in the Safety Act and their absence in EPCA is believed to arise from the difference in the application of the safety standards and CAFE standards. A safety standard applies to individual vehicles; that is, each vehicle must possess the requisite equipment or feature which must provide the requisite type and level of performance. If a vehicle does not, it is noncompliant. Typically, a vehicle does not entirely lack an item or equipment or feature. Instead, the equipment or features fails to perform adequately. Recalling the vehicle to repair or replace the noncompliant equipment or feature can usually be readily accomplished.

In contrast, a CAFE standard applies to a manufacturer's entire fleet for a model year. It does not require that a particular individual vehicle be equipped with any particular equipment or feature or meet a particular level of fuel economy. It does require that the manufacturer's fleet, as a whole, comply. Further, although under the attribute-based approach to setting CAFE standards fuel economy targets are established for individual vehicles based on their footprints, the vehicles are not required to comply with those targets on a model-by-model or vehicle-by-vehicle basis. However, as a practical matter, if a manufacturer chooses to design some vehicles so they fall below their target levels of fuel economy, it will need to design other vehicles so they exceed their targets if the manufacturer's overall fleet average is to meet the applicable standard.

Thus, under EPCA, there is no such thing as a noncompliant vehicle, only a noncompliant fleet. No particular vehicle in a noncompliant fleet is any more, or less, noncompliant than any other vehicle in the fleet.

After enforcement letters are sent, NHTSA continues to monitor receipt of credit allocation plans or civil penalty payments that are due within 60 days from the date of receipt of the letter by the vehicle manufacturer, and takes further action if the manufacturer is delinquent in responding.

3. What Compliance Flexibilities Are Available Under the CAFE Program and How Do Manufacturers Use Them?

There are three basic flexibilities permitted by EPCA/EISA that manufacturers can use to achieve compliance with CAFE standards beyond applying fuel economy-improving technologies: (1) Building dual- and alternative-fueled vehicles; (2) banking, trading, and transferring credits earned for exceeding fuel economy standards; and (3) paying fines. We note again that while these flexibility mechanisms will reduce compliance costs to some degree for most manufacturers, 49 U.S.C. 32902(h) expressly prohibits NHTSA from considering the availability of credits (either for building dual- or alternative-fueled vehicles or from accumulated transfers or trades) in determining the level of the standards. Thus, NHTSA may not raise CAFE standards because manufacturers have enough credits to meet higher standards. This is an important difference from EPA's authority under the CAA, which does not contain such a restriction, and which allows EPA to set higher standards as a result.

a. Dual- and Alternative-Fueled Vehicles

As discussed at length in prior rulemakings, EPCA encourages manufacturers to build alternative-fueled and dual- (or flexible-) fueled vehicles by providing special fuel economy calculations for "dedicated" (that is, 100 percent) alternative fueled vehicles and "dual-fueled" (that is,

[623] 49 U.S.C. 30120, Remedies for defects and noncompliance.

capable of running on either the alternative fuel or gasoline) vehicles. The fuel economy of a dedicated alternative fuel vehicle is determined by dividing its fuel economy in equivalent miles per gallon of gasoline or diesel fuel by 0.15.[624] Thus, a 15 mpg dedicated alternative fuel vehicle would be rated as 100 mpg. For dual-fueled vehicles, the rating is the average of the fuel economy on gasoline or diesel and the fuel economy on the alternative fuel vehicle divided by 0.15.[625]

For example, this calculation procedure turns a dual-fueled vehicle that averages 25 mpg on gasoline or diesel into a 40 mpg vehicle for CAFE purposes. This assumes that (1) the vehicle operates on gasoline or diesel 50 percent of the time and on alternative fuel 50 percent of the time; (2) fuel economy while operating on alternative fuel is 15 mpg (15/.15 = 100 mpg); and (3) fuel economy while operating on gas or diesel is 25 mpg. Thus:

CAFE FE = 1/{0.5/(mpg gas) + 0.5/(mpg alt fuel)} = 1/{0.5/25 + 0.5/100) = 40 mpg

In the case of natural gas, the calculation is performed in a similar manner. The fuel economy is the weighted average while operating on natural gas and operating on gas or diesel. The statute specifies that 100 cubic feet (ft^3) of natural gas is equivalent to 0.823 gallons of gasoline. The gallon equivalency of natural gas is equal to 0.15 (as for other alternative fuels).[626] Thus, if a vehicle averages 25 miles per 100 ft^3 of natural gas, then:

CAFE FE = (25/100) * (100/.823)* (1/0.15) = 203 mpg

Congress extended the incentive in EISA for dual-fueled automobiles through MY 2019, but provided for its phase out between MYs 2015 and 2019.[627] The maximum fuel economy increase which may be attributed to the incentive is thus as follows:

Model year	mpg increase
MYs 1993–2014	1.2
MY 2015	1.0
MY 2016	0.8
MY 2017	0.6
MY 2018	0.4
MY 2019	0.2
After MY 2019	0

49 CFR part 538 implements the statutory alternative-fueled and dual-fueled automobile manufacturing incentive. NHTSA is proposing to update Part 538 as part of this NPRM to reflect the EISA changes, but to the extent that 49 U.S.C. 32906(a) differs from the current version of 49 CFR 538.9, the statute supersedes the regulation, and regulated parties may rely on the text of the statute.

A major difference between EPA's statutory authority and NHTSA's statutory authority is that the CAA contains no specific prescriptions with regard to credits for dual- and alternative-fueled vehicles comparable to those found in EPCA/EISA. As an exercise of that authority, and as discussed in Section III above, EPA is offering similar credits for dual- and alternative-fueled vehicles through MY 2015 for compliance with its CO_2 standards, but for MY 2016 and beyond EPA will establish CO_2 emission levels for alternative fuel vehicles based on measurement of actual CO_2 emissions during testing, plus a manufacturer demonstration that the vehicles are actually being run on the alternative fuel. NHTSA has no such authority under EPCA/EISA to require that vehicles manufactured for the purpose of obtaining the credit actually be run on the alternative fuel, but requests comment on whether it should seek legislative changes to revise its authority to address this issue.

b. Credit Trading and Transfer

In the MY 2011 final rule, NHTSA established Part 536 for credit trading and transfer. Part 536 implements the provisions in EISA authorizing NHTSA to establish by regulation a credit trading program and directing it to establish by regulation a credit transfer program.[628] Since its enactment, EPCA has permitted manufacturers to earn credits for exceeding the standards and to carry those credits backward or forward. EISA extended the ''carry-forward'' period from three to five model years, and left the ''carry-back'' period at three model years. Under Part 536, credit holders (including, but not limited to, manufacturers) will have credit accounts with NHTSA, and will be able to hold credits, use them to achieve compliance with CAFE standards, transfer them between compliance categories, or trade them. A credit may also be cancelled before its expiry date, if the credit holder so chooses. Traded and transferred credits are subject to an ''adjustment factor'' to ensure total oil savings are preserved, as required by EISA. EISA also prohibits credits earned before MY 2011 from being transferred, so NHTSA has developed several regulatory restrictions on trading and transferring to facilitate Congress' intent in this regard. EISA also establishes a ''cap'' for the maximum increase in any compliance category attributable to transferred credits: for MYs 2011–2013, transferred credits can only be used to increase a manufacturer's CAFE level in a given compliance category by 1.0 mpg; for MYs 2014–2017, by 1.5 mpg; and for MYs 2018 and beyond, by 2.0 mpg.

NHTSA recognizes that some manufacturers may have to rely on credit transferring for compliance in MYs 2012–2017.[629] As a way to improve the transferring flexibility mechanism for manufacturers, NHTSA interprets EISA not to prohibit the banking of transferred credits for use in later model years. Thus, NHTSA believes that the language of EISA may be read to allow manufacturers to transfer credits from one fleet that has an excess number of credits, within the limits specified, to another fleet that may also have excess credits instead of transferring only to a fleet that has a credit shortfall. This would mean that a manufacturer could transfer a certain number of credits each year and bank them, and then the credits could be carried forward or back ''without limit'' later if and when a shortfall ever occurred in that same fleet. NHTSA bases this interpretation on 49 U.S.C. 32903(g)(2), which states that transferred credits ''are available to be used in the same model years that the manufacturer could have applied such credits under subsections (a), (b), (d), and (e), as well as for the model year in which the manufacturer earned such credits.'' The EISA limitation applies only to the application of such credits for compliance in particular model years, and not their transfer *per se.* If transferred credits have the same lifespan and may be used in carry-back and carry-forward plans, it seems reasonable that they should be allowed to be stored in any fleet, rather than only in the fleet in which they were

[624] 49 U.S.C. 32905(a).

[625] 49 U.S.C. 32905(b)

[626] 49 U.S.C. 32905(c).

[627] 49 U.S.C. 32906(a). NHTSA notes that the incentive for dedicated alternative-fuel automobiles, automobiles that run exclusively on an alternative fuel, at 49 U.S.C. 32905(a), was not phased-out by EISA.

[628] Congress required that DOT establish a credit ''transferring'' regulation, to allow individual manufacturers to move credits from one of their fleets to another (*e.g.,* using a credit earned for exceeding the light truck standard for compliance with the domestic passenger car standard). Congress allowed DOT to establish a credit ''trading'' regulation, so that credits may be bought and sold between manufacturers and other parties.

[629] In contrast, manufacturers stated in comments in NHTSA's MY 2011 rulemaking that they did not anticipate a robust market for credit trading, due to competitive concerns. NHTSA does not yet know whether those concerns will continue to deter manufacturers from exercising the trading flexibility during MYs 2012–2016.

earned. Of course, manufacturers could not transfer and bank credits for purposes of achieving the minimum standard for domestically-manufactured passenger cars, as prohibited by 49 U.S.C. 32903(g)(4). Transferred and banked credits would additionally still be subject to the adjustment factor when actually used, which would help to ensure that total oil savings are preserved while still offering greater flexibility to manufacturers. This interpretation of EISA also helps NHTSA, to some extent, to harmonize better with EPA's CO_2 program, which allows unlimited banking and transfer of credits. NHTSA seeks comment on this interpretation of EISA.

c. Payment of Fines

If a manufacturer's average miles per gallon for a given compliance category (domestic passenger car, imported passenger car, light truck) falls below the applicable standard, and the manufacturer cannot make up the difference by using credits earned or acquired, the manufacturer is subject to penalties. The penalty, as mentioned, is $5.50 for each tenth of a mpg that a manufacturer's average fuel economy falls short of the standard for a given model year, multiplied by the total volume of those vehicles in the affected fleet, manufactured for that model year. NHTSA has collected $772,850,459.00 to date in CAFE penalties, the largest ever being paid by DaimlerChrysler for its MY 2006 import passenger car fleet, $30,257,920.00. For their MY 2007 fleets, five manufacturers paid CAFE fines for not meeting an applicable standard—Ferrari, Maserati, Mercedes-Benz, Porsche, and Volkswagen—for a total of $37,385,941.00

NHTSA recognizes that some manufacturers may use the option to pay fines as a CAFE compliance flexibility—presumably, when paying fines is deemed more cost-effective than applying additional fuel economy-improving technology, or when adding fuel economy-improving technology would fundamentally change the characteristics of the vehicle in ways that the manufacturer believes its target consumers would not accept. NHTSA has no authority under EPCA/EISA to prevent manufacturers from turning to fine-payment if they choose to do so. This is another important difference from EPA's authority under the CAA, which allows EPA to revoke a manufacturer's certificate of compliance that permits it to sell vehicles if EPA determines that the manufacturer is in non-compliance, and does not permit manufacturers to pay fines in lieu of compliance with applicable standards.

NHTSA has grappled repeatedly with the issue of whether fines are motivational for manufacturers, and whether raising fines would increase manufacturers' compliance with the standards. EPCA authorizes increasing the civil penalty very slightly up to $10.00, exclusive of inflationary adjustments, if NHTSA decides that the increase in the penalty "will result in, or substantially further, substantial energy conservation for automobiles in the model years in which the increased penalty may be imposed; and will not have a substantial deleterious impact on the economy of the United States, a State, or a region of a State." 49 U.S.C. 32912(c).

To support a decision that increasing the penalty would result in "substantial energy conservation" without having "a substantial deleterious impact on the economy," NHTSA would likely need to provide some reasonably certain quantitative estimates of the fuel that would be saved, and the impact on the economy, if the penalty were raised. Comments received on this issue in the past have not explained in clear quantitative terms what the benefits and drawbacks to raising the penalty might be. Additionally, it may be that the range of possible increase that the statute provides, *i.e.,* up to $10 per tenth of a mpg, is insufficient to result in substantial energy conservation, although changing this would require an amendment to the statute by Congress. While NHTSA continues to seek to gain information on this issue to inform a future rulemaking decision, we request that commenters wishing to address this issue please provide, as specifically as possible, estimates of how raising or not raising the penalty amount will or will not substantially raise energy conservation and impact the economy.

4. Other CAFE Enforcement Issues—Variations in Footprint

NHTSA has a standardized test procedure for determining vehicle footprint,[630] which is defined by regulation as follows:

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.[631]

"Track width," in turn, is defined as "the lateral distance between the centerlines of the base tires at ground, including the camber angle." [632] "Wheelbase" is defined as "the longitudinal distance between front and rear wheel centerlines." [633]

NHTSA began requiring manufacturers to submit this information as part of their pre-model year reports in MY 2008 for light trucks, and will require manufacturers to submit this information for passenger cars as well beginning in MY 2011. Manufacturers have submitted the required information for their light trucks, but NHTSA has identified several issues with regard to footprint measurement, that could affect how required fuel economy levels are calculated for a manufacturer. The paragraphs that follow explain NHTSA's views regarding these issues, and solicit public input on what NHTSA should do to address them in the future.

a. Variations in Track Width

By definition, wheelbase measurement should be very consistent from one vehicle to another of the same model. Track width, in contrast, may vary in two respects: Wheel offset,[634] and camber. Most current vehicles have wheels with positive offset, with technical specifications for offset typically expressed in millimeters. Additionally, for most vehicles, the camber angle of each of a vehicle's wheels is specified as a range, *i.e.,* front axle, left and right within minus 0.9 to plus 0.3 degree and rear axle, left and right within minus 0.9 to plus 0.1 degree. Given the small variations in offset and camber angle dimensions, the potential effects of components (wheels) and vehicle specifications (camber) within existing designs on vehicle footprints are considered insignificant.

However, NHTSA recognizes that manufacturers may change the specifications of and the equipment on vehicles, even those that are not redesigned or refreshed, during a model year and from year to year. There may be opportunity for manufacturers to change specifications for wheel offset and camber to increase a vehicle's track

[630] NHTSA TP–537–01, March 30, 2009. *Available at http://www.nhtsa.gov/portal/site/nhtsa/menuitem.b166d5602714f9a73baf3210dba046a0/,* scroll down to "537" (last accessed July 18, 2009).

[631] 49 CFR 523.2.

[632] *Id.*

[633] *Id.*

[634] Offset of a wheel is the distance from its hub mounting surface to the centerline of the wheel, *i.e.,* measured laterally inboard or outboard.

Zero offset—the hub mounting surface is even with the centerline of the wheel.

Positive offset—the hub mounting surface is outboard of the centerline of the wheel (toward street side).

Negative offset—the hub mounting surface is inboard of the centerline of the wheel (away from street side).

width and footprint, and thus decrease their required fuel economy level. NHTSA believes that this is likely easiest on vehicles that already have sufficient space to accommodate changes without accompanying changes to the body profile and/or suspension component locations.

There may be drawbacks to such a decision, however. Changing from positive offset wheels to wheels with zero or negative offset will move tires and wheels outward toward the fenders. Increasing the negative upper limit of camber will tilt the top of the tire and wheel inward and move the bottom outward, placing the upper portion of the rotating tires and wheels in closer proximity to suspension components. In addition, higher negative camber can adversely affect tire life and the on-road fuel economy of the vehicle. Furthermore, it is likely that most vehicle designs have already used the available space in wheel areas since, by doing so, the vehicle's handling performance is improved. Therefore, it seems unlikely that manufacturers will make significant changes to wheel offset and camber.

b. How Manufacturers Designate ''Base Tires'' and Wheels

According to the definition of ''track width'' in 49 CFR 523.2, manufacturers must determine track width when the vehicle is equipped with ''base tires.'' Section 523.2 defines ''base tire,'' in turn, as ''the tire specified as standard equipment by a manufacturer on each configuration of a model type.'' NHTSA did not define ''standard equipment.''

In their pre-model year reports required by 49 CFR part 537, manufacturers have the option of either (A) reporting a base tire for each model type, or (B) reporting a base tire for each vehicle configuration within a model type, which represents an additional level of specificity. If different vehicle configurations have different footprint values, then reporting the number of vehicles for each footprint will improve the accuracy of the required fuel economy level for the fleet, since the pre-model year report data is part of what manufacturers use to determine their CAFE obligations.

For example, assume a manufacturer's pre-model year report listed five vehicle configurations that comprise one model type. If the manufacturer provides only one vehicle configuration's front and rear track widths, wheelbase, footprint and base tire size to represent the model type, and the other vehicle configurations all have a different tire size specified as standard equipment, the footprint value represented by the manufacturer may not capture the full spectrum of footprint values for that model type. Similarly, the base tires of a model type may be mounted on two or more wheels with different offset dimensions for different vehicle configurations. Of course, if the footprint value for all vehicle configurations is essentially the same, there would be no need to report by vehicle configuration. However, if footprints are different—larger or smaller—reporting for each group with similar footprints or for each vehicle configuration would produce a more accurate result.

c. Vehicle ''Design'' Values Reported by Manufacturers

NHTSA understands that the track widths and wheelbase values and the calculated footprint calculated values, as provided in pre-model year reports, are based on vehicle designs. This can lead to inaccurate calculations of required fuel economy level. For example, if the values reported by manufacturers are within an expected range of values, but are skewed to the higher end of the ranges, the required fuel economy level for the fleet will be artificially lower, an inaccurate attribute based value. Likewise, it would be inaccurate for manufacturers to submit values on the lower end of the ranges, but would decrease the likelihood that measured values would be less than the values reported and reduce the likelihood of an agency inquiry. Since not every vehicle is identical, it is also probable that variations between vehicles exist that can affect track width, wheelbase and footprint. As with other self-certifications, each manufacturer must decide how it will report, by model type, vehicle configuration, or a combination, and whether the reported values have sufficient margin to account for variations.

To address this, the agency will be monitoring the track widths, wheelbases and footprints reported by manufacturers, and anticipates measuring vehicles to determine if the reported and measured values are consistent. We will look for year-to-year changes in the reported values. We can compare MY 2008 light truck information and MY 2010 passenger car information to the information reported in subsequent model years. Moreover, under 49 CFR 537.8, manufacturers may make separate reports to explain why changes have occurred or they may be contacted by the agency to explain them.

d. How Manufacturers Report This Information in their Pre-Model Year Reports

49 CFR 537.7(c) requires that manufacturers' pre-model year reports include ''model type and configuration fuel economy and technical information.'' The fuel economy of a ''model type'' is, for many manufacturers, comprised of a number of vehicle configurations. 49 CFR 537.4 states that ''model type'' and ''vehicle configuration'' are defined in 40 CFR part 600. Under that Part, ''model type'' includes engine, transmission, and drive configuration (2WD, 4WD, or all-wheel drive), while ''vehicle configuration'' includes those parameters plus test weight. Model type is important for calculating fuel economy in the new attribute-based system—the required fuel economy level for each of a manufacturer's fleets is calculated using the number of vehicles within each model type and the applicable fuel economy target for each model type.

In MY 2008 and 2009 pre-model year reports for light trucks, manufacturers have expressed information in different ways. Some manufacturers that have many vehicle configurations within a model type have included information for each vehicle configuration's track width, wheelbase and footprint. Other manufacturers reported vehicle configuration information per § 537.7(c)(4), but provided only model type track width, wheelbase and footprint information for subsections 537.7(c)(4)(xvi)(B)(3), (4) and (5). NHTSA believes that these manufacturers may have reported the information this way because the track widths, wheelbase and footprint are essentially the same for each vehicle configuration within each model type. A third group of manufacturers submitted model type information only, presumably because each model type contains only one vehicle configuration.

NHTSA does not believe that this variation in reporting methodology presents an inherent problem, as long as manufacturers follow the specifications in Part 537 for reporting format, and as long as pre-model year reports provide information that is accurate and represents each vehicle configuration within a model type. The report may, but need not, be similar to what manufacturers submit to EPA as their end-of-model year report. However, NHTSA seeks comment on any potential benefits or drawbacks to requiring a more standardized reporting methodology. If commenters recommend increasing standardization, NHTSA requests that they provide specific examples of what information should be required and how NHTSA should require it to be provided.

J. Other Near-Term Rulemakings Mandated by EISA

1. Commercial Medium- and Heavy-Duty On-Highway Vehicles and Work Trucks

EISA added a new provision to 49 U.S.C. 32902 requiring DOT, in consultation with DOE and EPA, to examine the fuel efficiency of commercial medium- and heavy-duty on-highway vehicles [635] and work trucks [636] and determine the appropriate test procedures and methodologies for measuring their fuel efficiency, as well as the appropriate metric for measuring and expressing their fuel efficiency performance and the range of factors that affect their fuel efficiency. Work on developing these standards is on-going.

2. Consumer Information

EISA also added a new provision to 49 U.S.C. 32908 requiring DOT, in consultation with DOE and EPA, to develop and implement by rule a program to require manufacturers to label new automobiles sold in the United States with:

(1) Information reflecting an automobile's performance on the basis of criteria that EPA shall develop, not later than 18 months after the date of the enactment of EISA, to reflect fuel economy and greenhouse gas and other emissions over the useful life of the automobile; and

(2) A rating system that would make it easy for consumers to compare the fuel economy and greenhouse gas and other emissions of automobiles at the point of purchase, including a designation of automobiles with the lowest greenhouse gas emissions over the useful life of the vehicles; and with the highest fuel economy.

DOT must also develop and implement by rule a program to require manufacturers to include in the owner's manual for vehicles capable of operating on alternative fuels information that describes that capability and the benefits of using alternative fuels, including the renewable nature and environmental benefits of using alternative fuels.

EISA further requires DOT, in consultation with DOE and EPA, to

- Develop and implement by rule a consumer education program to improve consumer understanding of automobile performance described [by the label to be developed] and to inform consumers of the benefits of using alternative fuel in automobiles and the location of stations with alternative fuel capacity;
- Establish a consumer education campaign on the fuel savings that would be recognized from the purchase of vehicles equipped with thermal management technologies, including energy efficient air conditioning systems and glass; and
- By rule require a label to be attached to the fuel compartment of vehicles capable of operating on alternative fuels, with the form of alternative fuel stated on the label.

49 U.S.C. 32908(g)(2) and (3). DOT has 42 months from the date of EISA's enactment (by the end of 2011) to issue final rules under this subsection. Work on developing these standards is also on-going.

Additionally, in preparation for this future rulemaking, NHTSA will consider appropriate metrics for presenting fuel economy-related information on labels. Based on the non-linear relationship between mpg and fuel costs as well as emissions, inclusion of the ''gallons per 100 miles'' metric on fuel economy labels may be appropriate going forward, although the mpg information is currently required by law. A cost/distance metric may also be useful, as could a CO_2e grams per mile metric to facilitate comparisons between conventional vehicles and alternative fuel vehicles and to incorporate information about air conditioning-related emissions. NHTSA seeks comment on these options.

K. Regulatory Notices and Analyses

1. Executive Order 12866 and DOT Regulatory Policies and Procedures

Executive Order 12866, ''Regulatory Planning and Review'' (58 FR 51735, Oct. 4, 1993), provides for making determinations whether a regulatory action is ''significant'' and therefore subject to OMB review and to the requirements of the Executive Order. The Order defines a ''significant regulatory action'' as one that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local or Tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

The rulemaking proposed in this NPRM will be economically significant if adopted. Accordingly, OMB reviewed it under Executive Order 12866. The rule, if adopted, would also be significant within the meaning of the Department of Transportation's Regulatory Policies and Procedures.

The benefits and costs of this proposal are described above. Because the proposed rule would, if adopted, be economically significant under both the Department of Transportation's procedures and OMB guidelines, the agency has prepared a Preliminary Regulatory Impact Analysis (PRIA) and placed it in the docket and on the agency's Web site. Further, pursuant to OMB Circular A–4, we have prepared a formal probabilistic uncertainty analysis for this proposal. The circular requires such an analysis for complex rules where there are large, multiple uncertainties whose analysis raises technical challenges or where effects cascade and where the impacts of the rule exceed $1 billion. This proposal meets these criteria on all counts.

2. National Environmental Policy Act

NHTSA has initiated the Environmental Impact Statement (EIS) process under the National Environmental Policy Act (NEPA), 42 U.S.C. 4321–4347, and implementing regulations issued by the Council on Environmental Quality (CEQ), 40 CFR part 1500, and NHTSA, 49 CFR part 520. On April 1, 2009, NHTSA published a notice of intent to prepare an EIS for this rulemaking and requested scoping comments. (74 FR 14857) The notice invites Federal, State, and local agencies, Indian tribes, and the public to participate in the scoping process and to help identify the environmental issues and reasonable alternatives to be examined in the EIS. The scoping notice also provides information about the proposed standards, the alternatives NHTSA expects to consider in its NEPA analysis, and the scoping process.

Concurrently with this NPRM, NHTSA is releasing a Draft Environmental Impact Statement (DEIS). NHTSA prepared the DEIS to analyze and disclose the potential

[635] Defined as an on-highway vehicle with a gross vehicle weight rating of 10,000 pounds or more.

[636] Defined as a vehicle that is both rated at between 8,500 and 10,000 pounds gross vehicle weight; and also is not a medium-duty passenger vehicle (as defined in 40 CFR 86.1803–01, as in effect on the date of EISA's enactment.

environmental impacts of the proposed MY 2012–2016 CAFE standards for the total fleet of passenger cars and light trucks and reasonable alternative standards for the NHTSA CAFE Program pursuant to the Council on Environmental Quality (CEQ) regulations implementing NEPA, DOT Order 5610.1C, and NHTSA regulations.[637] The DEIS compares the potential environmental impacts of alternative mile per gallon (mpg) levels that will be considered by NHTSA for the final rule. It also analyzes direct, indirect, and cumulative impacts and analyzes impacts in proportion to their significance.

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 were assessed qualitatively in the DEIS.

Throughout the DEIS, NHTSA has relied extensively on findings of the United Nations Intergovernmental Panel on Climate Change (IPCC), the U.S. Climate Change Science Program (CCSP), and EPA. Our discussion relies heavily on the most recent, thoroughly peer-reviewed, and credible assessments of global and U.S. climate change: the IPCC Fourth Assessment Report (*Climate Change 2007*), EPA's proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act and the accompanying Technical Support Document (TSD), and CCSP and National Science and Technology Council reports that include the *Scientific Assessment of the Effects of Global Change on the United States* and Synthesis and Assessment Products. The DEIS cites these sources and the studies they review frequently.

Because of the link between the transportation sector and GHG emissions, NHTSA recognizes the need to consider the possible impacts on climate and global climate change in the analysis of the effects of these fuel economy standards. NHTSA also recognizes the difficulties and uncertainties involved in such an impact analysis. Accordingly, consistent with CEQ regulations on addressing incomplete or unavailable information in environmental impact analyses, NHTSA has reviewed existing credible scientific evidence that is relevant to this analysis and summarized it in the DEIS. NHTSA has also employed and summarized the results of research models generally accepted in the scientific community.

Although the alternatives have the potential to decrease GHG emissions substantially, they do not prevent climate change, but only result in reductions in the anticipated increases in CO_2 concentrations, temperature, precipitation, and sea level. They would also, to a small degree, delay the point at which certain temperature increases and other physical effects stemming from increased GHG emissions would occur. As discussed below, NHTSA presumes that these reductions in climate effects will be reflected in reduced impacts on affected resources.

NHTSA consulted with various *Federal* agencies in the development of the DEIS, including EPA, Bureau of Land Management, Centers for Disease Control and Prevention, Minerals Management Service, National Park Service, U.S. Army Corps of Engineers, U.S. Forest Service, and Advisory Council on Historic Preservation. NHTSA is also exploring its obligations under Section 7 of the Endangered Species Act with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration Fisheries Service.

The main direct and indirect effects resulting from the different alternatives analyzed in the DEIS are as follows:

Fuel consumption: For passenger cars, fuel consumption under the No Action Alternative is 171 billion gallons in 2060. Fuel consumption ranges from 156.1 billion gallons under Alternative 2 (3-Percent Alternative) to 133.7 billion gallons under Alternative 9 (TCTB). Fuel consumption is 149.3 billion gallons under the Preferred Alternative. For light trucks, fuel consumption under the No Action Alternative is 105.4 billion gallons in 2060. Fuel consumption ranges from 97.1 billion gallons under Alternative 2 (3-Percent Alternative) to 83.8 billion gallons under Alternative 9 (TCTB). Fuel consumption is 92.2 billion gallons under the Preferred Alternative (Alternative 4).

Air quality: Emissions of criteria pollutants change very little between the No Action Alternative and Alternatives 2 through 4. In the case of particulate matter ($PM_{2.5}$), sulfur oxides (SO_X), nitrogen oxides (NO_X), and volatile organic compounds (VOCs), the No Action Alternative results in the highest emissions, and emissions generally decline as fuel economy standards increase across alternatives. There are some increases from Alternative 6 through Alternative 9, but emissions remain below the levels under the No Action Alternative. In the case of carbon monoxide (CO), emissions under Alternatives 2 through 4 are slightly higher than under the No Action Alternative. Emissions of CO decline as fuel economy standards increase across Alternatives 5 through 9.

The trend for toxic air pollutant emissions across the alternatives is mixed. Emissions of nearly all toxic air pollutants are highest under the No Action Alternative, except for those of acrolein, which increases with each successive alternative and are highest under Alternative 9. The acrolein emissions are an upper-bound estimate and actual emissions might be less. Emissions of acetaldehyde, benzene, and DPM in 2030 decrease with successive alternatives from Alternative 1 to Alternative 9. Emissions of 1,3-butadiene increase slightly from Alternative 3 (4-Percent Alternative) to Alternative 4 (Preferred), and emissions of formaldehyde increase slightly from Alternative 8 (7-Percent Alternative) to Alternative 9 (TCTB) in 2030.

The reductions in emissions are expected to lead to reductions in adverse health effects. There would be reductions in adverse health effects nationwide under Alternatives 2 (3-Percent Alternative) through 9 (TCTB) compared to the No Action Alternative. These reductions primarily reflect the projected $PM_{2.5}$ reductions, and secondarily the reductions in SO_2. The economic value of health impacts would vary proportionally with changes in health outcomes.

Climate: The DEIS uses a climate model to estimate the changes in CO_2 concentrations, global mean surface temperature, and changes in sea level for each alternative CAFE standard. NHTSA used the publicly available modeling software, Model for Assessment of Greenhouse Gas-induced Climate Change (MAGICC) version 5.3.v2 to estimate changes in key direct and indirect effects. The application of MAGICC version 5.3.v2 uses the emissions estimates for CO_2, CH_4, N_2O, CO, NO_X, SO_2, and VOCs from the Volpe model. A sensitivity analysis was completed to examine the relationship among selected CAFE alternatives and likely climate sensitivities, and the associated direct and indirect effects for each combination. These relationships can be used to infer the effect of emissions associated with the regulatory alternatives on direct and indirect climate effects.

[637] NEPA is codified at 42 U.S.C. 4321–4347. CEQ NEPA implementing regulations are codified at 40 Code of Federal Regulations (CFR) Parts 1500–1508. NHTSA NEPA implementing regulations are codified at 49 CFR Part 520.

For the analysis using MAGICC, NHTSA has assumed that global emissions consistent with the No Action Alternative (Alternative 1) follow the trajectory provided by the Representative Concentration Pathway (RCP) 4.5 MiniCAM (Mini Climate Assessment Model) reference scenario.[638] The SAP 2.1 global emissions scenarios were created as part of CCSP's effort to develop a set of long-term (2000 to 2100) global emissions scenarios that incorporate an update of economic and technology data and utilize improved scenario development tools compared to the IPCC *Special Report on Emissions Scenarios* (SRES) developed more than a decade ago.

The results rely primarily on the RCP 4.5 MiniCAM reference scenario to represent an emissions scenario, that is, future global emissions assuming no additional climate policy. Each alternative was simulated by calculating the difference in annual GHG emissions in relation to the No Action Alternative and subtracting this change from the RCP 4.5 MiniCAM reference scenario to generate modified global-scale emissions scenarios, which each show the effect of the various regulatory alternatives on the global emissions path.

To estimate changes in global precipitation, this EIS uses increases in global mean surface temperature combined with a scaling approach and coefficients from the IPCC Fourth Assessment Report.

For all of the climate change analysis, the approaches focus on marginal changes in emissions that affect climate. Thus, the approaches result in a reasonable characterization of climate change for a given set of emissions reductions, regardless of the underlying details associated with those emissions reductions. The climate sensitivity analysis provides a basis for determining climate responses to varying climate sensitivities under the No Action Alternative (Alternative 1) and the Preferred Alternative (Alternative 4). Some responses of the climate system are believed to be non-linear; by using a range of emissions cases and climate sensitivities, the effects of the alternatives in relation to different scenarios and sensitivities can be estimated.

GHG emissions: Although GHG emissions from new passenger cars and light trucks will continue to rise over 2012 through 2100 (absent other reduction efforts), the effect of the alternatives is to slow this increase by varying amounts. Emissions for the period range from 196,341 million metric tons of CO_2 ($MMTCO_2$) for the TCTB Alternative (Alternative 9) to 244,821 $MMTCO_2$ for the No Action Alternative (Alternative 1). Compared to the No Action Alternative, projections of emissions reductions over the period 2012 to 2100 due to the MY 2012–2016 CAFE standards range from 19,169 to 48,480 $MMTCO_2$. Compared to cumulative global emissions of 5,293,896 $MMTCO_2$ over this period (projected by the RCP 4.5 MiniCAM reference scenario), this rulemaking is expected to reduce global CO_2 emissions by about 0.4 to 0.9 percent.

To get a sense of the relative impact of these reductions, it can be helpful to consider the relative importance of emissions from passenger cars and light trucks as a whole and to compare them against emissions projections from the transportation sector. As mentioned earlier, U.S. passenger cars and light trucks currently account for significant CO_2 emissions in the United States. With the action alternatives reducing U.S. passenger car and light truck CO_2 emissions by 7.8 to 19.8 percent, the CAFE alternatives would have a noticeable impact on total U.S. CO_2 emissions. Compared to total U.S. CO_2 emissions in 2100 projected by the MiniCAM reference scenario of 7,886 $MMTCO_2$, the action alternatives would reduce annual U.S. CO_2 emissions by 3.5 to 8.9 percent in 2100.

CO_2 concentration, global mean surface temperature, sea-level rise, and precipitation: Estimated CO_2 concentrations for 2100 range from 778.4 ppm under the most stringent alternative (TCTB) to 783.0 ppm under the No Action Alternative. For 2030 and 2050, the range is even smaller. Because CO_2 concentration is the key driver of other climate effects (which in turn act as drivers on resource impacts), this leads to small differences in these effects. For the No Action alternative, the temperature increase from 1990 is 0.92 °C for 2030, 1.56 °C for 2050, and 3.14 °C for 2100. The differences among alternatives are small. For 2100, the reduction in temperature increase, in relation to the No Action Alternative, ranges from 0.007 °C to 0.018 °C. Given that all the action alternatives reduce temperature increases slightly in relation to the No Action Alternative, they also slightly reduce predicted increases in precipitation.

In summary, the impacts of the proposed action and alternatives on global mean surface temperature, precipitation, or sea-level rise are small in absolute terms. This is because the action alternatives have a small proportional change in the emissions trajectories in the RCP 4.5 MiniCAM reference scenario.[639] This is due primarily to the global and multi-sectoral nature of the climate change issues.

Under CEQ regulations, NHTSA must also analyze cumulative impacts, defined as ''the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions.'' 40 CFR 1508.7. Following is a description of the cumulative effects of the proposed action and alternatives on energy, air quality, and climate.

The methodology for evaluating cumulative effects includes the reasonably foreseeable future actions of projected average annual passenger-car and light-truck mpg estimates from 2016 through 2030 that differ from mpg estimates reflected in the analysis of the direct and indirect impacts of MY 2012 through MY 2016 fuel economy requirements under each of the action alternatives, assuming no further increases in average new passenger-car or light-truck mpg after 2016. The evaluation of cumulative effects projects ongoing gains in average new passenger-car and light-truck mpg consistent with further increases in CAFE standards to an EISA-mandated minimum level of 35 mpg combined for passenger cars and light trucks by the year 2020, along with AEO April 2009 (updated) Reference Case projections of annual percentage gains of 0.51 percent in passenger-car mpg and 0.86 percent in light-truck mpg through 2030.[640] AEO Reference Case

[638] The reference scenario for global emissions assumes the absence of significant global GHG control policies. It is based on the Climate Change Science Program's (CCSP) Synthesis and Assessment Product (SAP) 2.1 MiniCAM reference scenario, and has been revised by the Joint Global Change Research Institute to update emission estimates of non-CO_2 gases.

[639] These conclusions are not meant to be interpreted as expressing NHTSA's views that impacts on global mean surface temperature, precipitation, or sea-level rise are not areas of concern for policymakers. Under NEPA, the agency is obligated to discuss the environmental impact[s] of *the proposed action.* 42 U.S.C. 4332(2)(C)(i) (emphasis added). This analysis fulfills NHTSA's obligations in this regard.

[640] NHTSA considers these AEO projected mpg increases to be reasonably foreseeable future actions under NEPA because the AEO projections reflect future consumer and industry actions that result in ongoing mpg gains through 2030. The AEO projections of fuel economy gains beyond the EISA requirement of combined achieved 35 mpg by 2020 result from a future forecasted increase in consumer demand for fuel economy resulting from projected fuel price increases. Since the AEO forecasts do not extend beyond the year 2030, the mpg estimates for MY 2030 through MY 2060 remain constant.

projections are regarded as the official U.S. government energy projections by both the public and private sector.

The assumption that all action alternatives reach the EISA 35 mpg target by 2020, with mpg growth at the AEO forecast rate from 2020 to 2030, results in estimated cumulative impacts for Alternatives 2, 3, and 4 that are substantially equivalent, with any minor variation in cumulative impacts across these Alternatives due to the specific modeling assumptions used to ensure that each Alternative achieves at least 35 mpg by 2020. Therefore, the cumulative impacts analysis adds substantively to the analysis of direct and indirect impacts when comparing cumulative impacts between Alternatives 4 through 9, but not when comparing cumulative impacts between Alternatives 2 through 4. Another important difference in the methodology for evaluating cumulative effects is that the No Action Alternative (Alternative 1) also reflects the AEO Reference Case projected annual percentage gains of 0.51 percent in car mpg and 0.86 percent in light truck mpg for the period 2016 through 2030, whereas the direct and indirect impacts analysis assumed no increases in average new passenger-car or light-truck mpg after 2016 under any alternative, including the No Action Alternative. NHTSA also considered other reasonably foreseeable actions that would affect greenhouse gas emissions, such as regional, national, and international initiatives and programs to reduce GHG emissions.

Fuel consumption: The nine alternatives examined in the DEIS will result in different future levels of fuel use, total energy, and petroleum consumption, which will in turn have an impact on emissions of GHG and criteria air pollutants. For passenger cars, by 2060, fuel consumption reaches 160.4 billion gallons under the No Action Alternative (Alternative 1). Consumption falls across the alternatives, from 139.4 billion gallons under the Preferred Alternative (Alternative 4) to 125.7 billion gallons under the TCTB Alternative (Alternative 9) representing a fuel savings of 21.0 to 34.7 billion gallons in 2060, as compared to fuel consumption projected under the No Action Alternative. For light trucks, fuel consumption by 2060 reaches 94.8 billion gallons under the No Action Alternative (Alternative 1). Consumption declines across the alternatives, from 83.3 billion gallons under the 3-Percent Alternative (Alternative 2) to 75.7 billion gallons under the TCTB Alternative (Alternative 9). This represents a fuel savings of 11.5 to 19.1 billion gallons in 2060, as compared to fuel consumption projected under the No Action Alternative.

Air quality: In the case of $PM_{2.5}$, SO_X, NO_X, and VOCs, the No Action Alternative results in the highest emissions, and emissions generally decline as fuel economy standards increase across alternatives. Exceptions to this declining trend are NO_X under the Preferred Alternative (Alternative 4); $PM_{2.5}$ under Alternatives 3 and 4, and Alternatives 8 and 9; SO_X under Alternatives 3 (4-Percent Alternative) and 4 (Preferred Alternative); and VOCs under Alternative 4. Despite these individual increases, emissions of $PM_{2.5}$, SO_X, NO_X, and VOCs remain below the levels under the No Action Alternative (Alternative 1). In the case of CO, emissions under Alternatives 2 through 4 are slightly higher than under the No Action Alternative. Emissions of CO decline as fuel economy standards increase across Alternatives 5 through 9.

As with criteria pollutants, emissions of most toxic air pollutants would decrease from one alternative to the next more stringent alternative. The exceptions are acetaldehyde emissions, which would increase under Alternative 4; acrolein emissions, which increase under each of the alternatives; benzene emissions, which would increase under Alternative 4; 1,3-butadiene, which would increase under Alternatives 2 and 4; diesel particulate matter (DPM), which would increase under Alternatives 3 and 4; and formaldehyde, which would increase under Alternatives 3, 5, 6, 8, and 9. The changes in toxic air pollutant emissions, whether positive or negative, generally would be small relative to Alternative 1 emissions levels.[641] The exceptions are acetaldehyde emissions, which would decrease by more than 10 percent under Alternative 9; acrolein emissions, which would increase across successive alternatives (as noted above, the acrolein emissions are an upper-bound estimate and actual emissions might be less); benzene emissions, which would decrease by more than 10 percent under Alternatives 8 and 9; and DPM emissions, which would decrease by more than 10 percent under all action alternatives.

Cumulative emissions generally would be less than noncumulative emissions for the same combination of pollutant, year, and alternative because of differing changes in VMT and fuel consumption under the cumulative case compared to the noncumulative case. The exceptions are acrolein for all alternatives except Alternative 9, and 1,3-butadiene for all alternatives except Alternative 2 (3-Percent Alternative).

The reductions in emissions are expected to lead to reductions in cumulative adverse health effects. There would be reductions in adverse health effects nationwide under Alternatives 2 (3-Percent Alternative) through 9 (TCTB) compared to the No Action Alternative. Reductions in adverse health effects decrease from Alternative 2 (3-Percent Alternative) through Alternative 4 (Preferred Alternative), and then increase under Alternatives 5 (5-Percent Alternative through Alternative 9 (TCTB). These reductions primarily reflect the projected $PM_{2.5}$ reductions, and secondarily the reductions in SO_2. The economic value of health impacts would vary proportionally with changes in health outcomes.

Climate change: As with the analysis of the direct and indirect effects of the proposed action and alternatives on climate change, for the cumulative impacts analysis this EIS uses MAGICC version 5.3.v2 to estimate the changes in CO_2 concentrations, global mean surface temperature, and changes in sea level for each alternative CAFE standard. To estimate changes in global precipitation, NHTSA uses increases in global mean surface temperature combined with a scaling approach and coefficients from the IPCC Fourth Assessment Report. A sensitivity analysis was completed to examine the relationship among the alternatives and likely climate sensitivities, and the associated direct and indirect effects for each combination. These relationships can be used to infer the effect of emissions associated with the regulatory alternatives on direct and indirect climate effects.

One of the key categories of inputs to MAGICC is a time series of global GHG emissions. In assessing the cumulative effects on climate, NHTSA used the CCSP SAP 2.1 MiniCAM Level 3 scenario to represent a Reference Case global emission scenario, that is, future global emissions assuming significant global actions to address climate change. This Reference Case global emission scenario serves as a baseline against which the climate benefits of the various alternatives can be measured.

The Reference Case global emissions scenario used in the cumulative impacts analysis (and described in Chapter 4 of this EIS) differs from the global emissions scenario used for the climate

[641] These conclusions are not meant to be interpreted as expressing NHTSA's views that impacts on air quality is not an area of concern for policymakers. Under NEPA, the agency is obligated to discuss the environmental impact[s] of *the proposed action.* 42 U.S.C. 4332(2)(C)(i) (emphasis added). This analysis fulfills NHTSA's obligations in this regard.

change modeling presented in Chapter 3. In Chapter 4, the Reference Case global emission scenario reflects reasonably foreseeable actions in global climate change policy; in Chapter 3, the global emissions scenario used for the analysis assumes that there are no significant global controls. Given that the climate system is non-linear, the choice of a global emissions scenario could produce different estimates of the benefits of the proposed action and alternatives, if the emission reductions of the alternatives were held constant.

The SAP 2.1 MiniCAM Level 3 scenario assumes a moderate level of global GHG reductions, resulting in a global atmospheric CO_2 concentration of roughly 650 parts per million by volume (ppmv) as of 2100. The following regional, national, and international initiatives and programs are reasonably foreseeable actions to reduce GHG emissions: Regional Greenhouse Gas Initiative (RGGI); Western Climate Initiative (WCI); Midwestern Greenhouse Gas Reduction Accord; EPA's Proposed GHG Emissions Standards; H.R. 2454: American Clean Energy and Security Act (''Waxman-Markey Bill''); Renewable Fuel Standard (RFS2); Program Activities of DOE's Office of Fossil Energy; Program Activities of DOE's Office of Nuclear Energy; United Nation's Framework Convention on Climate Change (UNFCCC)—The Kyoto Protocol and upcoming Conference of the Parties (COP) 15 in Copenhagen, Denmark; G8 Declaration—Summit 2009; and the Asia Pacific Partnership on Clean Development and Climate.[642] The SAP 2.1 MiniCAM Level 3 scenario provides a global context for emissions of a full suite of GHGs and ozone precursors for a Reference Case harmonious with implementation of the above policies and initiatives. Each of the action alternatives was simulated by calculating the difference in annual GHG emissions in relation to the No Action Alternative, and subtracting this change in the MiniCAM Level 3 scenario to generate modified global-scale emissions scenarios, which each show the effect of the various regulatory alternatives on the global emissions path.

NHTSA used the MiniCAM Level 3 scenario as the primary global emissions scenario for evaluating climate effects, and used the MiniCAM Level 2 scenario and the RCP 4.5 MiniCAM reference emissions scenario to evaluate the sensitivity of the results to alternative emission scenarios. The sensitivity analysis provides a basis for determining climate responses to varying levels of climate sensitivities and global emissions and under the No Action Alternative (Alternative 1) and the Preferred Alternative (Alternative 4). Some responses of the climate system are believed to be non-linear; by using a range of emissions cases and climate sensitivities, it is possible to estimate the effects of the alternatives in relation to different reference cases.

Cumulative GHG emissions: Projections of GHG emissions reductions over the 2012 to 2100 period due to the MY 2012–2016 CAFE standards and other reasonably foreseeable future actions ranged from 27,164 to 44,626 $MMTCO_2$. Compared to global emissions of 3,919,462 $MMTCO_2$ over this period (projected by the SAP 2.1 MiniCAM Level 3 scenario), the incremental impact of this rulemaking is expected to reduce global CO_2 emissions by about 0.7 to 1.1 percent from their projected levels under the No Action Alternative.

CO_2 concentration, global mean surface temperature, sea-level rise, and precipitation: For the mid-range results of MAGICC model simulations for the No Action Alternative and the eight action alternatives in terms of CO_2 concentrations and increase in global mean surface temperature in 2030, 2050, and 2100, the impact on the growth in CO_2 concentrations and temperature is just a fraction of the total growth in CO_2 concentrations and global mean surface temperature. However, the relative impact of the action alternatives is illustrated by the reduction in growth of both CO_2 concentrations and temperature in the TCTB Alternative (Alternative 9).

There is a fairly narrow band of estimated CO_2 concentrations as of 2100, from 653.5 ppm for the TCTB Alternative (Alternative 9) to 657.5 ppm for the No Action Alternative (Alternative 1). For 2030 and 2050, the range is even smaller. Because CO_2 concentrations are the key driver of all other climate effects, this leads to small differences in these effects.

The MAGICC simulations of mean global surface air temperature increases are also shown in Table S–18. For all alternatives, the cumulative global mean surface temperature increase is about 0.80 °C to 0.81 °C as of 2030; 1.32 to 1.33 °C as of 2050; and 2.59 to 2.61 °C as of 2100.[643] The differences among alternatives are small. For 2100, the reduction in temperature increase for the action alternatives in relation to the No Action Alternative is about 0.01 to 0.02 °C.

The impact on sea-level rise in 2100 ranges from 32.84 centimeters under the No Action Alternative (Alternative 1) to 32.68 centimeters under the TCTB Alternative (Alternative 9), for a maximum reduction of 0.16 centimeter by 2100 from the action alternatives.

Given that the action alternatives would reduce temperature increases slightly in relation to the No Action Alternative (Alternative 1), they also would reduce predicted increases in precipitation slightly. In summary, the impacts of the proposed action and alternatives and other reasonably foreseeable future actions on global mean surface temperature, sea-level rise, and precipitation are relatively small in the context of the expected changes associated with the emissions trajectories in the SRES scenarios.[644] This is due primarily to the global and multi-sectoral nature of the climate problem.

NHTSA examined the sensitivity of climate effects on key assumptions used in the analysis. The two variables for which assumptions were varied were climate sensitivity and global emissions.

Climate sensitivities used included 2.0, 3.0, and 4.5 °C for a doubling of CO_2 concentrations in the atmosphere. Global emissions scenarios used included the SAP 2.1 MiniCAM Level 3 (650 ppm as of 2100), the SAP 2.1 MiniCAM Level 2 (550 ppm as of 2100), and RCP 4.5 MiniCAM reference scenario (783 ppm as of 2100). The sensitivity analysis is based on the results provided for two alternatives—the No Action Alternative (Alternative 1) and the Preferred Alternative (Alternative 4). The sensitivity analysis was conducted only for two alternatives, as this was deemed sufficient to assess the effect of various climate sensitivities on the results.

[642] The regional, national, and international initiatives and programs discussed above are those which NHTSA has tentatively concluded are reasonably foreseeable past, current, or future actions to reduce GHG emissions. Although some of the actions, policies, or programs listed are not associated with precise GHG reduction commitments, collectively they illustrate a current and continuing trend of U.S. and global awareness, emphasis, and efforts towards significant GHG reductions. Together they imply that future commitments for reductions are probable and, therefore, reasonably foreseeable under NEPA.

[643] Because the actual increase in global mean surface temperature lags the commitment to warming, the impact on global mean surface temperature increase is less than the long-term commitment to warming.

[644] These conclusions are not meant to be interpreted as expressing NHTSA's views that impacts on global mean surface temperature, precipitation, or sea-level rise are not areas of concern for policymakers. Under NEPA, the agency is obligated to discuss the environmental impact[s] of *the proposed action.* 42 U.S.C. 4332(2)(C)(i) (emphasis added). This analysis fulfills NHTSA's obligations in this regard.

The results of these simulations illustrate the uncertainty due to factors influencing future global emissions of GHGs (factors other than the CAFE rulemaking). The use of different climate sensitivities [645] (the equilibrium warming that occurs at a doubling of CO_2 from pre-industrial levels) can affect not only warming but also indirectly affect sea-level rise and CO_2 concentration. The use of alternative global emissions scenarios can influence the results in several ways. Emissions reductions can lead to larger reductions in the CO_2 concentrations in later years because more anthropogenic emissions can be expected to stay in the atmosphere.

NHTSA's analysis indicates that the sensitivity of the simulated CO_2 emissions in 2030, 2050, and 2100 to assumptions of global emissions and climate sensitivity is low; stated simply, CO_2 emissions do not change much with changes in global emissions and climate sensitivity. For 2030 and 2050, the choice of global emissions scenario has little impact on the results. By 2100, the Preferred Alternative (Alternative 4) has the greatest impact in the global emissions scenario with the highest CO_2 emissions (MiniCAM Reference) and the least impact in the scenario with the lowest CO_2 emissions (MiniCAM Level 2). The total range of the impact of the Preferred Alternative on CO_2 concentrations in 2100 is from 2.2 to 2.6 ppm. The Reference Case using the MiniCAM Level 3 scenario and a 3.0 °C climate sensitivity has an impact of 2.4 ppm.

The sensitivity of the simulated global mean surface temperatures for 2030 is also low due primarily to the slow rate at which the global mean surface temperature increases in response to increases in radiative forcing. The relatively slow response in the climate system explains the observation that even by 2100, when CO_2 concentrations more than double in comparison to pre-industrial levels, the temperature increase is below the equilibrium sensitivity levels, *i.e.,* the climate system has not had enough time to equilibrate to the new CO_2 concentrations. Nonetheless, as of 2100 there is a larger range in temperatures across the different values of climate sensitivity: The reduction in global mean surface temperature from the No Action Alternative to the Preferred Alternative ranges from 0.008 °C for the 2.0 °C climate sensitivity to 0.012 °C for the 4.5 °C climate sensitivity, for the MiniCAM Level 3 emissions scenario.

The impact on global mean surface temperature due to assumptions concerning global emissions of GHGs is also important. The scenario with the higher global emissions of GHGs (*viz.,* the MiniCAM Reference) has a slightly lower reduction in global mean surface temperature, and the scenario with lower global emissions (*viz.,* the MiniCAM Level 2) has a slightly higher reduction. This is in large part due to the non-linear and near-logarithmic relationship between radiative forcing and CO_2 concentrations. At high emissions levels, CO_2 concentrations are higher and, as a result, a fixed reduction in emissions yields a lower reduction in radiative forcing and global mean surface temperature.

The sensitivity of the simulated sea-level rise to changes in climate sensitivity and global GHG emissions mirrors that of global temperature. Scenarios with lower climate sensitivities have lower increases in sea-level rise. The greater the climate sensitivity, the greater the decrement in sea-level rise for the Preferred Alternative as compared to the No Action Alternative.

Resource impacts of climate change: The effects of the alternatives on climate—CO_2 concentrations, temperature, precipitation, and sea-level rise—can translate into impacts on key resources including terrestrial and freshwater ecosystems; marine, coastal systems, and low-lying areas; food, fiber, and forest products; industries, settlements, and society; and human health. Although the alternatives have the potential to substantially decrease GHG emissions, they would not alone prevent climate change from occurring. The magnitude of the changes in climate effects that the alternatives would produce—two to five parts per million of CO_2, a few hundredths of a degree Celsius difference in temperature, a small percentage change in the rate of precipitation increase, and 1 or 2 millimeters of sea-level rise—are too small to address quantitatively in terms of their impacts on resources. Given the enormous resource values at stake, these distinctions could be important—very small percentages of huge numbers can still yield substantial results—but they are too small for current quantitative techniques to resolve. Consequently, the discussion of resource impacts does not distinguish among the CAFE alternatives; rather, it provides a qualitative review of the benefits of reducing GHG emissions and the magnitude of the risks involved in climate change.[646]

NHTSA examined the impacts resulting from global climate change due to all global emissions on the U.S. and global scale. Impacts to freshwater resources could include changes in precipitation patterns, decreasing aquifer recharge in some locations, changes in snowpack and timing of snowmelt, salt-water intrusion from sea-level changes, changes in weather patterns resulting in flooding or drought in certain regions, increased water temperature, and numerous other changes to freshwater systems that disrupt human use and natural aquatic habitats. Impacts to terrestrial ecosystems could include shifts in species range and migration patterns, potential extinctions of sensitive species unable to adapt to changing conditions, increases in the occurrence of forest fires and pest infestation, and changes in habitat productivity because of increased atmospheric CO_2. Impacts to coastal ecosystems, primarily from predicted sea-level rise, could include the loss of coastal areas due to submersion and erosion, additional impacts from severe weather and storm surges, and increased salinization of estuaries and freshwater aquifers (for example, one impact could be reductions in manatee habitat in the Florida coastal areas). Impacts to land use and several key economic sectors could include flooding and severe-weather impacts to coastal, floodplain, and island settlements; extreme heat and cold waves; increases in drought in some locations; and weather- or sea-level related disruptions of the service, agricultural, and transportation sectors. Impacts to human health could include increased mortality and morbidity due to excessive heat, increases in respiratory conditions due to poor air quality, increases in water and food-

[645] Equilibrium climate sensitivity (or climate sensitivity) is the projected responsiveness of Earth's global climate system to forcing from GHG drivers, and is often expressed in terms of changes to global surface temperature resulting from a doubling of CO_2 in relation to pre-industrial atmospheric concentrations. According to IPCC, using a likely emissions scenario that results in a doubling of the concentration of atmospheric CO_2, there is a 66- to 90-percent probability of an increase in surface warming of 2.5 to 4.0 °C by the end of the century (relative to 1990 average global temperatures), with 3 °C as the single most likely surface temperature increase.

[646] *See* 42 U.S.C. 4332 (requiring *Federal* agencies to "identify and develop methods and procedures * * * which will insure that presently unquantified environmental amenities and values may be given appropriate consideration"); 40 CFR 1502.23 (requiring an EIS to discuss the relationship between a cost-benefit analysis and any analyses of unquantified environmental impacts, values, and amenities); CEQ, *Considering Cumulative Effects Under the National Environmental Policy Act* (1984), *available at http://ceq.hss.doe.gov/nepa/ccenepa/ccenepa.htm* (recognizing that agencies are sometimes "limited to qualitative evaluations of effects because cause-and-effect relationships are poorly understood" or cannot be quantified).

borne diseases, changes to the seasonal patterns of vector-borne diseases, and increases in malnutrition.

Non-climate cumulative impacts of CO_2 emissions: In addition to its role as a GHG in the atmosphere, CO_2 is transferred from the atmosphere to water, plants, and soil. In water, CO_2 combines with water molecules to form carbonic acid. When CO_2 dissolves in seawater, a series of well-known chemical reactions begin that increase the concentration of hydrogen ions and make seawater more acidic, which has adverse effects on corals and some other marine life.

Increased concentrations of CO_2 in the atmosphere can also stimulate plant growth to some degree, a phenomenon known as the CO_2 fertilization effect. This effect could have positive ramifications for agricultural productivity and forest growth. The available evidence indicates that different plants respond in different ways to enhanced CO_2 concentrations.

As with the climate effects of CO_2, the changes in non-climate impacts associated with the alternatives are difficult to assess quantitatively. Whether the distinction in concentrations is substantial across alternatives is not clear because the damage functions and potential existence of thresholds for CO_2 concentration are not known. However, what is clear is that a reduction in the rate of increase in atmospheric CO_2, which all the action alternatives would provide to some extent, would reduce the ocean acidification effect and the CO_2 fertilization effect.

For much more information on NHTSA's NEPA analysis, please see the DEIS.

3. Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.,* as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996), whenever an agency is required to publish a notice of rulemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the effect of the rule on small entities (*i.e.,* small businesses, small organizations, and small governmental jurisdictions). The Small Business Administration's regulations at 13 CFR part 121 define a small business, in part, as a business entity ''which operates primarily within the United States.'' 13 CFR 121.105(a). No regulatory flexibility analysis is required if the head of an agency certifies the rule will not have a significant economic impact on a substantial number of small entities.

I certify that the proposed rule would not have a significant economic impact on a substantial number of small entities. The following is NHTSA's statement providing the factual basis for the certification (5 U.S.C. 605(b)).

If adopted, the proposal would directly affect twenty-one large single stage motor vehicle manufacturers.[647] The proposal would also affect two small domestic single stage motor vehicle manufacturers, Saleen and Tesla.[648] According to the Small Business Administration's small business size standards (*see* 13 CFR 121.201), a single stage automobile or light truck manufacturer (NAICS code 336111, Automobile Manufacturing; 336112, Light Truck and Utility Vehicle Manufacturing) must have 1,000 or fewer employees to qualify as a small business. Both Saleen and Tesla have less than 1,000 employees and make less than 1,000 vehicles per year. We believe that the rulemaking would not have a significant economic impact on these small vehicle manufacturers because under Part 525, passenger car manufacturers making less than 10,000 vehicles per year can petition NHTSA to have alternative standards set for those manufacturers. Tesla produces only electric vehicles with fuel economy values far beyond those proposed today, so we would not expect them to need to petition for relief. Saleen modifies a very small number of vehicles produced by one of the 21 large single-stage manufacturers, and currently does not meet the 27.5 mpg passenger car standard, nor is it anticipated to be able to meet the standards proposed today. However, Saleen already petitions the agency for relief. If the standard is raised, it has no meaningful impact on Saleen, because it must still go through the same process to petition for relief. Given that there already is a mechanism for handling small businesses, which is the purpose of the Regulatory Flexibility Act, a regulatory flexibility analysis was not prepared.

4. Executive Order 13132 (Federalism)

Executive Order 13132 requires NHTSA to develop an accountable process to ensure ''meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications.'' The Order defines the term ''Policies that have federalism implications'' to include regulations that 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.'' Under the Order, NHTSA may not issue a regulation that has federalism implications, that imposes substantial direct compliance costs, and that is not required by statute, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by State and local governments, or NHTSA consults with State and local officials early in the process of developing the proposed regulation.

NHTSA solicits comment on this proposed action from State and local officials. In his January 26 memorandum, the President requested NHTSA to ''consider whether any provisions regarding preemption are consistent with the EISA, the Supreme Court's decision in *Massachusetts* v. *EPA* and other relevant provisions of law and the policies underlying them.'' NHTSA is deferring consideration of the preemption issue. The agency believes that it is unnecessary to address the issue further at this time because of the consistent and coordinated *Federal* standards that would apply nationally under the proposed National Program.

5. Executive Order 12988 (Civil Justice Reform)

Pursuant to Executive Order 12988, ''Civil Justice Reform,''[649] NHTSA has considered whether this rulemaking would have any retroactive effect. This proposed rule does not have any retroactive effect.

6. Unfunded Mandates Reform Act

Section 202 of the Unfunded Mandates Reform Act of 1995 (UMRA) requires Federal agencies to prepare a written assessment of the costs, benefits, and other effects of a proposed or final rule that includes a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of more than $100 million in any one year (adjusted for inflation with base year of 1995). Adjusting this amount by the implicit gross domestic product price deflator for 2006 results in $126 million (116.043/92.106=1.26). Before promulgating a rule for which a written statement is needed, section 205 of

[647] BMW, Daimler (Mercedes), Chrysler, Ferrari, Ford, Subaru, General Motors, Honda, Hyundai, Kia, Lotus, Maserati, Mazda, Mitsubishi, Nissan, Porsche, Subaru, Suzuki, Tata, Toyota, and Volkswagen.

[648] The Regulatory Flexibility Act only requires analysis of small domestic manufacturers. There are two passenger car manufacturers that we know of, Saleen and Tesla, and no light truck manufacturers.

[649] 61 FR 4729 (Feb. 7, 1996).

UMRA generally requires NHTSA 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 NHTSA to adopt an alternative other than the least costly, most cost-effective, or least burdensome alternative if the agency publishes with the final rule an explanation why that alternative was not adopted.

This proposed rule will not result in the expenditure by State, local, or tribal governments, in the aggregate, of more than $126 million annually, but it will result in the expenditure of that magnitude by vehicle manufacturers and/or their suppliers. In promulgating this proposal, NHTSA considered a variety of alternative average fuel economy standards lower and higher than those proposed. NHTSA is statutorily required to set standards at the maximum feasible level achievable by manufacturers based on its consideration and balancing of relevant factors and has tentatively concluded that the proposed fuel economy standards are the maximum feasible standards for the passenger car and light truck fleets for MYs 2012–2016 in light of the statutory considerations.

7. Paperwork Reduction Act

Under the procedures established by the Paperwork Reduction Act of 1995, a person is not required to respond to a collection of information by a Federal agency unless the collection displays a valid OMB control number. This section describes a request for clearance for a collection of information associated with product plan information to assist the agency in developing final corporate average fuel economy standards for MY 2012 through 2016 passenger cars and light trucks. The establishment of those standards is required by the Energy Policy and Conservation Act, as amended by the Energy Independence and Security Act (EISA) of 2007, Pub. L. 110–140. In compliance with the PRA, this notice requests comment on the Information Collection Request (ICR) abstracted below. The ICR describes the nature of the information collection and its expected burden. This is a request for an extension of an existing collection.

Agency: National Highway Traffic Safety Administration (NHTSA).

Title: 49 CFR parts 531 and 533 Passenger Car Average Fuel Economy Standards—Model Years 2008–2020; Light Truck Average Fuel Economy Standards—Model Years 2008–2020; Production Plan Data

Type of Request: Extension of existing collection.

OMB Clearance Number: 2127–0655.

Form Number: This collection of information will not use any standard forms.

Summary of the Collection of Information

In this collection of information, NHTSA is requesting any updates to previously-submitted future product plans from vehicle manufacturers, as well as production data through the recent past, including data about engines and transmissions for model year (MY) 2008 through MY 2020 passenger cars and light trucks and the assumptions underlying those plans. If manufacturers have not previously submitted product plan information to NHTSA and wish to do so, NHTSA also requests such information from them.

NHTSA requests information for MYs 2008–2020 to supplement other information used by NHTSA in developing a realistic forecast of the MY 2012–2016 vehicle market, and in evaluating what technologies may feasibly be applied by manufacturers to achieve compliance with the MY 2012–2016 standards. Information regarding earlier model years may help the agency to better account for cumulative effects such as volume- and time-based reductions in costs, and also may help to reveal product mix and technology application trends during model years for which the agency is currently receiving actual corporate average fuel economy (CAFE) compliance data. Information regarding later model years may help the agency gain a better understanding of how manufacturers' plans through MY 2016 relate to their longer-term expectations regarding Energy Independence and Security Act requirements, market trends, and prospects for more advanced technologies.

NHTSA will also consider information from model years before and after MYs 2012–2016 when reviewing manufacturers' planned schedules for redesigning and freshening their products, in order to examine how manufacturers anticipate tying technology introduction to product design schedules and to consider how the agency should account for those schedules in its analysis for the final rule. In addition, the agency is requesting information regarding manufacturers' estimates of the future vehicle population, and fuel economy improvements and incremental costs attributed to this notice.

Description of the Need for the Information and Use of the Information

NHTSA needs the information described above to aid in assessing what CAFE standards should be established for MY 2012 through 2016 passenger cars and light trucks.

Description of the Likely Respondents (Including Estimated Number, and Proposed Frequency of Response to the Collection of Information)

It is estimated that this collection affects approximately 22 motor vehicle manufacturers. The information that is the subject of this collection of information is collected whenever NHTSA publishes a notice of proposed rulemaking for the purpose of setting CAFE standards.

Estimate of the Total Annual Reporting and Recordkeeping Burden Resulting From the Collection of Information

It is estimated that this collection affects approximately 22 vehicle manufacturers. One major manufacturer (General Motors) estimated their burden to be approximately 4,300 hours. The burden to other manufacturers was estimated using sales weights relative to General Motor's total sales (*e.g.,* if a manufacturer produces 50 percent as many vehicles as General Motors, their burden is estimated to be 4,300 * 0.5 = 2,150 hours). Therefore the burden to each manufacturer depends on the number of vehicles that manufacturer produces. The total estimated burden is 16,000 hours annually.

Number of Affected Vehicle Manufacturers.	22
Annual Labor Hours for Each Manufacturer To Prepare and Submit Required Information.	Variable
Total Annual Information Collection Burden.	16,000 Hours

The monetized cost associated with this information collection is determined by multiplying the total labor hours by an appropriate labor rate. For this information collection, we believe vehicle manufacturers will use mechanical engineers to prepare and submit the data. Therefore, we are applying a labor rate of $36.02 per hour which is the median national wage for mechanical engineers.[650] Thus, the

[650] The national median hourly rate for mechanical engineers, May 2008, according to the Bureau of Labor Statistics, is $36.02. *See http://www.bls.gov/oes/2008/may/oes_nat.htm#b17-0000* (last accessed August 26, 2009).

estimated monetized annual cost is 16,000 hours × $36.02 per hour = $576,320.

Comments are specifically sought on the following issues:

• Whether the collection of information is necessary for the proper performance of the functions of the Department, including whether the information will have practical utility.

• Whether the Department's estimate for the burden of the information collection is accurate.

• Ways to minimize the burden of the collection of information on respondents, including the use of automated collection techniques or other forms of information technology.

Please send comments to the docket number cited in the heading of this notice. PRA comments are due within 60 days following publication of this document in the **Federal Register**. The agency recognizes that the amendment to the existing collection of information may be subject to revision in response to public comments and the OMB review.

For further information on this proposal to extend the collection of information, please contact Ken Katz, Fuel Economy Division, Office of International Policy, Fuel Economy, and Consumer Programs, National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE., Washington, DC 20590. You may also contact him by phone at (202) 366–0846 or by fax at (202) 493–2290.

8. Regulation Identifier Number

The Department of Transportation assigns a regulation identifier number (RIN) to each regulatory action listed in the Unified Agenda of Federal Regulations. The Regulatory Information Service Center publishes the Unified Agenda in April and October of each year. You may use the RIN contained in the heading at the beginning of this document to find this action in the Unified Agenda.

9. Executive Order 13045

Executive Order 13045 [651] applies to any rule that: (1) Is determined to be economically significant as defined under E.O. 12866, and (2) concerns an environmental, health, or safety risk that NHTSA has reason to believe may have a disproportionate effect on children. If the regulatory action meets both criteria, we must evaluate the environmental health or safety effects of the proposed rule on children, and explain why the proposed regulation is preferable to other potentially effective and reasonably foreseeable alternatives considered by us.

Chapter 4 of NHTSA's DEIS notes that breathing PM can cause respiratory ailments, heart attack, and arrhythmias (Dockery *et al.* 1993, Samet *et al.* 2000, Pope *et al.* 1995, 2002, 2004, Pope and Dockery 2006, Dominici *et al.* 2006, Laden *et al.* 2006, all in Ebi *et al.* 2008). Populations at greatest risk could include children, the elderly, and those with heart and lung disease, diabetes (Ebi *et al.* 2008), and high blood pressure (Künzli *et al.* 2005, in Ebi *et al.* 2008). Chronic exposure to PM could decrease lifespan by 1 to 3 years (Pope 2000, in American Lung Association 2008). Increasing PM concentrations are expected to have a measurable adverse impact on human health (Confalonieri *et al.* 2007).

Additionally, the DEIS notes that substantial morbidity and childhood mortality has been linked to water- and food-borne diseases. Climate change is projected to alter temperature and the hydrologic cycle through changes in precipitation, evaporation, transpiration, and water storage. These changes, in turn, potentially affect water-borne and food-borne diseases, such as salmonellosis, campylobacter, leptospirosis, and pathogenic species of vibrio. They also have a direct impact on surface water availability and water quality. It has been estimated that more than 1 billion people in 2002 did not have access to adequate clean water (McMichael *et al.* 2003, in Epstein *et al.* 2006). Increased temperatures, greater evaporation, and heavy rain events have been associated with adverse impacts on drinking water through increased waterborne diseases, algal blooms, and toxins (Chorus and Bartram 1999, Levin *et al.* 2002, Johnson and Murphy 2004, all in Epstein *et al.* 2006). A seasonal signature has been associated with waterborne disease outbreaks (EPA 2009b). In the United States, 68 percent of all waterborne diseases between 1948 and 1994 were observed after heavy rainfall events (Curriero *et al.* 2001a, in Epstein *et al.* 2006).

Climate change could further impact a pathogen by directly affecting its life cycle (Ebi *et al.* 2008). The global increase in the frequency, intensity, and duration of red tides could be linked to local impacts already associated with climate change (Harvell *et al.* 1999, in Epstein *et al.* 2006); toxins associated with red tide directly affect the nervous system (Epstein *et al.* 2006).

Many people do not report or seek medical attention for their ailments of water-borne or food-borne diseases; hence, the number of actual cases with these diseases is greater than clinical records demonstrate (Mead *et al.* 1999, in Ebi *et al.* 2008). Many of the gastrointestinal diseases associated with water-borne and food-borne diseases can be self-limiting; however, vulnerable populations include young children, those with a compromised immune system, and the elderly.

Thus, as detailed in the DEIS, NHTSA has evaluated the environmental health and safety effects of the proposed rule on children. The DEIS also explains why the proposed regulation is preferable to other potentially effective and reasonably foreseeable alternatives considered by the agency.

10. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act (NTTAA) requires NHTA to evaluate and use existing voluntary consensus standards in its regulatory activities unless doing so would be inconsistent with applicable law (*e.g.,* the statutory provisions regarding NHTSA's vehicle safety authority) or otherwise impractical.

Voluntary consensus standards are technical standards developed or adopted by voluntary consensus standards bodies. Technical standards are defined by the NTTAA as ''performance-base or design-specific technical specification and related management systems practices.'' They pertain to ''products and processes, such as size, strength, or technical performance of a product, process or material.''

Examples of organizations generally regarded as voluntary consensus standards bodies include the American Society for Testing and Materials (ASTM), the Society of Automotive Engineers (SAE), and the American National Standards Institute (ANSI). If NHTSA does not use available and potentially applicable voluntary consensus standards, we are required by the Act to provide Congress, through OMB, an explanation of the reasons for not using such standards.

There are currently no voluntary consensus standards relevant to today's proposed CAFE standards.

11. Executive Order 13211

Executive Order 13211 [652] applies to any rule that: (1) Is determined to be economically significant as defined under E.O. 12866, and is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (2) that is designated by the Administrator of the Office of

[651] 62 FR 19885 (Apr. 23, 1997).

[652] 66 FR 28355 (May 18, 2001).

Information and Regulatory Affairs as a significant energy action. If the regulatory action meets either criterion, we must evaluate the adverse energy effects of the proposed rule and explain why the proposed regulation is preferable to other potentially effective and reasonably feasible alternatives considered by us.

The proposed rule seeks to establish passenger car and light truck fuel economy standards that will reduce the consumption of petroleum and will not have any adverse energy effects. Accordingly, this proposed rulemaking action is not designated as a significant energy action.

12. Department of Energy Review

In accordance with 49 U.S.C. 32902(j)(1), we submitted this proposed rule to the Department of Energy for review. That Department did not make any comments that we have not addressed.

13. Plain Language

Executive Order 12866 requires each agency to write all rules in plain language. Application of the principles of plain language includes consideration of the following questions:

• Have we organized the material to suit the public's needs?
• Are the requirements in the rule clearly stated?
• Does the rule contain technical language or jargon that isn't clear?
• Would a different format (grouping and order of sections, use of headings, paragraphing) make the rule easier to understand?
• Would more (but shorter) sections be better?
• Could we improve clarity by adding tables, lists, or diagrams?
• What else could we do to make the rule easier to understand?

If you have any responses to these questions, please include them in your comments on this proposal.

14. Privacy Act

Anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an organization, business, labor union, etc.). You may review DOT's complete Privacy Act statement in the **Federal Register** (65 FR 19477–78, April 11, 2000) or you may visit *http://www.dot.gov/privacy.html.*

List of Subjects

40 CFR Part 86

Administrative practice and procedure, Confidential business information, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 600

Administrative practice and procedure, Electric power, Fuel economy, Incorporation by reference, Labeling, Reporting and recordkeeping requirements.

49 CFR Part 531 and 533

Fuel economy.

49 CFR Part 537

Fuel economy, Reporting and recordkeeping requirements.

49 CFR Part 538

Administrative practice and procedure, Fuel economy, Motor vehicles, Reporting and recordkeeping requirements.

Environmental Protection Agency

40 CFR Chapter I

For the reasons set forth in the preamble, the Environmental Protection Agency proposes to amend parts 86 and 600 of title 40, Chapter I of the Code of Federal Regulations as follows:

PART 86—CONTROL OF EMISSIONS FROM NEW AND IN-USE HIGHWAY VEHICLES AND ENGINES

1. The authority citation for part 86 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

2. Section 86.1 is amended by adding paragraphs (b)(2)(xxxix) through (xxxxi) to read as follows:

§ 86.1 Reference materials.

* * * * *

(b) * * *

(2) * * *

(xxxix) SAE J2064, December 2005, R134a Refrigerant Automotive Air-Conditioned Hose, IBR approved for § 86.166–12.

(xxxx) SAE J2727, revised August 2008, HFC–134a Mobile Air Conditioning System Refrigerant Emission Chart, IBR approved for § 86.166–12.

(xxxxi) SAE J2765, October, 2008, Procedure for Measuring System COP [Coefficient of Performance] of a Mobile Air Conditioning System on a Test Bench, IBR approved for § 86.1866–12.

* * * * *

Subpart B—[Amended]

3. Section 86.111–94 is amended by revising paragraph (b) introductory text to read as follows:

§ 86.111–94 Exhaust gas analytical system.

* * * * *

(b) *Major component description.* The exhaust gas analytical system, Figure B94–7, consists of a flame ionization detector (FID) (heated, 235 °± 15 °F (113 °± 8 °C) for methanol-fueled vehicles) for the determination of THC, a methane analyzer (consisting of a gas chromatograph combined with a FID) for the determination of CH_4, non-dispersive infrared analyzers (NDIR) for the determination of CO and CO_2, a chemiluminescence analyzer (CL) for the determination of NO_X, and an analyzer meeting the requirements specified in § 86.167–12 for the determination of N_2O for 2012 and later model year vehicles. A heated flame ionization detector (HFID) is used for the continuous determination of THC from petroleum-fueled diesel-cycle vehicles (may also be used with methanol-fueled diesel-cycle vehicles), Figure B94–5 (or B94–6). The analytical system for methanol consists of a gas chromatograph (GC) equipped with a flame ionization detector. The analysis for formaldehyde is performed using high-pressure liquid chromatography (HPLC) of 2,4-dinitrophenylhydrazine (DNPH) derivatives using ultraviolet (UV) detection. The exhaust gas analytical system shall conform to the following requirements:

* * * * *

4. Section 86.127–00 is amended as follows:

a. By revising the introductory text.
b. By revising paragraph (a) introductory text.
c. By revising paragraph (a)(1),
d. By revising paragraph (b).
e. By revising paragraph (c).
f. By revising paragraphs (d) and (e).

§ 86.127–00 Test procedures; overview.

Applicability. The procedures described in this subpart are used to determine the conformity of vehicles with the standards set forth in subpart A or S of this part (as applicable) for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles. Except where noted, the procedures of paragraphs (a) through (b) of this section, § 86.127–96 (c) and (d), and the contents of §§ 86.135–94, 86.136–90, 86.137–96, 86.140–94, 86.142–90, and 86.144–94 are applicable for determining emission results for vehicle exhaust emission systems designed to comply with the FTP emission standards, or the FTP emission element required for determining compliance with composite SFTP standards. Paragraphs (f) and (g) of this section discuss the additional test elements of aggressive driving (US06) and air conditioning (SC03) that comprise the exhaust emission components of the SFTP. Section 86.127–96(e) discusses fuel spitback emissions and paragraphs (h) and (i) of this section are applicable to all vehicle emission test procedures. Section 86.127–00 includes text that specifies requirements that differ from § 86.127–96. Where a paragraph in § 86.127–96 is identical and applicable to § 86.127–00, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.127–96.''

(a) The overall test consists of prescribed sequences of fueling, parking, and operating test conditions. Vehicles are tested for any or all of the following emissions, depending upon the specific test requirements and the vehicle fuel type:

(1) Gaseous exhaust THC, NMHC, CO, NO_X, CO_2, N_2O, CH_4, CH_3OH, C_2H_5OH, C_2H_4O, and HCHO.

* * * * *

(b) The FTP Otto-cycle exhaust emission test is designed to determine gaseous THC, CO, CO_2, CH_4, NO_X, N_2O, and particulate mass emissions from gasoline-fueled, methanol-fueled and gaseous-fueled Otto-cycle vehicles as well as methanol and formaldehyde from methanol-fueled Otto-cycle vehicles, as well as methanol, ethanol, acetaldehyde, and formaldehyde from ethanol-fueled vehicles while simulating an average trip in an urban area of 11 miles (18 kilometers). The test consists of engine start-ups and vehicle operation on a chassis dynamometer through a specified driving schedule (see paragraph (a) of appendix I to this part for the Urban Dynamometer Driving Schedule). A proportional part of the diluted exhaust is collected continuously for subsequent analysis, using a constant volume (variable dilution) sampler or critical flow venturi sampler.

(c) The diesel-cycle exhaust emission test is designed to determine particulate and gaseous mass emissions during a test similar to the test in § 86.127(b). For petroleum-fueled diesel-cycle vehicles, diluted exhaust is continuously analyzed for THC using a heated sample line and analyzer; the other gaseous emissions (CH_4, CO, CO_2, N_2O, and NO_X) are collected continuously for analysis as in § 86.127(b). For methanol- and ethanol-fueled vehicles, THC, methanol, formaldehyde, CO, CO_2, CH_4, N_2O, and NO_X are collected continuously for analysis as in § 86.127(b). Additionally, for ethanol-fueled vehicles, ethanol and acetaldehyde are collected continuously for analysis as in § 86.127(b). THC, methanol, ethanol, acetaldehyde, and formaldehyde are collected using heated sample lines, and a heated FID is used for THC analyses. Simultaneous with the gaseous exhaust collection and analysis, particulates from a proportional part of the diluted exhaust are collected continuously on a filter. The mass of particulate is determined by the procedure described in § 86.139. This testing requires a dilution tunnel as well as the constant volume sampler.

(d)–(e) [Reserved]. For guidance see § 86.127–96.

* * * * *

5. Section 86.135–00 is amended by revising paragraph (a) to read as follows:

§ 86.135–12 Dynamometer procedure.

* * * * *

(a) *Overview.* The dynamometer run consists of two tests, a ''cold'' start test, after a minimum 12-hour and a maximum 36-hour soak according to the provisions of §§ 86.132 and 86.133, and a ''hot'' start test following the ''cold'' start by 10 minutes. Engine startup (with all accessories turned off), operation over the UDDS and engine shutdown make a complete cold start test. Engine startup and operation over the first 505 seconds of the driving schedule complete the hot start test. The exhaust emissions are diluted with ambient air in the dilution tunnel as shown in Figure B94–5 and Figure B94–6. A dilution tunnel is not required for testing vehicles waived from the requirement to measure particulates. Six particulate samples are collected on filters for weighing; the first sample plus backup is collected during the first 505 seconds of the cold start test; the second sample plus backup is collected during the remainder of the cold start test (including shutdown); the third sample plus backup is collected during the hot start test. Continuous proportional samples of gaseous emissions are collected for analysis during each test phase. For gasoline-fueled, natural gas-fueled and liquefied petroleum gas-fueled Otto-cycle vehicles, the composite samples collected in bags are analyzed for THC, CO, CO_2, CH_4, NO_X, and, for 2012 and later model year vehicles, N_2O. For petroleum-fueled diesel-cycle vehicles (optional for natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled diesel-cycle vehicles), THC is sampled and analyzed continuously according to the provisions of § 86.110. Parallel samples of the dilution air are similarly analyzed for THC, CO, CO_2, CH_4, NO_X, and, for 2012 and later model year vehicles, N_2O. For natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled vehicles, bag samples are collected and analyzed for THC (if not sampled continuously), CO, CO_2, CH_4, NO_X, and, for 2012 and later model year vehicles, N_2O. For methanol-fueled vehicles, methanol and formaldehyde samples are taken for both exhaust emissions and dilution air (a single dilution air formaldehyde sample, covering the total test period may be collected). For ethanol-fueled vehicles, methanol, ethanol, acetaldehyde, and formaldehyde samples are taken for both exhaust emissions and dilution air (a single dilution air formaldehyde sample, covering the total test period may be collected). Parallel bag samples of dilution air are analyzed for THC, CO, CO_2, CH_4, NO_X, and, for 2012 and later model year vehicles, N_2O. Methanol and formaldehyde samples may be omitted for 1990 through 1994 model years when a FID calibrated on methanol is used.

* * * * *

6. A new § 86.165–12 is added to subpart B to read as follows:

§ 86.165–12 Air conditioning idle test procedure.

(a) *Applicability.* This section describes procedures for determining air conditioning-related CO_2 emissions from 2014 and later model year light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles. The results of this test are used to qualify for air conditioning efficiency CO_2 credits according to § 86.1866–12(c).

(b) *Overview.* The test consists of a brief period to stabilize the vehicle at idle, followed by a ten-minute period at idle when CO_2 emissions are measured without any air conditioning systems operating, followed by a ten-minute period at idle when CO_2 emissions are measured with the air conditioning system operating. This test is designed to determine the air conditioning-related CO_2 emission value, in grams per minute. If engine stalling occurs during cycle operation, follow the provisions of § 86.136–90 to restart the test. Measurement instruments must meet the specifications described in this subpart.

(c) *Test cell ambient conditions.*

(1) Ambient humidity within the test cell during all phases of the test sequence shall be controlled to an average of 50 ± 5 grains of water/pound of dry air.

(2) Ambient air temperature within the test cell during all phases of the test sequence shall be controlled to 75 ± 2 °F on average and 75 ± 5 °F as an instantaneous measurement. Air temperature shall be recorded

continuously at a minimum of 30 second intervals.

(d) *Test sequence.*

(1) Connect the vehicle exhaust system to the raw sampling location or dilution stage according to the provisions of this subpart. For dilution systems, dilute the exhaust as described in this subpart. Continuous sampling systems must meet the specifications provided in this subpart.

(2) Test the vehicle in a fully warmed-up condition. If the vehicle has soaked for two hours or less since the last exhaust test element, preconditioning may consist of a 505 Cycle, 866 Cycle, US06, or SC03, as these terms are defined in § 86.1803–01, or a highway fuel economy test procedure, as defined in § 600.002–08 of this chapter. For longer soak periods, precondition the vehicle using one full Urban Dynamometer Driving Schedule. Ensure that the vehicle has stabilized at test cell ambient conditions such that the vehicle interior temperature is not substantially different from the external test cell temperature. Windows may be opened during preconditioning to achieve this stabilization.

(3) Immediately after the preconditioning, turn off any cooling fans, if present, close the vehicle's hood, fully close all the vehicle's windows, ensure that all the vehicle's air conditioning systems are set to full off, start the CO_2 sampling system, and then idle the vehicle for not less than 1 minute and not more than 5 minutes to achieve normal and stable idle operation.

(4) Measure and record the continuous CO_2 concentration for 600 seconds. Measure the CO_2 concentration continuously using raw or dilute sampling procedures. Multiply this concentration by the continuous (raw or dilute) flow rate at the emission sampling location to determine the CO_2 flow rate. Calculate the CO_2 cumulative flow rate continuously over the test interval. This cumulative value is the total mass of the emitted CO_2.

(5) Within 60 seconds after completing the measurement described in paragraph (d)(4) of this section, turn on the vehicle's air conditioning system. Set automatic air conditioning systems to a temperature 9 °F (5 °C) below the ambient temperature of the test cell. Set manual air conditioning systems to maximum cooling with recirculation turned off, except that recirculation shall be enabled if the air conditioning system automatically defaults to a recirculation mode when set to maximum cooling. Continue idling the vehicle while measuring and recording the continuous CO_2 concentration for 600 seconds as described in paragraph (d)(4) of this section. Air conditioning systems with automatic temperature controls are finished with the test. Manually controlled air conditioning systems must complete one additional idle period described in paragraph (d)(6) of this section.

(6) This paragraph (d)(6) applies only to manually controlled air conditioning systems. Within 60 seconds after completing the measurement described in paragraph (d)(5) of this section, leave the vehicle's air conditioning system on and set as described in paragraph (d)(5) of this section but set the fan speed to the lowest setting that continues to provide air flow. Recirculation shall be turned off except that if the system defaults to a recirculation mode when set to maximum cooling and maintains recirculation with the low fan speed, then recirculation shall continue to be enabled. After the fan speed has been set, continue idling the vehicle while measuring and recording the continuous CO_2 concentration for a total of 600 seconds as described in paragraph (d)(4) of this section.

(e) *Calculations.* (1) For the measurement with no air conditioning, calculate the CO_2 emissions (in grams per minute) by dividing the total mass of CO_2 from paragraph (d)(4) of this section by 10.0 (the duration in minutes for which CO2 is measured). Round this result to the nearest whole gram per minute.

(2)(i) For the measurement with air conditioning in operation for automatic air conditioning systems, calculate the CO_2 emissions (in grams per minute) by dividing the total mass of CO_2 from paragraph (d)(5) of this section by 10.0. Round this result to the nearest whole gram per minute.

(ii) For the measurement with air conditioning in operation for manually controlled air conditioning systems, calculate the CO_2 emissions (in grams per minute) by summing the total mass of CO_2 from paragraphs (d)(5) and (d)(6) of this section and dividing by 20.0. Round this result to the nearest whole gram per minute.

(3) Calculate the increased CO_2 emissions due to air conditioning (in grams per minute) by subtracting the results of paragraph (e)(1) of this section from the results of paragraph (e)(2)(i) or (ii) of this section, whichever is applicable.

7. A new § 86.166–12 is added to subpart B to read as follows:

§ 86.166–12 Method for calculating emissions due to air conditioning leakage.

This section describes procedures used to determine a refrigerant leakage rate from vehicle-based air conditioning units. The results of this test are used to determine air conditioning leakage credits according to § 86.1866–12(b).

(a) *Emission totals.* Calculate an annual rate of refrigerant leakage from an air conditioning system using the following equation:

$$\text{Grams/YR}_{TOT} = \text{Grams/YR}_{RP} + \text{Grams/YR}_{SP} + \text{Grams/YR}_{FH} + \text{Grams/YR}_{MC} + \text{Grams/YR}_{C} - \text{Grams/YR}_{CREDIT}$$

Where:

Grams/YR_{TOT} = Total air conditioning system emission rate in grams per year and rounded to the nearest tenth of a gram per year.

Grams/YR_{RP} = Emission rate for rigid pipe connections as described in paragraph (b) of this section.

Grams/YR_{SP} = Emission rate for service ports and refrigerant control devices as described in paragraph (c) of this section.

Grams/YR_{FH} = Emission rate for flexible hoses as described in paragraph (d) of this section.

Grams/YR_{MC} = Emission rate for heat exchangers, mufflers, receiver/driers, and accumulators as described in paragraph (e) of this section.

Grams/YR_{C} = Emission rate for compressors as described in paragraph (f) of this section.

Grams/YR_{CREDIT} = Leakage monitoring credit, as applicable, from paragraph (g) of this section.

(b) *Fittings.* Determine the grams per year emission rate for rigid pipe connections using the following equation:

$$\text{Grams/YR}_{RP} = 0.00522 \cdot [(125 \cdot SO) + (75 \cdot SCO) + (50 \cdot MO) + (10 \cdot SW) + (5 \cdot SWO) + (MG)]$$

Where:

Grams/YR_{RP} = Total emission rate for rigid pipe connections in grams per year.

SO = The number of single O-ring connections.

SCO = The number of single captured O-ring connections.

MO = The number of multiple O-ring connections.

SW = The number of seal washer connections.

SWO = The number of seal washer with O-ring connections.

MG = The number of metal gasket connections.

(c) *Service ports and refrigerant control devices.* Determine the grams per year emission rate for service ports and refrigerant control devices using the following equation:

$$\text{Grams/YR}_{SP} = (0.3 \cdot HSSP \cdot 0.522) + (0.2 \cdot LSSP \cdot 0.522) + (0.2 \cdot STV \cdot 0.522) + (0.2 \cdot TXV \cdot 0.522)$$

Where:

Grams/YR_{SP} = The emission rate for service ports and refrigerant control devices, in grams per year.

HSSP = The number of high side service ports.

LSSP = The number of low side service ports.
STV = The total number of switches, transducers, and pressure relief valves.
TXV = The number of TXV refrigerant control devices.

(d) *Flexible hoses.* Determine the permeation emission rate in grams per year for each segment of flexible hose using the following equation, and then sum the values for each hose in the system to calculate a total emission rate for the system:

$$Grams/YR_{FH} = 0.00522 \cdot (3.14159 \cdot ID \cdot L \cdot ER)$$

Where:

$Grams/YR_{FH}$ = Emission rate for a segment of flexible hose in grams per year.
ID = Inner diameter of hose, in millimeters.
L = Length of hose, in millimeters.
ER = Emission rate per unit internal surface area of the hose, in g/mm². Select the appropriate value from the following table:

Material/configuration	ER	
	High-pressure side	Low-pressure side
All rubber hose	0.0216	0.0144
Standard barrier or veneer hose	0.0054	0.0036
Ultra-low permeation barrier or veneer hose	0.00225	0.00167

(e) *Heat exchangers, mufflers, receiver/driers, and accumulators.* Use an emission rate of 0.261 grams per year as a combined value for all heat exchangers, mufflers, receiver/driers, and accumulators ($Grams/YR_{MC}$).

(f) *Compressors.* Determine the emission rate for compressors using the following equation, except that the final term in the equation (''1500/SSL'') is not applicable to electric (or semi-hermetic) compressors:

$$Grams/YR_{C} = 0.00522 \cdot [(300 \cdot OHS) + (200 \cdot MHS) + (150 \cdot FAP) + (100 \cdot GHS) + (1500/SSL)]$$

Where:

$Grams/YR_{C}$ = The emission rate for the compressors in the air conditioning system, in grams per year.
OHS = The number of O-ring housing seals.
MHS = The number of molded housing seals.
FAP = The number of fitting adapter plates.
GHS = The number of gasket housing seals.
SSL = The number of lips on shaft seal (for belt-driven compressors only).

(g) *Leakage monitoring credits.* Electronic monitoring systems that provide indication of a refrigerant loss to the operator through an interior driver information display or an air conditioning-specific malfunction indicator when the air conditioning system has lost 40 percent of its charge capacity shall use a credit of 1 g/yr.

(h) *Definitions.* The following definitions apply to this section:

(1) *All rubber hose* means a Type A or Type B hose as defined by SAE J2064 with a permeation rate not greater than 15 kg/m²/year when tested according to SAE J2064. SAE J2064 is incorporated by reference; see § 86.1.

(2) *Standard barrier or veneer hose* means a Type C, D, E, or F hose as defined by SAE J2064 with a permeation rate not greater than 5 kg/m²/year when tested according to SAE J2064. SAE J2064 is incorporated by reference; see § 86.1.

(3) *Ultra-low permeation barrier or veneer hose* means a hose with a permeation rate not greater than 1.5 kg/m²/year when tested according to SAE J2064. SAE J2064 is incorporated by reference; see § 86.1.

8. A new § 86.167–12 is added to subpart B to read as follows:

§ 86.167–12 N_2O measurement devices.

(a) *General component requirements.* We recommend that you use an analyzer that meets the specifications in Table 1 of 40 CFR 1065.205. Note that your system must meet the linearity verification in 40 CFR 1065.307.

(b) *Instrument types.* You may use any of the following analyzers to measure N_2O:

(1) *Nondispersive infra-red (NDIR) analyzer.* You may use an NDIR analyzer that has compensation algorithms that are functions of other gaseous measurements and the engine's known or assumed fuel properties. The target value for any compensation algorithm is 0.0% (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.

(2) *Fourier transform infra-red (FTIR) analyzer.* You may use an FTIR analyzer that has compensation algorithms that are functions of other gaseous measurements and the engine's known or assumed fuel properties. The target value for any compensation algorithm is 0.0% (that is, no bias high and no bias low), regardless of the uncompensated signal's bias. Use EPA Test Method 320 ''Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy'' for spectral interpretation (see 40 CFR part 63 appendix A).

(3) *Photoacoustic analyzer.* You may use a photoacoustic analyzer that has compensation algorithms that are functions of other gaseous measurements. The target value for any compensation algorithm is 0.0% (that is, no bias high and no bias low), regardless of the uncompensated signal's bias. Use an optical wheel configuration that gives analytical priority to measurement of the least stable components in the sample. Select a sample integration time of at least 5 seconds. Take into account sample chamber and sample line volumes when determining flush times for your instrument.

(4) *Gas chromatograph (GC) analyzer.* You may use a gas chromatograph with Electron Capture Detector (ECD) to measure N_2O concentrations of diluted exhaust for batch sampling. You may use a packed or porous layer open tubular (PLOT) column phase of suitable polarity and length to achieve adequate resolution of the N_2O peak for analysis. Examples of acceptable columns are a PLOT column consisting of bonded polystyrene-divinylbenzene or a Porapack Q packed column. Take the column temperature profile and carrier gas selection into consideration when setting up your method to achieve adequate N_2O peak resolution.

(c) *Interference validation.* Perform interference validation for NDIR, FTIR, and Photoacoustic analyzers using the procedures of § 86.168–12 as follows:

(1) Certain interference gases can positively interfere with these analyzers by causing a response similar to N_2O as follows:

(i) The interference gases for NDIR analyzers are CO, CO_2, H_2O, CH_4 and SO_2. Note that interference species, with the exception of H_2O, are dependent on the N_2O infrared absorption band chosen by the instrument manufacturer and should be determined independently for each analyzer.

(ii) Use good engineering judgment to determine interference gases for FTIR. Note that interference species, with the exception of H_2O, are dependent on the N_2O infrared absorption band chosen by the instrument manufacturer and should be determined independently for each analyzer.

(iii) The interference gases for photoacoustic analyzers are CO, CO_2, and H_2O.

(2) Analyzers must have combined interference that is within (0.0 ± 1.0) mol/mol. We strongly recommend a lower interference that is within (0.0 ± 0.5) mol/.

9. A new § 86.168–12 is added to subpart B to read as follows:

§ 86.168–12 Interference verification for N_2O analyzers.

(a) *Scope and frequency. See* 40 CFR 1065.275 to determine whether you need to verify the amount of interference after initial analyzer installation and after major maintenance.

(b) *Measurement principles.* Interference gasses can positively interfere with certain analyzers by causing a response similar to N_2O. If the analyzer uses compensation algorithms that utilize measurements of other gases to meet this interference verification, simultaneously conduct these other measurements to test the compensation algorithms during the analyzer interference verification.

(c) *System requirements.* See 40 CFR 1065.275 for system requirements related to allowable interference levels.

(d) *Procedure.* Perform the interference verification as follows:

(1) Start, operate, zero, and span the N_2O FTIR analyzer as you would before an emission test. If the sample is passed through a dryer during emission testing, you may run this verification test with the dryer if it meets the requirements of 40 CFR 1065.342. Operate the dryer at the same conditions as you will for an emission test. You may also run this verification test without the sample dryer.

(2) Create a humidified test gas by bubbling a multi component span gas that incorporates the target interference species and meets the specifications in 40 CFR 1065.750 through distilled water in a sealed vessel. If the sample is not passed through a dryer during emission testing, control the vessel temperature to generate an H_2O level at least as high as the maximum expected during emission testing. If the sample is passed through a dryer during emission testing, control the vessel temperature to generate an H_2O level at least as high as the level determined in 40 CFR 1065.145(e)(2) for that dryer. Use interference span gas concentrations that are at least as high as the maximum expected during testing.

(3) Introduce the humidified interference test gas into the sample system. You may introduce it downstream of any sample dryer, if one is used during testing.

(4) If the sample is not passed through a dryer during this verification test, measure the water mole fraction, x_{H2O}, of the humidified interference test gas as close as possible to the inlet of the analyzer. For example, measure dewpoint, T_{dew}, and absolute pressure, p_{total}, to calculate x_{H2O}. Verify that the water content meets the requirement in paragraph (d)(2) of this section. If the sample is passed through a dryer during this verification test, you must verify that the water content of the humidified test gas downstream of the vessel meets the requirement in paragraph (d)(2) of this section based on either direct measurement of the water content (*e.g.,* dewpoint and pressure) or an estimate based on the vessel pressure and temperature. Use good engineering judgment to estimate the water content. For example, you may use previous direct measurements of water content to verify the vessel's level of saturation.

(5) If a sample dryer is not used in this verification test, use good engineering judgment to prevent condensation in the transfer lines, fittings, or valves from the point where x_{H2O} is measured to the analyzer. We recommend that you design your system so that the wall temperatures in the transfer lines, fittings, and valves from the point where x_{H2O} is measured to the analyzer are at least 5 °C above the local sample gas dewpoint.

(6) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response.

(7) While the analyzer measures the sample's concentration, record its output for 30 seconds. Calculate the arithmetic mean of this data.

(8) The analyzer meets the interference verification if the result of paragraph (d)(7) of this section meets the tolerance in 40 CFR 1065.275.

(9) You may also run interference procedures separately for individual interference gases. If the interference gas levels used are higher than the maximum levels expected during testing, you may scale down each observed interference value by multiplying the observed interference by the ratio of the maximum expected concentration value to the actual value used during this procedure. You may run separate interference concentrations of H_2O (down to 0.025 mol/mol H_2O content) that are lower than the maximum levels expected during testing, but you must scale up the observed H_2O interference by multiplying the observed interference by the ratio of the maximum expected H_2O concentration value to the actual value used during this procedure. The sum of the scaled interference values must meet the tolerance specified in 40 CFR 1065.275.

Subpart S—[Amended]

10. A new § 86.1801–12 is added to read as follows:

§ 86.1801–12 Applicability.

(a) *Applicability.* Except as otherwise indicated, the provisions of this subpart apply to new light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, and Otto-cycle complete heavy-duty vehicles, including multi-fueled, alternative fueled, hybrid electric, plug-in hybrid electric, and electric vehicles. These provisions also apply to new incomplete light-duty trucks below 8,500 Gross Vehicle Weight Rating. 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 of this subpart.

(b) *Aftermarket conversions.* The provisions of this subpart apply to aftermarket conversion systems, aftermarket conversion installers, and aftermarket conversion certifiers, as those terms are defined in 40 CFR 85.502, of all model year light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, and complete Otto-cycle heavy-duty vehicles.

(c) *Optional applicability.*

(1) [Reserved]

(2) 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 complete heavy-duty vehicles. Heavy-duty engine or heavy-duty vehicle provisions of subpart A of this part do not apply to such a vehicle.

(3) [Reserved]

(4) Upon preapproval by the Administrator, a manufacturer may optionally certify an aftermarket conversion of a complete heavy-duty vehicle greater than 10,000 pounds Gross Vehicle Weight Rating and of 14,000 pounds Gross Vehicle Weight Rating or less under the heavy-duty engine or heavy-duty vehicle provisions of subpart A of this part. Such preapproval will be granted only upon demonstration that chassis-based certification would be infeasible or unreasonable for the manufacturer to perform.

(5) A manufacturer may optionally certify an aftermarket conversion of a complete heavy-duty vehicle greater than 10,000 pounds Gross Vehicle Weight Rating and of 14,000 pounds

Gross Vehicle Weight Rating or less under the heavy-duty engine or heavy-duty vehicle provisions of subpart A of this part without advance approval from the Administrator if the vehicle was originally certified to the heavy-duty engine or heavy-duty vehicle provisions of subpart A of this part.

(d) *Small volume manufacturers.* Special certification procedures are available for any manufacturer whose projected or actual combined sales in all States and territories of the United States 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) are fewer than 15,000 units for the model year in which the manufacturer seeks certification. The small volume manufacturer's light-duty vehicle and light-duty truck certification procedures and described in § 86.1838–01.

(e)–(g) [Reserved]

(h) *Applicability of provisions of this subpart to light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, and heavy-duty vehicles.* Numerous sections in this subpart provide requirements or procedures applicable to a ''vehicle'' or ''vehicles.'' Unless otherwise specified or otherwise determined by the Administrator, the term ''vehicle'' or ''vehicles'' in those provisions apply equally to light-duty vehicles (LDVs), light-duty trucks (LDTs), medium-duty passenger vehicles (MDPVs), and heavy-duty vehicles (HDVs), as those terms are defined in § 86.1803–01.

(i) *Applicability of provisions of this subpart to exhaust CO_2* emissions. Numerous sections in this subpart refer to requirements relating to ''exhaust emissions.'' Unless otherwise specified or otherwise determined by the Administrator, the term ''exhaust emissions'' refers at a minimum to emissions of all pollutants described by emission standards in this subpart, including carbon dioxide (CO_2) starting with the 2012 model year.

(j) *Conditional exemption from greenhouse gas emission standards for small businesses.* Businesses meeting the Small Business Administration size standard defining a small business as described in 13 CFR 121.201 are eligible for exemption from the greenhouse gas emission standards specified in § 86.1818–12 and associated provisions. To be exempted from these provisions, businesses must submit a declaration to EPA containing a detailed written description of how the business qualifies as a small business under the provisions of 13 CFR 121.201. This declaration must be signed by a chief officer of the company, and must be made prior to each model year for which the small business status is requested. The declaration must be submitted to EPA at least 30 days prior to the introduction into commerce of any vehicles for each model year for which the small business status is requested, but not later than December of the calendar year prior to the model year for which exemption is requested. Exemption will be granted when EPA approves the small business declaration. The declaration of small business status must be sent to the Environmental Protection Agency at the following address: Director, Certification and Innovative Strategies Division, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, Michigan 48105.

(1) The following categories of businesses (with their associated NAICS codes) may apply for exemption based on the Small Business Administration size standards in 13 CFR 121.201.

(i) Vehicle manufacturers (NAICS code 336111).

(ii) Independent commercial importers (NAICS codes 811111, 811112, 811198, 423110, 424990, and 441120).

(iii) Alternate fuel vehicle converters (NAICS codes 335312, 336312, 336322, 336399, 454312, 485310, and 811198).

(2) For purposes of determining the number of employees or annual sales revenue for small entities, the entity shall include the employees or annual sales revenue of any subsidiary companies, any parent company, subsidiaries of the parent company in which the parent has a controlling interest, and any joint ventures.

(3) An entity may use the provisions of this paragraph (j) only if it has primary responsibility for designing and assembling, converting, or modifying the subject vehicles.

(4) An entity may import vehicles under this paragraph (j) only if that entity has primary responsibility for designing and assembling, converting or modifying the subject vehicles.

11. Section 86.1803–01 is amended as follows:

a. By adding the definition for ''Air conditioning idle test.''

b. By adding the definition for ''Air conditioning system.''

c. By revising the definition for ''Banking.''

d. By adding the definition for ''Base level.''

e. By adding the definition for ''Base tire.''

f. By adding the definition for ''Base vehicle.''

g. By revising the definition for ''Basic engine.''

h. By adding the definition for ''Battery electric vehicle.''

i. By adding the definition for ''Carbon-related exhaust emissions.''

j. By adding the definition for ''Combined CO_2.''

k. By adding the definition for ''Electric vehicle.''

l. By revising the definition for ''Engine code.''

m. By adding the definition for ''Ethanol fueled vehicle.''

n. By revising the definition for ''Flexible fuel vehicle.''

o. By adding the definition for ''Footprint.''

p. By adding the definition for ''Fuel cell.''

q. By adding the definition for ''Fuel cell electric vehicle.''

r. By adding the definition for ''Highway fuel economy test procedure.''

s. By adding the definition for ''Hybrid electric vehicle.''

t. By adding the definition for ''Interior volume index.''

u. By adding the definition for ''Motor vehicle.''

v. By adding the definition for ''Multi-fuel vehicle.''

w. By adding the definition for ''Petroleum equivalency factor.''

x. By adding the definition for ''Petroleum-equivalent fuel economy.''

y. By adding the definition for ''Petroleum powered accessory.''

z. By adding the definition for ''Plug-in hybrid electric vehicle.''

aa. By adding the definition for ''Production volume.''

bb. By revising the definition for ''Round, rounded, or rounding.''

cc. By adding the definition for ''Subconfiguration.''

dd. By adding the definition for ''Track width.''

ee. By revising the definition for ''Transmission class.''

ff. By revising the definition for ''Transmission configuration.''

gg. By adding the definition for ''Wheelbase.''

§ 86.1803–01 Definitions.

* * * * *

Air Conditioning Idle Test means the test procedure specified in § 86.165–12.

Air conditioning system means a unique combination of air conditioning and climate control components, including: compressor type (*e.g.,* belt, gear, or electric-driven, or a combination of compressor drive mechanisms); compressor refrigerant capacity; the number and type of rigid pipe and flexible hose connections; the number of high side service ports; the number of low side service ports; the number of switches, transducers, and expansion valves; the number of TXV refrigerant control devices; the number and type of heat exchangers, mufflers, receiver/dryers, and accumulators; and the type of flexible hose (*e.g.,* rubber, standard barrier or veneer, ultra-low permeation).

* * * * *

Banking means one of the following:

(1) The retention of NO_X emission credits for complete heavy-duty vehicles by the manufacturer generating the emission credits, for use in future model year certification programs as permitted by regulation.

(2) The retention of cold temperature non-methane hydrocarbon (NMHC) emission credits for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles by the manufacturer generating the emission credits, for use in future model year certification programs as permitted by regulation.

(3) The retention of NO_X emission credits for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles for use in future model year certification programs as permitted by regulation.

(4) The retention of CO_2 emission credits for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles for use in future model year certification programs as permitted by regulation.

Base level has the meaning given in § 600.002–08 of this chapter.

Base tire has the meaning given in § 600.002–08 of this chapter.

Base vehicle has the meaning given in § 600.002–08 of this chapter.

Basic engine has the meaning given in § 600.002–08 of this chapter.

Battery electric vehicle means a motor vehicle propelled solely by an electric motor where energy for the motor is supplied by a battery.

* * * * *

Carbon-related exhaust emissions means the summation of the carbon-containing constituents of the exhaust emissions, with each constituent adjusted by a coefficient representing the carbon weight fraction of each constituent, as specified in § 600.113–08.

* * * * *

Combined CO_2 means the CO_2 value determined for a vehicle (or vehicles) by averaging the city and highway fuel economy values, weighted 0.55 and 0.45 respectively.

* * * * *

Electric vehicle means a motor vehicle that is powered solely by an electric motor drawing current from a rechargeable energy storage system, such as from storage batteries or other portable electrical energy storage devices, including hydrogen fuel cells, provided that:

(1) Recharge energy must be drawn from a source off the vehicle, such as residential electric service; and

(2) The vehicle must be certified to the emission standards of Bin #1 of Table S04–1 in § 86.1811–09(c)(6).

* * * * *

Engine code means a unique combination within a test group of displacement, fuel injection (or carburetor) calibration, choke calibration, distributor calibration, auxiliary emission control devices, and other engine and emission control system components specified by the Administrator. For electric vehicles, engine code means a unique combination of manufacturer, electric traction motor, motor configuration, motor controller, and energy storage device.

* * * * *

Ethanol-fueled vehicle means any motor vehicle or motor vehicle engine that is engineered and designed to be operated using ethanol fuel (*i.e.,* a fuel that contains at least 50 percent ethanol (C_2H_5OH) by volume) as fuel.

* * * * *

Flexible fuel vehicle means any motor vehicle engineered and designed to be operated on a petroleum fuel, a methanol or ethanol fuel, or any mixture of the two. Methanol-fueled and ethanol-fueled vehicles that are only marginally functional when using gasoline (*e.g.,* the engine has a drop in rated horsepower of more than 80 percent) are not flexible fuel vehicles.

Footprint is 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) and 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.

Fuel cell means an electrochemical cell that produces electricity via the reaction of a consumable fuel on the anode with an oxidant on the cathode in the presence of an electrolyte.

Fuel cell electric vehicle means a motor vehicle propelled solely by an electric motor where energy for the motor is supplied by a fuel cell.

* * * * *

Highway Fuel Economy Test Procedure (HFET) has the meaning given in § 600.002–08 of this chapter.

* * * * *

Hybrid electric vehicle (HEV) means a motor vehicle which draws propulsion energy from onboard sources of stored energy that are both an internal combustion engine or heat engine using consumable fuel, and a rechargeable energy storage system such as a battery, capacitor, hydraulic accumulator, or flywheel.

* * * * *

Interior volume index has the meaning given in § 600.315–08 of this chapter.

* * * * *

Motor vehicle has the meaning given in 40 CFR 85.1703.

* * * * *

Multi-fuel vehicle means any motor vehicle capable of operating on two or more different fuel types, either separately or simultaneously.

* * * * *

Petroleum equivalency factor means the value specified in 10 CFR 474.3(b), which incorporates the parameters listed in 49 U.S.C. 32904(a)(2)(B) and is used to calculate petroleum-equivalent fuel economy.

Petroleum-equivalent fuel economy means the value, expressed in miles per gallon, that is calculated for an electric vehicle in accordance with 10 CFR 474.3(a), and reported to the Administrator of the Environmental Protection Agency for use in determining the vehicle manufacturer's corporate average fuel economy.

* * * * *

Petroleum-powered accessory means a vehicle accessory (*e.g.,* a cabin heater, defroster, and/or air conditioner) that:

(1) Uses gasoline or diesel fuel as its primary energy source; and

(2) Meets the requirements for fuel, operation, and emissions in 40 CFR part 88.104–94(g).

Plug-in hybrid electric vehicle (PHEV) means a hybrid electric vehicle that:

(1) Has the capability to charge the battery from an off-vehicle electric source, such that the off-vehicle source cannot be connected to the vehicle while the vehicle is in motion, and

(2) Has an equivalent all-electric range of no less than 10 miles.

* * * * *

Production volume has the meaning given in § 600.002–08 of this chapter.

* * * * *

Round, rounded or *rounding* means, unless otherwise specified, that numbers will be rounded according to ASTM–E29–93a, which is incorporated by reference in this part pursuant to § 86.1.

* * * * *

Subconfiguration has the meaning given in § 600.002–08 of this chapter.

* * * * *

Track width is the lateral distance between the centerlines of the base tires at ground, including the camber angle.

* * * * *

Transmission class has the meaning given in § 600.002–08 of this chapter.

Transmission configuration has the meaning given in § 600.002–08 of this chapter.

* * * * *

Wheelbase is the longitudinal distance between front and rear wheel centerlines.

* * * * *

12. A new section 86.1805–12 is added to read as follows:

§ 86.1805–12 Useful life.

(a) Except as permitted under paragraph (b) of this section or required under paragraphs (c) and (d) of this section, the full useful life for all LDVs and LLDTs is a period of use of 10 years or 120,000 miles, whichever occurs first. The full useful life for all HLDTs, MDPVs, and complete heavy-duty vehicles is a period of 11 years or 120,000 miles, whichever occurs first. These full useful life values apply to all exhaust, evaporative and refueling emission requirements except for standards which are specified to only be applicable at the time of certification. These full useful life requirements also apply to all air conditioning leakage credits, air conditioning efficiency credits, and other credit programs used by the manufacturer to comply with fleet average CO_2 emission standards.

(b) Manufacturers may elect to optionally certify a test group to the Tier 2 exhaust emission standards for 150,000 miles to gain additional NO_X credits, as permitted in § 86.1860–04(g), or to opt out of intermediate life standards as permitted in § 86.1811–04(c). In such cases, useful life is a period of use of 15 years or 150,000 miles, whichever occurs first, for all exhaust, evaporative and refueling emission requirements except for cold CO standards and standards which are applicable only at the time of certification.

(c) Where intermediate useful life exhaust emission standards are applicable, such standards are applicable for five years or 50,000 miles, whichever occurs first.

(d) Where cold CO standards are applicable, the useful life requirement for compliance with the cold CO standard only, is 5 years or 50,000 miles, whichever occurs first.

13. Section 86.1806–05 is amended by revising paragraph (a)(1) to read as follows:

§ 86.1806–05 On-board diagnostics for vehicles less than or equal to 14,000 pounds GVWR.

(a) * * *

(1) Except as provided by paragraph (a)(2) of this section, all light-duty vehicles, light-duty trucks and complete heavy-duty vehicles weighing 14,000 pounds GVWR or less (including MDPVs) must be equipped with an onboard diagnostic (OBD) system capable of monitoring all emission-related powertrain systems or components during the applicable useful life of the vehicle. All systems and components required to be monitored by these regulations must be evaluated periodically, but no less frequently than once per applicable certification test cycle as defined in paragraphs (a) and (d) of Appendix I of this part, or similar trip as approved by the Administrator. Emissions of CO_2 are not required to be monitored by the OBD system.

* * * * *

14. Section 86.1809–10 is amended by revising paragraphs (d)(1) and (e) to read as follows:

§ 86.1809–10 Prohibition of defeat devices.

* * * * *

(d) * * *

(1) The manufacturer must show to the satisfaction of the Administrator that the vehicle design does not incorporate strategies that unnecessarily reduce emission control effectiveness exhibited during the Federal Test Procedure or Supplemental Federal Test Procedure (FTP or SFTP), or, for 2012 and later model years, the Highway Fuel Economy Test Procedure or the Air Conditioning Idle Test, when the vehicle is operated under conditions that may reasonably be expected to be encountered in normal operation and use.

* * * * *

(e) For each test group the manufacturer must submit, with the Part II certification application, an engineering evaluation demonstrating to the satisfaction of the Administrator that a discontinuity in emissions of non-methane organic gases, carbon monoxide, carbon dioxide, oxides of nitrogen and formaldehyde measured on the Federal Test Procedure (subpart B of this part) does not occur in the temperature range of 20 to 86 °F. For diesel vehicles, the engineering evaluation must also include particulate emissions.

15. Section 86.1810–09 is amended by revising paragraph (f) to read as follows:

§ 86.1810–09 General standards; increase in emissions; unsafe condition; waivers.

* * * * *

(f) *Altitude requirements.* (1) All emission standards apply at low altitude conditions and at high altitude conditions, except for the following standards, which apply only at low altitude conditions:

(i) The supplemental exhaust emission standards as described in § 86.1811–04(f);

(ii) The cold temperature NMHC emission standards as described in § 86.1811–10(g);

(iii) The evaporative emission standards as described in § 86.1811–09(e).

(2) For vehicles that comply with the cold temperature NMHC standards described in § 86.1811–10(g) and the CO_2, N_2O, and CH_4 exhaust emission standards described in § 86.1818–12, manufacturers must submit an engineering evaluation indicating that common calibration approaches are utilized at high altitudes. Any deviation from low altitude emission control practices must be included in the auxiliary emission control device (AECD) descriptions submitted at certification. Any AECD specific to high altitude must require engineering emission data for EPA evaluation to quantify any emission impact and validity of the AECD.

* * * * *

16. A new § 86.1818–12 is added to read as follows:

§ 86.1818–12 Greenhouse gas emission standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles.

(a) *Applicability.* This section contains regulations implementing greenhouse gas emission standards for CO_2, N_2O, and CH_4 applicable to all LDVs, LDTs and MDPVs. This section applies to 2012 and later model year LDVs, LDTs and MDPVs, including multi-fuel vehicles, vehicles fueled with alternative fuels, hybrid electric vehicles, plug-in hybrid electric vehicles, electric vehicles, and fuel cell electric vehicles. Unless otherwise specified, multi-fuel vehicles must comply with all requirements established for each consumed fuel. The provisions of this section also apply to aftermarket conversion systems, aftermarket conversion installers, and aftermarket conversion certifiers, as those terms are defined in 40 CFR 85.502, of all model year light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles. Manufacturers meeting the requirements of § 86.1801–12(j) are exempted from the requirements of this section.

(b) *Definitions.* For the purposes of this section, the following definitions shall apply:

(1) *Passenger automobile* means a motor vehicle that is a passenger automobile as that term is defined in 49 CFR 523.4.

(2) *Light truck* means a motor vehicle that is a non-passenger automobile as that term is defined by the Department of Transportation in 49 CFR 523.5.

(c) *Fleet average CO_2 standards for passenger automobiles and light trucks.* (1) For a given individual model year's production of vehicles, manufacturers must comply with a fleet average CO_2 standard calculated according to the provisions of this paragraph (c). Manufacturers must calculate separate fleet average CO_2 standards for their passenger automobile and the light truck fleets, as those terms are defined in this section. Each manufacturer's fleet average CO_2 standards determined in this paragraph (c) shall be expressed in whole grams per mile, in the model year specified as applicable. Manufacturers eligible for and choosing to participate in the optional interim fleet average CO_2 standards for qualifying manufacturers specified in paragraph (e) of this section shall not include vehicles subject to the optional interim fleet average CO_2 standards in the calculations of their primary passenger automobile or light truck standards determined in this paragraph (c). Manufacturers shall demonstrate compliance with the applicable standards according to the provisions of § 86.1865–12.

(2) *Passenger automobiles.*

(i) *Calculation of CO_2 target values for passenger automobiles.* A CO_2 target value shall be determined for each passenger automobile as follows:

(A) For passenger automobiles with a footprint of less than or equal to 41 square feet, the gram/mile CO_2 target value shall be selected for the appropriate model year from the following table:

Model year	CO_2 target value (grams/mile)
2012	242
2013	234
2014	227
2015	215
2016 and later	204

(B) For passenger automobiles with a footprint of greater than 56 square feet, the gram/mile CO_2 target value shall be selected for the appropriate model year from the following table:

Model year	CO_2 target value (grams/mile)
2012	313
2013	305
2014	297
2015	286
2016 and later	275

(C) For passenger automobiles with a footprint that is greater than 41 square feet and less than or equal to 56 square feet, the gram/mile CO_2 target value shall be calculated using the following equation:

$$\text{TargetCO}_2 = [4.72 \times f] + b$$

Where:

f is the vehicle footprint, as defined in § 86.1803; and

b is selected from the following table for the appropriate model year:

Model year	*b*
2012	48.8
2013	40.8
2014	33.2
2015	22.0
2016 and later	10.9

(ii) *Calculation of the fleet average CO_2 standard for passenger automobiles.* In each model year manufacturers must comply with the CO_2 exhaust emission standard for their passenger automobile fleet, calculated for that model year as follows:

(A) A CO_2 target value shall be determined according to paragraph (c)(2)(i) of this section for each unique combination of model type and footprint value.

(B) Each CO_2 target value, determined for each unique combination of model type and footprint value, shall be multiplied by the total production of that model type/footprint combination for the appropriate model year.

(C) The resulting products shall be summed, and that sum shall be divided by the total production of passenger automobiles in that model year. The result shall be rounded to the nearest whole gram per mile. This result shall be the applicable fleet average CO_2 standard for the manufacturer's passenger automobile fleet.

(3) *Light trucks.*

(i) *Calculation of CO_2 target values for light trucks.* A CO_2 target value shall be determined for each light truck as follows:

(A) For light trucks with a footprint of less than or equal to 41 square feet, the gram/mile CO_2 target value shall be selected for the appropriate model year from the following table:

Model year	CO_2 target value (grams/mile)
2012	298
2013	287
2014	276
2015	261
2016 and later	246

(B) For light trucks with a footprint of greater than 66 square feet, the gram/mile CO_2 target value shall be selected for the appropriate model year from the following table:

Model year	CO_2 target value (grams/mile)
2012	399
2013	388
2014	377
2015	362
2016 and later	347

(C) For light trucks with a footprint that is greater than 41 square feet and less than or equal to 66 square feet, the gram/mile CO_2 target value shall be calculated using the following equation:

$$CO_2\text{TargetValue} = (4.04 \times f) + b$$

Where:

f is the footprint, as defined in § 86.1803; and

b is selected from the following table for the appropriate model year:

Model year	*b*
2012	132.6
2013	121.6
2014	110.3
2015	95.2
2016 and later	80.4

(ii) *Calculation of fleet average CO_2 standards for light trucks.* In each model year manufacturers must comply with the CO_2 exhaust emission standard for their light truck fleet, calculated for that model year as follows:

(A) A CO_2 target value shall be determined according to paragraph (c)(2)(i) of this section for each unique combination of model type and footprint value.

(B) Each CO_2 target value, which represents a unique combination of model type and footprint value, shall be multiplied by the total production of that model type/footprint combination for the appropriate model year.

(C) The resulting products shall be summed, and that sum shall be divided by the total production of light trucks in that model year. The result shall be rounded to the nearest whole gram per mile. This result shall be the applicable fleet average CO_2 standard for the manufacturer's light truck fleet.

(d) *In-use CO_2 exhaust emission standards.* The in-use exhaust CO_2 emission standard for each model type shall be the combined city/highway carbon-related exhaust emission value calculated according to the provisions of 40 CFR 600.208–08 (except that total model year production data shall be used instead of sales projections) multiplied by 1.1 and rounded to the nearest whole gram per mile. These standards apply to in-use testing performed by the manufacturer pursuant to regulations at § 86.1845–04 and 86.1846–01 and to in-use testing performed by EPA. For any model type that is not covered by vehicle testing conducted according to 40 CFR 600.208–08 the applicable in-use standard shall be the CO_2-equivalent value submitted at certification according to the provisions of § 86.1841 multiplied by 1.1 and rounded to the nearest whole gram per mile.

(e) *Optional interim fleet average CO_2 standards for qualifying manufacturers.* (1) The interim fleet average CO_2 standards in this paragraph (e) are optionally applicable to each qualifying manufacturer as follows:

(i) A qualifying manufacturer is a manufacturer with sales of 2009 model year combined passenger automobiles and light trucks in the United States of less than 400,000 vehicles, except that manufacturers with no U.S. sales in the 2009 model year do not qualify for the optional interim standards.

(ii) For the purposes of making the determination in paragraph (e)(1)(i) of this section, ''manufacturer'' shall mean that term as defined at 49 CFR 531.4 and as that definition was applied to the 2009 model year for the purpose of determining compliance with the 2009 corporate average fuel economy standards at 49 CFR parts 531 and 533.

(iii) Only 2012 through 2015 model year passenger automobiles and light trucks are eligible for these standards. All model year 2016 and later passenger automobiles and light trucks are subject to the fleet average standards described in paragraph (c) of this section.

(iv) A qualifying manufacturer may select any combination of 2012 through 2015 model year passenger automobiles and/or light trucks to comply with these optional standards up to a cumulative total of 100,000 vehicles. Vehicles selected to comply with these standards shall not be included in the calculations of the manufacturer's fleet average standards under paragraph (c) of this section.

(v) A qualifying manufacturer may not use these optional interim fleet average CO_2 standards until they have used all available banked CO_2 credits and/or CO_2 credits available for transfer. A qualifying manufacturer with a net positive credit balance in any model year after considering all available credits generated, carried forward from a prior model year, transferred from other averaging sets, or obtained from other manufacturers, may not use these optional interim fleet average CO_2 standards in such model year.

(2) To calculate an optional interim fleet average CO_2 standard, qualifying manufacturers shall determine the fleet average standard separately for the passenger automobiles and light trucks selected by the manufacturer to be subject to the interim fleet average CO_2 standard, subject to the limitations expressed in paragraphs (e)(1)(iii) and (iv) of this section.

(i) The interim fleet average CO_2 standard applicable to qualified passenger automobiles shall be the standard calculated using the provisions of paragraph (c)(2)(ii) of this section for the appropriate model year multiplied by 1.25 and rounded to the nearest whole gram per mile. For the purposes of applying paragraph (c)(2)(ii) of this section to determine the standard, the passenger automobile fleet shall be limited to those passenger automobiles subject to the interim fleet average CO_2 standard.

(ii) The interim fleet average CO_2 standard applicable to qualified light trucks shall be the standard calculated using the provisions of paragraph (c)(3)(ii) of this section for the appropriate model year multiplied by 1.25 and rounded to the nearest whole gram per mile. For the purposes of applying paragraph (c)(3)(ii) of this section to determine the standard, the light truck fleet shall be limited to those light trucks subject to the interim fleet average CO_2 standard.

(3) Manufacturers choosing to optionally apply these standards are subject to the restrictions on credit banking and trading specified in § 86.1865–12.

(f) *N_2O standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles.* Exhaust emissions of nitrous oxide (N_2O) shall not exceed 0.010 grams per mile at full useful life, as measured according to the Federal Test Procedure (FTP) described in subpart B of this part.

(g) *Methane standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles.* Exhaust emissions of methane (CH_4) shall not exceed 0.030 grams per mile at full useful life, as measured according to the Federal Test Procedure (FTP) described in subpart B of this part.

17. Section 86.1823–08 is amended by adding paragraph (m) to read as follows:

§ 86.1823–08 Durability demonstration procedures for exhaust emissions.

* * * * *

(m) *Durability demonstration procedures for vehicles subject to the greenhouse gas exhaust emission standards specified in 86.1818–12.*

(1) *CO_2.* (i) Unless otherwise specified under paragraph (m)(1)(ii) of this section, manufacturers may use a multiplicative CO_2 deterioration factor of one or an additive deterioration factor of zero.

(ii) Based on an analysis of industry-wide data, EPA may periodically establish and/or update the deterioration factor for CO_2 emissions including air conditioning and other credit related emissions. Deterioration factors established and/or updated under this paragraph (m)(1)(ii) will provide adequate lead time for manufacturers to plan for the change.

(iii) Alternatively, manufacturers may use the whole-vehicle mileage accumulation procedures in § 86.1823–08 paragraphs (c) or (d)(1) to determine CO_2 deterioration factors. In this case, each FTP test performed on the durability data vehicle selected under § 86.1822–01 of this part must also be accompanied by an HFET test, and combined FTP/HFET CO_2 results determined by averaging the city (FTP) and highway (HFET) CO_2 values, weighted 0.55 and 0.45 respectively. The deterioration factor will be determined for this combined CO_2 value. Calculated multiplicative deterioration factors that are less than one shall be set to equal one, and calculated additive deterioration factors that are less than zero shall be set to zero.

(iv) If, in the good engineering judgment of the manufacturer, the deterioration factors determined according to paragraphs (m)(1)(i), (m)(1)(ii), or (m)(1)(iii) of this section do not adequately account for the expected CO_2 emission deterioration over the vehicle's useful life, the manufacturer may petition EPA to request a more appropriate deterioration factor.

(2) *N_2O and CH_4.* Deterioration factors for N_2O and CH_4 shall be determined according to the provisions of § 86.1823–08.

(3) *Air Conditioning leakage and efficiency or other emission credit requirements to comply with exhaust CO_2 standards.* Manufactures will attest to the durability of components and systems used to meet the CO_2 standards. Manufacturers may submit engineering data to provide durability demonstration.

18. Section 86.1827–01 is amended by revising paragraph (a)(5) and by adding paragraph (f) to read as follows:

§ 86.1827–01 Test group determination.

* * * * *

(a) * * *

(5) Subject to the same emission standards (except for CO_2), or FEL in the case of cold temperature NMHC standards, except that a manufacturer may request to group vehicles into the same test group as vehicles subject to more stringent standards, so long as all the vehicles within the test group are certified to the most stringent standards applicable to any vehicle within that test group. Light-duty trucks and light-duty vehicles may be included in the same test group if all vehicles in the test group are subject to the same emission standards, with the exception of the CO_2 standard, the light-duty truck idle CO standard, and/or the total HC standard.

* * * * *

(f) Unless otherwise approved by the Administrator, a manufacturer of electric vehicles must create separate test groups based on the type of battery technology, the capacity and voltage of the battery, and the type and size of the electric motor.

19. Section 86.1829–01 is amended by revising paragraph (b)(1)(i) and by adding paragraph (b)(1)(iii)(G) to read as follows:

§ 86.1829–01 Durability and emission testing requirements; waivers.

* * * * *

(b) * * *

(1) * * *

(i) *Testing at low altitude.* One EDV shall be tested in each test group for exhaust emissions using the FTP and SFTP test procedures of subpart B of this part and the HFET test procedure of subpart B of part 600 of this chapter. The configuration of the EDV will be determined under the provisions of § 86.1828–01 of this subpart.

* * * * *

(iii) * * *

(G) For the 2012 model year only, in lieu of testing a vehicle for N_2O emissions, a manufacturer may provide a statement in its application for certification that such vehicles comply with the applicable standards. Such a statement must be based on previous emission tests, development tests, or other appropriate information and good engineering judgment.

* * * * *

20. Section 86.1835–01 is amended as follows:

a. By revising paragraph (a)(4).

b. By revising paragraph (b)(1) introductory text.

c. By adding paragraph (b)(1)(vi).

d. By revising paragraph (b)(3).

e. By revising paragraph (c)(1)(ii).

§ 86.1835–01 Confirmatory certification testing.

(a) * * *

(4) Retesting for fuel economy reasons or for compliance with applicable exhaust CO_2 emission standards may be conducted under the provisions of 40 CFR 600.008–01.

(b) * * *

(1) If the Administrator determines not to conduct a confirmatory test under the provisions of paragraph (a) of this section, manufacturers of light-duty vehicles, light-duty trucks, and/or medium-duty passenger vehicles will conduct a confirmatory test at their facility after submitting the original test data to the Administrator whenever any of the conditions listed in paragraphs (b)(1)(i) through (vi) of this section exist, and complete heavy-duty vehicles manufacturers will conduct a confirmatory test at their facility after submitting the original test data to the Administrator whenever the conditions listed in paragraph (b)(1)(i) or (b)(1)(ii) of this section exist, as follows:

* * * * *

(vi) The exhaust CO_2 emissions of the test as measured in accordance with the procedures in 40 CFR Part 600 are lower than expected based on procedures approved by the Administrator.

* * * * *

(3) For light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles the manufacturer shall conduct a retest of the FTP or highway test if the difference between the fuel economy or carbon-related exhaust emissions of the confirmatory test and the original manufacturer's test equals or exceeds three percent (or such lower percentage to be applied consistently to all manufacturer conducted confirmatory testing as requested by the manufacturer and approved by the Administrator).

(i) For use in the fuel economy and CO_2 fleet averaging program described in 40 CFR parts 86 and 600, the manufacturer may, in lieu of conducting a retest, accept as official the lower of the original and confirmatory test fuel economy results, and the higher of the original and confirmatory test CO_2 results.

(ii) The manufacturer shall conduct a second retest of the FTP or highway test if the fuel economy or CO_2 emissions difference between the second confirmatory test and the original manufacturer test equals or exceeds three percent (or such lower percentage as requested by the manufacturer and approved by the Administrator) and the fuel economy or CO_2 emissions difference between the second confirmatory test and the first confirmatory test equals or exceeds three percent (or such lower percentage as requested by the manufacturer and approved by the Administrator). In lieu of conducting a second retest, the manufacturer may accept as official (for use in the fuel economy program and the CO_2 fleet averaging program) the lowest fuel economy and highest CO_2 emissions of the original test, the first confirmatory test, and the second confirmatory test fuel economy results.

(c) * * *

(1) * * *

(ii) Official test results for fuel economy and exhaust CO_2 emission purposes are determined in accordance with the provisions of 40 CFR 600.008–01.

* * * * *

21. Section 86.1841–01 is amended by adding paragraph (a)(3) and revising paragraph (b) to read as follows:

§ 86.1841–01 Compliance with emission standards for the purpose of certification.

(a) * * *

(3) Compliance with CO_2 exhaust emission standards shall be demonstrated at certification by the certification levels on the FTP and HFET tests for carbon-related exhaust emissions determined according to § 600.113–08 of this chapter.

* * * * *

(b) To be considered in compliance with the standards for the purposes of certification, the certification levels for the test vehicle calculated in paragraph (a) of this section shall be less than or equal to the standards for all emission constituents to which the test group is subject, at both full and intermediate useful life as appropriate for that test group.

* * * * *

22. Section 86.1845–04 is amended as follows:

a. By revising paragraph (a)(1).

b. By revising paragraph (b)(5)(i).

c. By revising paragraph (c)(5)(i).

§ 86.1845–04 Manufacturer in-use verification testing requirements.

(a) * * *

(1) A manufacturer of LDVs, LDTs, MDPVs and/or complete HDVs must test, or cause to have tested, a specified number of LDVs, LDTs, MDPVs and complete HDVs. Such testing must be conducted in accordance with the provisions of this section. For purposes of this section, the term vehicle includes light-duty vehicles, light-duty trucks and medium-duty passenger vehicles.

* * * * *

(b) * * *

(5) * * *

(i) Each test vehicle of a test group shall be tested in accordance with the Federal Test Procedure and the US06 portion of the Supplemental Federal Test Procedure as described in subpart B of this part, when such test vehicle is tested for compliance with applicable exhaust emission standards under this subpart. Test vehicles subject to applicable exhaust CO_2 emission standards under this subpart shall also be tested in accordance with the highway fuel economy test as described in subpart B of 40 CFR part 600.

* * * * *

(c) * * *

(5) * * *

(i) Each test vehicle shall be tested in accordance with the Federal Test Procedure and the US06 portion of the Supplemental Federal Test Procedure as described in subpart B of this part when such test vehicle is tested for compliance with applicable exhaust emission standards under this subpart. Test vehicles subject to applicable exhaust CO_2 emission standards under this subpart shall also be tested in accordance with the highway fuel economy test as described in subpart B of 40 CFR part 600. The US06 portion of the SFTP is not required to be performed on vehicles certified in accordance with the National LEV provisions of subpart R of this part. One test vehicle from each test group shall receive a Federal Test Procedure at high altitude. The test vehicle tested at high altitude is not required to be one of the same test vehicles tested at low altitude. The test vehicle tested at high altitude is counted when determining the compliance with the requirements shown in Table S04–06 and Table S04–07 in paragraph (b)(3) of this section or the expanded sample size as provided for in this paragraph (c).

* * * * *

23. Section 86.1846–01 is amended by revising paragraphs (a)(1) and (b) introductory text to read as follows:

§ 86.1846–01 Manufacturer in-use confirmatory testing requirements.

(a) * * *

(1) A manufacturer of LDVs, LDTs and/or MDPVs must test, or cause testing to be conducted, under this section when the emission levels shown by a test group sample from testing under §§ 86.1845–01 or 86.1845–04, as applicable, exceeds the criteria specified in paragraph (b) of this section. The testing required under this section applies separately to each test group and at each test point (low and high mileage) that meets the specified criteria. The testing requirements apply separately for each model year starting with model year 2001. These provisions do not apply to heavy-duty vehicles or heavy-duty engines prior to the 2007 model year. These provisions do not apply to emissions of CO_2, CH_4, and N_2O.

* * * * *

(b) *Criteria for additional testing.* A manufacturer shall test a test group or a subset of a test group as described in paragraph (j) of this section when the results from testing conducted under §§ 86.1845–01 and 86.1845–04, as applicable, show mean emissions for that test group of any pollutant(s) (except CO_2, CH_4, and N_2O) to be equal to or greater than 1.30 times the applicable in-use standard and a failure rate, among the test group vehicles, for the corresponding pollutant(s) of fifty percent or greater.

* * * * *

24. Section 86.1848–10 is amended by adding paragraph (c)(9) to read as follows:

§ 86.1848–10 Certification.

* * * * *

(c) * * *

(9) For 2012 and later model year LDVs, LDTs, and MDPVs, all certificates of conformity issued are conditional upon compliance with all provisions of §§ 86.1818–12 and 86.1865–12 both during and after model year production. The manufacturer bears the burden of establishing to the satisfaction of the Administrator that the terms and conditions upon which the certificate(s) was (were) issued were satisfied. For recall and warranty purposes, vehicles not covered by a certificate of conformity will continue to be held to the standards stated or referenced in the certificate that otherwise would have applied to the vehicles.

(i) Failure to meet the fleet average CO_2 requirements will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of the fleet average CO_2 standard will not be covered by the certificate(s). The vehicles sold in violation will be determined according to § 86.1865–12(k)(7).

(ii) Failure to comply fully with the prohibition against selling credits that are not generated or that are not available, as specified in § 86.1865–12, will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of this prohibition will not be covered by the certificate(s).

* * * * *

25. A new § 86.1854–12 is added to read as follows:

§ 86.1854–12 Prohibited acts.

(a) The following acts and the causing thereof are prohibited:

(1) In the case of a manufacturer, as defined by § 86.1803, of new motor vehicles or new motor vehicle engines for distribution in commerce, the sale, or the offering for sale, or the introduction, or delivery for introduction, into commerce, or (in the case of any person, except as provided by regulation of the Administrator), the importation into the United States of any new motor vehicle or new motor vehicle engine subject to this subpart, unless such vehicle or engine is covered by a certificate of conformity issued (and in effect) under regulations found in this subpart (except as provided in Section 203(b) of the Clean Air Act (42 U.S.C. 7522(b)) or regulations promulgated thereunder).

(2)(i) For any person to fail or refuse to permit access to or copying of records or to fail to make reports or provide information required under Section 208 of the Clean Air Act (42 U.S.C. 7542) with regard to vehicles.

(ii) For a person to fail or refuse to permit entry, testing, or inspection authorized under Section 206(c) (42 U.S.C. 7525(c)) or Section 208 of the Clean Air Act (42 U.S.C. 7542) with regard to vehicles.

(iii) For a person to fail or refuse to perform tests, or to have tests performed as required under Section 208 of the Clean Air Act (42 U.S.C. 7542) with regard to vehicles.

(iv) For a person to fail to establish or maintain records as required under §§ 86.1844, 86.1862, 86.1864, and 86.1865 with regard to vehicles.

(v) For any manufacturer to fail to make information available as provided by regulation under Section 202(m)(5) of the Clean Air Act (42 U.S.C. 7521(m)(5)) with regard to vehicles.

(3)(i) For any person to remove or render inoperative any device or element of design installed on or in a vehicle or engine in compliance with regulations under this subpart prior to its sale and delivery to the ultimate purchaser, or for any person knowingly to remove or render inoperative any such device or element of design after such sale and delivery to the ultimate purchaser.

(ii) For any person to manufacture, sell or offer to sell, or install, any part or component intended for use with, or as part of, any vehicle or engine, where a principal effect of the part or component is to bypass, defeat, or render inoperative any device or element of design installed on or in a vehicle or engine in compliance with regulations issued under this subpart, and where the person knows or should know that the part or component is being offered for sale or installed for this use or put to such use.

(4) For any manufacturer of a vehicle or engine subject to standards prescribed under this subpart:

(i) To sell, offer for sale, introduce or deliver into commerce, or lease any such vehicle or engine unless the manufacturer has complied with the requirements of Section 207 (a) and (b) of the Clean Air Act (42 U.S.C. 7541 (a), (b)) with respect to such vehicle or engine, and unless a label or tag is affixed to such vehicle or engine in accordance with Section 207(c)(3) of the Clean Air Act (42 U.S.C. 7541(c)(3)).

(ii) To fail or refuse to comply with the requirements of Section 207 (c) or (e) of the Clean Air Act (42 U.S.C. 7541 (c) or (e)).

(iii) Except as provided in Section 207(c)(3) of the Clean Air Act (42 U.S.C. 7541(c)(3)), to provide directly or indirectly in any communication to the ultimate purchaser or any subsequent purchaser that the coverage of a warranty under the Clean Air Act is conditioned upon use of any part, component, or system manufactured by the manufacturer or a person acting for the manufacturer or under its control, or conditioned upon service performed by such persons.

(iv) To fail or refuse to comply with the terms and conditions of the warranty under Section 207 (a) or (b) of the Clean Air Act (42 U.S.C. 7541 (a) or (b)).

(b) For the purposes of enforcement of this subpart, the following apply:

(1) No action with respect to any element of design referred to in paragraph (a)(3) of this section (including any adjustment or alteration of such element) shall be treated as a prohibited act under paragraph (a)(3) of this section if such action is in accordance with Section 215 of the Clean Air Act (42 U.S.C. 7549);

(2) Nothing in paragraph (a)(3) of this section is to be construed to require the use of manufacturer parts in maintaining or repairing a vehicle or engine. For the purposes of the preceding sentence, the term ''manufacturer parts'' means, with respect to a motor vehicle engine, parts produced or sold by the manufacturer of the motor vehicle or motor vehicle engine;

(3) Actions for the purpose of repair or replacement of a device or element of design or any other item are not considered prohibited acts under paragraph (a)(3) of this section if the action is a necessary and temporary procedure, the device or element is replaced upon completion of the procedure, and the action results in the proper functioning of the device or element of design;

(4) Actions for the purpose of a conversion of a motor vehicle or motor vehicle engine for use of a clean alternative fuel (as defined in title II of the Clean Air Act) are not considered prohibited acts under paragraph (a) of this section if:

(i) The vehicle complies with the applicable standard when operating on the alternative fuel; and

(ii) In the case of engines converted to dual fuel or flexible use, the device or element is replaced upon completion of the conversion procedure, and the action results in proper functioning of the device or element when the motor vehicle operates on conventional fuel.

26. A new § 86.1865–12 is added to subpart S to read as follows:

§ 86.1865–12 How to comply with the fleet average CO_2 standards.

(a) *Applicability.* (1) Unless otherwise exempted under the provisions of § 86.1801–12(j), CO_2 fleet average exhaust emission standards apply to:

(i) 2012 and later model year passenger automobiles and light trucks.

(ii) Aftermarket conversion systems as defined in 40 CFR 85.502.

(iii) Vehicles imported by ICIs as defined in 40 CFR 85.1502.

(2) The terms ''passenger automobile'' and ''light truck'' as used in this section have the meanings as defined in § 86.1818–12.

(b) *Useful life requirements.* Full useful life requirements for CO_2 standards are defined in § 86.1818–12. There is not an intermediate useful life standard for CO_2 standards.

(c) *Altitude.* Altitude requirements for CO_2 standards are provided in § 86.1810–12(f).

(d) *Small volume manufacturer certification procedures.* Certification procedures for small volume manufacturers are provided in § 86.1838–01. Small businesses meeting certain criteria may be exempted from the fleet average CO_2 standards under § 86.1801–12(j).

(e) *CO_2 fleet average exhaust emission standards.* The fleet average standards referred to in this section are the corporate fleet average CO_2 standards for passenger automobiles and light trucks set forth in 86.1818–12(c) and (e). The fleet average CO_2 standards applicable in a given model year are calculated separately for passenger automobiles and light trucks for each manufacturer and each model year according to the provisions in § 86.1818–12. Each manufacturer must comply with the applicable CO_2 fleet average standard on a production-weighted average basis, for each separate averaging set, at the end of each model year, using the procedure described in paragraph (c) of this section.

(f) *In-use CO_2 standards.* In-use CO_2 exhaust emission standards applicable to each model type are provided in § 86.1818–12(d).

(g) *Durability procedures and method of determining deterioration factors (DFs).* Deterioration factors for CO_2 exhaust emission standards are provided in § 86.1823–08(m).

(h) *Vehicle test procedures.* (1) The test procedures for demonstrating compliance with CO_2 exhaust emission standards are contained in subpart B of this part and subpart B of part 600 of this chapter.

(2) Testing of all passenger automobiles and light trucks to determine compliance with CO_2 exhaust emission standards set forth in this section must be on a loaded vehicle weight (LVW) basis, as defined in § 86.1803–01.

(3) Testing for the purpose of providing certification data is required only at low altitude conditions. If hardware and software emission control strategies used during low altitude condition testing are not used similarly across all altitudes for in-use operation, the manufacturer must include a statement in the application for certification, in accordance with §§ 86.1844–01(d)(11) and 86.1810–12(f), stating what the different strategies are and why they are used.

(i) *Calculating the fleet average carbon-related exhaust emissions.* (1) Manufacturers must compute separate production-weighted fleet average carbon-related exhaust emissions at the end of the model year for passenger automobiles and light trucks, using actual production, where production means vehicles produced and delivered for sale, and certifying model types to standards as defined in § 86.1818–12. The model type carbon-related exhaust emission results determined according to 40 CFR 600 subpart F become the certification standard for each model type.

(2) Manufacturers must separately calculate production-weighted fleet average carbon-related exhaust emissions levels for the following averaging sets according to the provisions of part 600 subpart F of this chapter:

(i) Passenger automobiles subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(2);

(ii) Light trucks subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(3);

(iii) Passenger automobiles subject to the optional interim fleet average CO_2 standards specified in § 86.1818–12(e), if applicable; and

(iv) Light trucks subject to the optional interim fleet average CO_2 standards specified in § 86.1818–12(e), if applicable.

(j) *Certification compliance and enforcement requirements for CO_2 exhaust emission standards.* (1) Compliance and enforcement requirements are provided in § 86.1864–10 and § 86.1848–10(c)(8).

(2) The certificate issued for each test group requires all model types within that test group to meet the emission standard to which each model type is certified.

(3) Each manufacturer must comply with the applicable CO_2 fleet average standard on a production-weighted average basis, at the end of each model year, using the procedure described in paragraph (i) of this section.

(4) Manufacturers must compute separate CO_2 fleet averages for passenger automobiles and light trucks. The production-weighted CO_2 fleet averages must be compared with the applicable fleet average standard.

(5) Each manufacturer must comply on an annual basis with the fleet average standards as follows:

(i) Manufacturers must report in their annual reports to the Agency that they met the relevant corporate average standard by showing that their production-weighted average CO_2 emissions levels of passenger automobiles and light trucks, as applicable, are at or below the applicable fleet average standard; or

(ii) If the production-weighted average is above the applicable fleet average standard, manufacturers must obtain and apply sufficient CO_2 credits as authorized under paragraph (k)(7) of this section. A manufacturer must show that they have offset any exceedence of the corporate average standard via the use of credits. Manufacturers must also include their credit balances or deficits in their annual report to the Agency.

(iii) If a manufacturer fails to meet the corporate average CO_2 standard for four consecutive years, the vehicles causing the corporate average exceedence will be considered not covered by the certificate of conformity (see paragraph (k)(7) of this section). A manufacturer will be subject to penalties on an individual-vehicle basis for sale of vehicles not covered by a certificate.

(iv) EPA will review each manufacturer's production to designate the vehicles that caused the exceedence of the corporate average standard. EPA will designate as nonconforming those vehicles in test groups with the highest certification emission values first, continuing until reaching a number of vehicles equal to the calculated number of noncomplying vehicles as determined in paragraph (k)(7) of this section. In a group where only a portion of vehicles would be deemed nonconforming, EPA will determine the actual nonconforming vehicles by counting backwards from the last vehicle produced in that test group. Manufacturers will be liable for penalties for each vehicle sold that is not covered by a certificate.

(k) *Requirements for the CO_2 averaging, banking and trading (ABT) program.* (1) A manufacturer whose CO_2 fleet average emissions exceed the applicable standard must complete the calculation in paragraph (k)(4) of this section to determine the size of its CO_2 deficit. A manufacturer whose CO_2 fleet average emissions are less than the applicable standard must complete the calculation in paragraph (k)(4) of this section to generate CO_2 credits. In either case, the number of credits or debits must be rounded to the nearest whole number.

(2) There are no property rights associated with CO_2 credits generated under this subpart. Credits are a limited authorization to emit the designated amount of emissions. Nothing in this part or any other provision of law should be construed to limit EPA's authority to terminate or limit this authorization through a rulemaking.

(3) Each manufacturer must comply with the reporting and recordkeeping requirements of paragraph (l) of this section for CO_2 credits, including early credits. The averaging, banking and trading program is enforceable through the certificate of conformity that allows the manufacturer to introduce any regulated vehicles into commerce.

(4) Credits are earned on the last day of the model year. Manufacturers must calculate, for a given model year, the number of credits or debits it has generated according to the following equation, rounded to the nearest megagram:

CO_2 Credits or Debits (Mg) = [(CO_2 Standard—Manufacturer's Production-Weighted Fleet Average CO_2 Emissions) × (Total Number of Vehicles Produced) × (Vehicle Lifetime Miles)] ÷ 1,000,000

Where:

CO_2 Standard = the applicable standard for the model year as determined by § 86.1818–12;

Manufacturer's Production-Weighted Fleet Average CO_2 Emissions = average calculated according to paragraph (i) of this section;

Total Number of Vehicles Produced = The number of vehicles domestically produced plus those imported as defined in 40 CFR 600.511–80; and

Vehicle Lifetime Miles is 190,971 for passenger automobiles and 221,199 for light trucks.

(5) Total credits or debits generated in a model year, maintained and reported separately for passenger automobiles and light trucks, shall be the sum of the credits or debits calculated in paragraph (k)(4) of this section and any of the following credits, if applicable:

(i) Air conditioning leakage credits earned according to the provisions of 86.1866–12(b);

(ii) Air conditioning efficiency credits earned according to the provisions of 86.1866–12(c);

(iii) Off-cycle technology credits earned according to the provisions of 86.1866–12(d).

(6) Unused CO_2 credits shall retain their full value through the five subsequent model years after the model year in which they were generated. Credits available at the end of the fifth model year after the year in which they were generated shall expire.

(7) Credits may be used as follows:

(i) Credits generated and calculated according to the method in paragraph (k)(4) of this section may not be used to offset deficits other than those deficits accrued with respect to the standard in § 86.1818–12. Credits may be banked and used in a future model year in which a manufacturer's average CO_2 level exceeds the applicable standard. Credits may be exchanged between the passenger automobile and light truck fleets of a given manufacturer. Credits may also be traded to another manufacturer according to the provisions in paragraph (k)(8) of this section. Before trading or carrying over credits to the next model year, a manufacturer must apply available credits to offset any deficit, where the deadline to offset that credit deficit has not yet passed.

(ii) The use of credits shall not change Selective Enforcement Auditing or in-use testing failures from a failure to a non-failure. The enforcement of the averaging standard occurs through the vehicle's certificate of conformity. A manufacturer's certificate of conformity is conditioned upon compliance with the averaging provisions. The certificate will be void ab initio if a manufacturer fails to meet the corporate average standard and does not obtain appropriate credits to cover its shortfalls in that model year or subsequent model years (see deficit carry-forward provisions in paragraph (k)(7) of this section). Manufacturers must track their certification levels and production unless they produce only vehicles certified to CO_2 levels below the standard and do not plan to bank credits.

(iii) *Special provisions for manufacturers using the optional interim fleet average CO_2 standards.* (A) Credits generated by vehicles subject to the fleet average CO_2 standards specified in § 86.1818–12(c) may only be used to offset a deficit generated by vehicles subject to the optional interim fleet average CO_2 standards specified in § 86.1818–12(e).

(B) Credits generated by a passenger automobile or light truck averaging set subject to the optional interim fleet average CO_2 standards specified in § 86.1818–12(e)(2)(i) or (ii) of this section may be used to offset a deficit generated by an averaging set subject to the optional interim fleet average CO_2 standards through the 2015 model year.

(C) Credits generated by an averaging set subject to the optional interim fleet average CO_2 standards specified in § 86.1818–12(e)(2)(i) or (ii) of this section may not be used to offset a deficit generated by an averaging set subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(2) or (3) or otherwise transferred to an averaging set subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(2) or (3).

(D) Credits generated by vehicles subject to the optional interim fleet average CO_2 standards specified in § 86.1818–12(e)(2)(i) or (ii) may be banked for use in a future model year, except that all such credits shall expire at the end of the 2015 model year.

(E) A manufacturer with any vehicles subject to the optional interim fleet average CO_2 standards specified in § 86.1818–12(e)(2)(i) or (ii) of this section in a model year in which that manufacturer also generates credits with vehicles subject to the fleet average CO_2 standards specified in § 86.1818–12(c) may not trade those credits or bank those credits earned against the fleet average standards in § 86.1818–12(c) for use in a future model year.

(8) The following provisions apply if debits are accrued:

(i) If a manufacturer calculates that it has negative credits (also called ''debits'' or a ''credit deficit'') for a given model year, it may carry that deficit forward into the next three model years. Such a carry-forward may only occur after the manufacturer exhausts any supply of banked credits. At the end of the third model year, the deficit must be covered with an appropriate number of credits that the manufacturer generates or purchases. Any remaining deficit is subject to a voiding of the certificate ab initio, as described in this paragraph (k)(8). Manufacturers are not permitted to have a credit deficit for four consecutive years.

(ii) If debits are not offset within the specified time period, the number of vehicles not meeting the fleet average CO_2 standards (and therefore not covered by the certificate) must be calculated.

(A) Determine the gram per mile quantity of debits for the noncompliant vehicle category by multiplying the total megagram deficit by 1,000,000 and then dividing by the vehicle lifetime miles for the vehicle category (passenger automobile or light truck) specified in paragraph (k)(4) of this section.

(B) Divide the result by the fleet average standard applicable to the model year in which the deficit failed to be offset and round to the nearest whole number to determine the number of vehicles not meeting the fleet average CO_2 standards.

(iii) EPA will determine the vehicles not covered by a certificate because the condition on the certificate was not satisfied by designating vehicles in those test groups with the highest CO_2 emission values first and continuing until reaching a number of vehicles equal to the calculated number of noncomplying vehicles as determined in paragraph (k)(7) of this section. If this calculation determines that only a portion of vehicles in a test group contribute to the debit situation, then EPA will designate actual vehicles in that test group as not covered by the certificate, starting with the last vehicle produced and counting backwards.

(iv)(A) If a manufacturer ceases production of passenger cars and light trucks, the manufacturer continues to be responsible for offsetting any debits outstanding within the required time period. Any failure to offset the debits will be considered a violation of paragraph (k)(7)(i) of this section and may subject the manufacturer to an enforcement action for sale of vehicles not covered by a certificate, pursuant to paragraphs (k)(7)(ii) and (iii) of this section.

(B) If a manufacturer is purchased by, merges with, or otherwise combines with another manufacturer, the controlling entity is responsible for offsetting any debits outstanding within the required time period. Any failure to offset the debits will be considered a violation of paragraph (k)(7)(i) of this section and may subject the manufacturer to an enforcement action for sale of vehicles not covered by a certificate, pursuant to paragraphs (k)(7)(ii) and (iii) of this section.

(v) For purposes of calculating the statute of limitations, a violation of the requirements of paragraph (k)(7)(i) of this section, a failure to satisfy the conditions upon which a certificate(s) was issued and hence a sale of vehicles not covered by the certificate, all occur upon the expiration of the deadline for offsetting debits specified in paragraph (k)(7)(i) of this section.

(9) The following provisions apply to CO_2 credit trading:

(i) EPA may reject CO_2 credit trades if the involved manufacturers fail to submit the credit trade notification in the annual report.

(ii) A manufacturer may not sell credits that are not available for sale pursuant to the provisions in paragraph (k)(6)(i) of this section.

(iii) In the event of a negative credit balance resulting from a transaction, both the buyer and seller are liable. EPA may void ab initio the certificates of conformity of all test groups participating in such a trade.

(iv) (A) If a manufacturer trades a credit that it has not generated pursuant to paragraph (k) of this section or acquired from another party, the manufacturer will be considered to have generated a debit in the model year that the manufacturer traded the credit. The manufacturer must offset such debits by the deadline for the annual report for that same model year.

(B) Failure to offset the debits within the required time period will be considered a failure to satisfy the conditions upon which the certificate(s) was issued and will be addressed pursuant to paragraph (k)(7) of this section.

(v) A manufacturer may only trade credits that it has generated pursuant to paragraph (k)(4) of this section or acquired from another party.

(l) *Maintenance of records and submittal of information relevant to compliance with fleet average CO_2 standards*—(1) *Maintenance of records.* (i) Manufacturers producing any light-duty vehicles, light-duty trucks, or medium-duty passenger vehicles subject to the provisions in this subpart must establish, maintain, and retain all the following information in adequately organized records for each model year:

(A) Model year.

(B) Applicable fleet average CO_2 standards for each averaging set as defined in paragraph (i) of this section.

(C) The calculated fleet average CO_2 value for each averaging set as defined in paragraph (i) of this section.

(D) All values used in calculating the fleet average CO_2 values.

(ii) Manufacturers producing any passenger cars or light trucks subject to the provisions in this subpart must establish, maintain, and retain all the following information in adequately organized records for each passenger car or light truck subject to this subpart:

(A) Model year.

(B) Applicable fleet average CO_2 standard.

(C) EPA test group.

(D) Assembly plant.

(E) Vehicle identification number.

(F) Carbon-related exhaust emission standard to which the passenger car or light truck is certified.

(G) In-use carbon-related exhaust emission standard.

(H) Information on the point of first sale, including the purchaser, city, and State.

(iii) Manufacturers must retain all required records for a period of eight years from the due date for the annual report. Records may be stored in any format and on any media, as long as manufacturers can promptly send EPA organized written records in English if we ask for them. Manufacturers must keep records readily available as EPA may review them at any time.

(iv) The Administrator may require the manufacturer to retain additional records or submit information not specifically required by this section.

(v) Pursuant to a request made by the Administrator, the manufacturer must submit to the Administrator the information that the manufacturer is required to retain.

(vi) EPA may void ab initio a certificate of conformity for vehicles certified to emission standards as set forth or otherwise referenced in this subpart for which the manufacturer fails to retain the records required in this section or to provide such information to the Administrator upon request, or to submit the reports required in this section in the specified time period.

(2) *Reporting.* (i) Each manufacturer must submit an annual report. The annual report must contain for each applicable CO_2 standard, the calculated fleet average CO_2 value, all values required to calculate the CO_2 emissions value, the number of credits generated or debits incurred, all the values required to calculate the credits or debits, and the resulting balance of credits or debits.

(ii) For each applicable fleet average CO_2 standard, the annual report must also include documentation on all credit transactions the manufacturer has engaged in since those included in the last report. Information for each transaction must include all of the following:

(A) Name of credit provider.

(B) Name of credit recipient.

(C) Date the trade occurred.

(D) Quantity of credits traded in megagrams.

(E) Model year in which the credits were earned.

(iii) Manufacturers calculating early air conditioning leakage and/or efficiency credits under paragraph (b) of this section shall report the following information for each model year separately for passenger automobiles and light trucks and for each air conditioning system used to generate credits:

(A) A description of the air conditioning system.

(B) The leakage credit value and all the information required to determine this value.

(C) The total credits earned for each averaging set, model year, and region, as applicable.

(iv) Manufacturers calculating early advanced technology vehicle credits under paragraph (c) of this section shall report, for each model year and separately for passenger automobiles and light trucks, the following information:

(A) The number of each model type of eligible vehicle sold.

(B) The carbon-related exhaust emission value by model type and model year.

(v) Manufacturers calculating early off-cycle technology credits under paragraph (d) of this section shall report, for each model year and separately for passenger automobiles and light trucks, all test results and data required for calculating such credits.

(vi) Unless a manufacturer reports the data required by this section in the annual production report required under § 86.1844–01(e) or the annual report required under § 600.512–12, a manufacturer must submit an annual report for each model year after production ends for all affected vehicles produced by the manufacturer subject to the provisions of this subpart and no later than May 1 of the calendar year following the given model year. Annual reports must be submitted to: Director, Compliance and Innovative Strategies Division, U.S. Environmental Protection Agency, 2000 Traverwood, Ann Arbor, Michigan 48105.

(vii) Failure by a manufacturer to submit the annual report in the specified time period for all vehicles subject to the provisions in this section is a violation of section 203(a)(1) of the Clean Air Act (42 U.S.C. 7522 (a)(1)) for each applicable vehicle produced by that manufacturer.

(viii) If EPA or the manufacturer determines that a reporting error occurred on an annual report previously submitted to EPA, the manufacturer's credit or debit calculations will be recalculated. EPA may void erroneous credits, unless traded, and will adjust erroneous debits. In the case of traded erroneous credits, EPA must adjust the selling manufacturer's credit balance to reflect the sale of such credits and any resulting credit deficit.

(3) *Notice of opportunity for hearing.* Any revoking of the certificate under paragraph (l)(1)(vi) of this section will be made only after EPA has offered the affected manufacturer an opportunity for a hearing conducted in accordance with § 86.614–84 for light-duty vehicles or § 86.1014–84 for light-duty trucks and, if a manufacturer requests such a hearing, will be made only after an initial decision by the Presiding Officer.

27. A new section 86.1866–12 is added to subpart S to read as follows:

§ 86.1866–12 CO_2 fleet average credit programs.

(a) *Additional credits for certification of advanced technology vehicles.* A manufacturer may generate additional credits by certifying and producing electric vehicles, plug-in hybrid electric vehicles, or fuel cell electric vehicles, as those terms are defined in § 86.1803–01, in the 2012 through 2016 model years. When calculating the fleet average CO_2 emissions according to the provisions of part 600 subpart F of this chapter, the manufacturer may multiply the number of advanced technology vehicles produced by [1.2–2.0]. This multiplier may be used if the following conditions are met:

(1) Documentation of the use of this multiplier and the number of credits generated by its use shall be included in the annual report to the Administrator;

(2) Vehicles must be certified to Tier 2 Bin No. 5 or a more stringent set of emissions standards in § 86.1811–04(c)(6);

(3) These multipliers may not be used after the 2016 model year;

(b) *Credits for reduction of air conditioning refrigerant leakage.* Manufacturers may generate credits applicable to the CO_2 fleet average program described in § 86.1865–12 by implementing specific air conditioning system technologies designed to reduce air conditioning refrigerant leakage over the useful life of their passenger cars and/or light trucks. Credits shall be calculated according to this paragraph

(b) for each air conditioning system that the manufacturer is using to generate CO_2 credits.

(1) The manufacturer shall calculate an annual rate of refrigerant leakage from an air conditioning system in grams per year according to the provisions of § 86.166–12.

(2) The CO_2-equivalent gram per mile leakage reduction to be used to calculate the total credits generated by the air conditioning system shall be determined according to the following formulae, rounded to the nearest tenth of a gram per mile:

(i) Passenger automobiles:

$$\text{Leakage credit} = MaxCredit \times \left[1 - \left(\frac{Leakage}{16.6}\right) \times \left(\frac{GWP_{NEW}}{GWP_{HFC134a}}\right)\right]$$

Where:

MaxCredit is 12.6 for air conditioning systems using HFC 134a, and 13.8 for air conditioning systems using a refrigerant with a lower global warming potential.

Leakage means the annual refrigerant leakage rate determined according to the provisions of § 86.166–12(a), except if the calculated rate is less than 8.3 grams per year the rate for the purpose of this formula shall be 8.3 grams per year;

GWP_{NEW} means the global warming potential of the refrigerant, if such refrigerant is not R134a, as determined by the Administrator;

$GWP_{HFC134a}$ means the global warming potential of HFC 134a, which shall be equal to 1430 unless determined otherwise by the Administrator.

(ii) Light trucks:

$$\text{Leakage credit} = MaxCredit \times \left[1 - \left(\frac{Leakage}{20.7}\right) \times \left(\frac{GWP_{NEW}}{GWP_{HFC134a}}\right)\right]$$

Where:

MaxCredit is 15.6 for air conditioning systems using HFC 134a, and 17.2 for air conditioning systems using a refrigerant with a lower global warming potential.

Leakage means the annual refrigerant leakage rate determined according to the provisions of § 86.166–12(a), except if the calculated rate is less than 10.4 grams per year the rate for the purpose of this formula shall be 10.4 grams per year;

GWP_{NEW} means the global warming potential of the refrigerant, if such refrigerant is not HFC 134a, as determined by the Administrator;

GWP_{R134a} means the global warming potential of HFC 134a, which shall be equal to 1430 unless determined otherwise by the Administrator.

(3) The total leakage reduction credits generated by the air conditioning system shall be calculated separately for passenger cars and light trucks according to the following formula:

Total Credits (megagrams) = (Leakage × Production × VLM) ÷ 1,000,000

Where:

Leakage = the CO_2-equivalent leakage credit value in grams per mile determined in paragraph (b)(2) of this section.

Production = The total number of passenger cars or light trucks, whichever is applicable, produced with the air conditioning system to which to the leakage credit value from paragraph (b)(2) of this section applies.

VLM = vehicle lifetime miles, which for passenger cars shall be 190,971 and for light trucks shall be 221,199.

(4) The results of paragraph (b)(3) of this section, rounded to the nearest whole number, shall be included in the manufacturer's credit/debit totals calculated in § 86.1865–12(k)(5).

(c) *Credits for improving air conditioning system efficiency.* Manufacturers may generate credits applicable to the CO_2 fleet average program described in § 86.1865–12 by implementing specific air conditioning system technologies designed to reduce air conditioning-related CO_2 emissions over the useful life of their passenger cars and/or light trucks. Credits shall be calculated according to this paragraph (c) for each air conditioning system that the manufacturer is using to generate CO_2 credits. Manufacturers may also generate early air conditioning efficiency credits under this paragraph (b) for the 2009 through 2011 model years according to the provisions of § 86.1867–12(c). For model years 2012 and 2013 the manufacturer may determine air conditioning efficiency credits using the requirements in paragraphs (c)(1) through (4) of this section. For model years 2014 and later the eligibility requirements specified in paragraph (c)(5) of this section must be met before an air conditioning system is allowed to generate credits.

(1) Air conditioning efficiency credits are available for the following technologies in the gram per mile amounts indicated:

(i) Reduced reheat, with externally-controlled, variable-displacement compressor: 1.7 g/mi.

(ii) Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable displacement compressor: 1.1 g/mi.

(iii) Default to recirculated air mode whenever the air conditioning system is being used to reduce cabin air temperature and the outside air temperature is greater than 75 °F: 1.7 g/mi.

(iv) Blower motor and cooling fan controls which limit waste energy (*e.g.* pulsewidth modulated power controller): 0.9 g/mi.

(v) Electronic expansion valve: 1.1 g/mi.

(vi) Improved evaporators and condensers (with system analysis on each component indicating a coefficient of performance improvement greater than 10%, when compared to previous design): 1.1 g/mi.

(vii) Oil separator: 0.6 g/mi.

(2) Air conditioning efficiency credits are determined on an air conditioning system basis. For each air conditioning system that is eligible for a credit based on the use of one or more of the items listed in paragraph (c)(1) of this section, the total credit value is the sum of the gram per mile values listed in paragraph (c)(1) of this section for each item that applies to the air conditioning system. If the sum of those values for an air conditioning system is greater than 5.7 grams per mile, the total credit value is deemed to be 5.7 grams per mile.

(3) The total efficiency credits generated by an air conditioning system shall be calculated separately for passenger cars and light trucks according to the following formula:

Total Credits (Megagrams) = (Credit × Production × VLM) ÷ 1,000,000

Where:

Credit = the CO_2 efficiency credit value in grams per mile determined in paragraph (c)(2) of this section.
Production = The total number of passenger cars or light trucks, whichever is applicable, produced with the air conditioning system to which the efficiency credit value from paragraph (c)(2) of this section applies.
VLM = vehicle lifetime miles, which for passenger cars shall be 190,971 and for light trucks shall be 221,199.

(4) The results of paragraph (c)(3) of this section, rounded to the nearest whole number, shall be included in the manufacturer's credit/debit totals calculated in § 86.1865–12(k)(5).

(5) Use of the Air Conditioning Idle Test Procedure is required after the 2013 model year as specified in this paragraph (c)(5).

(i) After the 2013 model year, for each air conditioning system selected by the manufacturer to generate air conditioning efficiency credits, the manufacturer shall perform the Air Conditioning Idle Test Procedure specified in § 86.165–14 of this part.

(ii) Using good engineering judgment, the manufacturer must select the vehicle configuration to be tested that is expected to result in the greatest increased CO_2 emissions as a result of the operation of the air conditioning system for which efficiency credits are being sought. If the air conditioning system is being installed in passenger automobiles and light trucks, a separate determination of the quantity of credits for passenger automobiles and light trucks must be made, but only one test vehicle is required to represent the air conditioning system, provided it represents the worst-case impact of the system on CO_2 emissions.

(iii) For an air conditioning system to be eligible to generate credits in the 2014 and later model years, the increased CO_2 emissions as a result of the operation of that air conditioning system determined according to the Idle Test Procedure in § 86.165–14 must be less than 14.9 grams per minute.

(iv) Air conditioning systems with compressors that are solely powered by electricity shall submit Air Conditioning Idle Test Procedure data to be eligible to generate credits in the 2014 and later model years, but such systems are not required to meet a specific threshold to be eligible to generate such credits, as long as the engine remains off for a period of at least 2 minutes during the air conditioning on portion of the Idle Test Procedure in § 86.165–12 (d).

(6) The following definitions apply to this paragraph (c):

(i) *Reduced reheat, with externally-controlled, variable displacement compressor* means a system in which compressor displacement is controlled via an electronic signal, based on input from sensors (*e.g.* position or setpoint of interior temperature control, interior temperature, evaporator outlet air temperature, or refrigerant temperature) and air temperature at the outlet of the evaporator can be controlled to a level at 41 °F, or higher.

(ii) *Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable displacement compressor* means a system in which the output of either compressor is controlled by cycling the compressor clutch off-and-on via an electronic signal, based on input from sensors (*e.g.* position or setpoint of interior temperature control, interior temperature, evaporator outlet air temperature, or refrigerant temperature) and air temperature at the outlet of the evaporator can be controlled to a level at 41 °F, or higher.

(iii) *Default to recirculated air mode* means that the default position of the mechanism which controls the source of air supplied to the air conditioning system shall change from outside air to recirculated air when the operator or the automatic climate control system has engaged the air conditioning system (*i.e.* evaporator is removing heat), except under those conditions where dehumidification is required for visibility (*i.e.* defogger mode). In vehicles equipped with interior air quality sensors (*e.g.* humidity sensor, or carbon dioxide sensor), the controls may determine proper blend of air supply sources to maintain freshness of the cabin air while continuing to maximize the use of recirculated air. At any time, the vehicle operator may manually select the non-recirculated air setting during vehicle operation but the system must default to recirculated air mode on subsequent vehicle operations (*i.e.* next vehicle start). The climate control system may delay switching to recirculation mode until the interior air temperature is less than the outside air temperature, at which time the system must switch to recirculated air mode.

(iv) *Blower motor and cooling fan controls which limit waste energy* means a method of controlling fan and blower speeds which does not use resistive elements to decrease the voltage supplied to the motor.

(v) *Electronic expansion valve* means a valve which throttles the expansion of the refrigerant where the position of the valve (and flow of refrigerant) is controlled via an electronic signal, based on input from sensors (*e.g.* position or setpoint of interior temperature control, interior temperature, evaporator outlet air temperature, or refrigerant temperature).

(vi) *Improved evaporators and condensers* means that the coefficient of performance (COP) of air conditioning system using improved evaporator and condenser designs is 10 percent higher, as determined using the bench test procedures described in SAE J2765 ''Procedure for Measuring System COP of a Mobile Air Conditioning System on a Test Bench,'' when compared to a system using standard, or prior model year, component designs. SAE J2765 is incorporated by reference; see § 86.1.

(vii) *Oil separator* means a mechanism which removes at least 50 percent of the oil entrained in the oil/refrigerant mixture exiting the compressor and returns it to the compressor housing or compressor inlet, or a compressor design which does not rely on the circulation of an oil/refrigerant mixture for lubrication.

(d) *Credits for CO_2-reducing technologies where the CO_2 reduction is not captured on the Federal Test Procedure or the Highway Fuel Economy Test.* Manufacturers may optionally generate credits applicable to the CO_2 fleet average program described in § 86.1865–12 by implementing innovative technologies that have a measurable, demonstrable, and verifiable real-world CO_2 reduction. These optional credits are referred to as ''off-cycle'' credits and may be earned through the 2016 model year.

(1) *Qualification criteria.* To qualify for this credit, the following must be true:

(i) The technology must be an innovative and novel vehicle- or engine-based approach to reducing greenhouse gas emissions, and not in widespread use.

(ii) The CO_2-reducing impact of the technology must not be significantly measurable over the Federal Test Procedure and the Highway Fuel Economy Test. The technology must improve CO_2 emissions beyond the driving conditions of those tests.

(iii) The technology must be able to be demonstrated to be effective for the full useful life of the vehicle. Unless the manufacturer demonstrates that the technology is not subject to in-use deterioration, the manufacturer must account for the deterioration in their analysis.

(2) *Quantifying the CO_2 reductions of an off-cycle technology.* The manufacturer may use one of the two options specified in this paragraph (d)(2) to measure the CO_2-reducing potential of an innovative off-cycle technology. The option described in paragraph (d)(2)(ii) of this section may

be used only with EPA approval, and to use that option the manufacturer must be able to justify to the Administrator why the 5-cycle option described in paragraph (d)(2)(i) of this section insufficiently characterizes the effectiveness of the off-cycle technology. The manufacturer should notify EPA in their pre-model year report of their intention to generate any credits under paragraph (d) of this section.

(i) *Technology demonstration using EPA 5-cycle methodology.* To demonstrate an off-cycle technology and to determine a CO_2 credit using the EPA 5-cycle methodology, the manufacturer shall determine 5-cycle city/highway combined carbon-related exhaust emissions both with the technology installed and operating and without the technology installed and/or operating. The manufacturer shall conduct the following steps, both with the off-cycle technology installed and operating and without the technology operating or installed.

(A) Determine carbon-related exhaust emissions over the FTP, the HFET, the US06, the SC03, and the cold temperature FTP test procedures according to the test procedure provisions specified in 40 CFR part 600 subpart B and using the calculation procedures specified in § 600.113–08 of this chapter.

(B) Calculate 5-cycle city and highway carbon-related exhaust emissions using data determined in paragraph (d)(2)(i)(A) of this section according to the calculation procedures in paragraphs (d) through (f) of 40 CFR 600.114–08.

(C) Calculate a 5-cycle city/highway combined carbon-related exhaust emission value using the city and highway values determined in paragraph (d)(2)(i)(B) of this section.

(D) Subtract the 5-cycle city/highway combined carbon-related exhaust emission value determined with the off-cycle technology operating from the 5-cycle city/highway combined carbon-related exhaust emission value determined with the off-cycle technology not operating. The result is the gram per mile credit amount assigned to the technology.

(ii) *Technology demonstration using alternative EPA-approved methodology.* In cases where the EPA 5-cycle methodology described in paragraph (d)(2)(i) of this section cannot adequately measure the emission reduction attributable to an innovative off-cycle technology, the manufacturer may develop an alternative approach. Prior to a model year in which a manufacturer intends to seek these credits, the manufacturer must submit a detailed analytical plan to EPA. EPA will work with the manufacturer to ensure that an analytical plan will result in appropriate data for the purposes of generating these credits. The alternative demonstration program must be approved in advance by the Administrator and should:

(A) Use modeling, on-road testing, on-road data collection, or other approved analytical or engineering methods;

(B) Be robust, verifiable, and capable of demonstrating the real-world emissions benefit with strong statistical significance;

(C) Result in a demonstration of baseline and controlled emissions over a wide range of driving conditions and number of vehicles such that issues of data uncertainty are minimized;

(D) Result in data on a model type basis unless the manufacturer demonstrates that another basis is appropriate and adequate.

(iii) *Calculation of total off-cycle credits.* Total off-cycle credits in Megagrams of CO_2 shall be calculated separately for passenger automobiles and light trucks according to the following formula:

$$\text{Total Credits (Megagrams)} = (\text{Credit} \times \text{Production} \times \text{VLM}) \div 1{,}000{,}000$$

Where:

Credit = the 5-cycle credit value in grams per mile determined in paragraph (d)(2)(i)(D) or (d)(2)(ii) of this section.

Production = The total number of passenger cars or light trucks, whichever is applicable, produced with the off-cycle technology to which to the credit value determined in paragraph (d)(2)(i)(D) or (d)(2)(ii) of this section applies.

VLM = vehicle lifetime miles, which for passenger cars shall be 190,971 and for light trucks shall be 221,199.

28. A new § 86.1867–12 is added to subpart S to read as follows:

§ 86.1867–12 Optional early CO_2 credit programs.

Manufacturers may optionally generate CO_2 credits in the 2009 through 2011 model years for use in the 2012 and later model years subject to the provisions of this section. Manufacturers may generate early fleet average credits, air conditioning leakage credits, air conditioning efficiency credits, early advanced technology credits, and early off-cycle technology credits. Manufacturers generating any credits under this section must submit an early credits report to the Administrator as required in this section.

(a) *Early fleet average CO_2 reduction credits.* Manufacturers may optionally generate credits for reductions in their fleet average CO_2 emissions achieved in the 2009 through 2011 model years. To generate early fleet average CO_2 reduction credits, manufacturers must select one of the four pathways described in paragraphs (a)(1) through (4) of this section. The manufacturer may select only one pathway, and that pathway must remain in effect for the 2009 through 2011 model years. Fleet average credits (or debits) must be calculated and reported to EPA for each model year under each selected pathway. Early credits are subject to five year carry-forward restrictions based on the model year in which the credits are generated.

(1) *Pathway 1.* To earn credits under this pathway, the manufacturer shall calculate an average carbon-related exhaust emission value to the nearest one gram per mile for the classes of motor vehicles identified in this paragraph (a)(1), and the results of such calculations will be reported to the Administrator for use in determining compliance with the applicable CO_2 early credit threshold values.

(i) An average carbon-related exhaust emission value calculation will be made for the combined LDV/LDT1 averaging set.

(ii) An average carbon-related exhaust emission value calculation will be made for the combined LDT2/HLDT/MDPV averaging set.

(iii) Average carbon-related exhaust emission values shall be determined according to the provisions of 40 CFR 600.510–12, except that:

(A) Total U.S. model year sales data will be used, instead of production data;

(B) The average carbon-related exhaust emissions for alcohol fueled model types shall be calculated according to the provisions of 40 CFR 600.510–12(j)(2)(ii)(B), without the use of the 0.15 multiplicative factor.

(C) The average carbon-related exhaust emissions for natural gas fueled model types shall be calculated according to the provisions of 40 CFR 600.510–12(j)(2)(iii)(B), without the use of the 0.15 multiplicative factor.

(D) The average carbon-related exhaust emissions for alcohol dual fueled model types shall be calculated according to the provisions of 40 CFR 600.510–12(j)(2)(vi), without the use of the 0.15 multiplicative factor and with F=0. For the 2010 and 2011 model years only, if the California Air Resources Board has approved a manufacturer's request to use a non-zero value of F, the manufacturer may use such an approved value.

(E) The average carbon-related exhaust emissions for natural gas dual fueled model types shall be calculated according to the provisions of 40 CFR

600.510–12(j)(2)(vii), without the use of the 0.15 multiplicative factor and with F=0. For the 2010 and 2011 model years only, if the California Air Resources Board has approved a manufacturer's request to use a non-zero value of F, the manufacturer may use such an approved value.

(F) 40 CFR 600.510–12(j)(3) shall not apply. Electric, fuel cell electric, and plug-in hybrid electric model type carbon-related exhaust emission values shall be included in the fleet average determined under paragraph (a)(1) of this section only to the extent that such vehicles are not being used to generate early advanced technology vehicle credits under paragraph (c) of this section.

(iv) Fleet average CO_2 credit threshold values.

Model year	LDV/LDT1	LDT2/HLDT/ MDPV
2009	321	437
2010	299	418
2011	265	388

(v) Credits are earned on the last day of the model year. Manufacturers must calculate, for a given model year, the number of credits or debits it has generated according to the following equation, rounded to the nearest megagram:

CO_2 Credits or Debits (Mg) = [(CO_2 Credit Threshold − Manufacturer's Sales Weighted Fleet Average CO_2 Emissions) × (Total Number of Vehicles Sold) × (Vehicle Lifetime Miles)] ÷ 1,000,000

Where:

CO_2 Credit Threshold = the applicable credit threshold value for the model year and vehicle averaging set as determined by paragraph (a)(1)(iv) of this section;

Manufacturer's Sales Weighted Fleet Average CO_2 Emissions = average calculated according to paragraph (a)(1)(iii) of this section;

Total Number of Vehicles Sold = The number of vehicles domestically sold as defined in 40 CFR 600.511–80; and

Vehicle Lifetime Miles is 190,971 for the LDV/LDT1 averaging set and 221,199 for the LDT2/HLDT/MDPV averaging set.

(vi) Deficits generated against the applicable CO_2 credit threshold values in paragraph (a)(1)(iv) of this section in any averaging set for any of the 2009–2011 model years must be offset using credits accumulated by any averaging set in any of the 2009–2011 model years before determining the number of credits that may be carried forward to the 2012. Deficit carry forward and credit banking provisions of § 86.1865–12 apply to early credits earned under this paragraph (a)(1), except that deficits may not be carried forward from any of the 2009–2011 model years into the 2012 model year.

(2) *Pathway 2.* To earn credits under this pathway, manufacturers shall calculate an average carbon-related exhaust emission value to the nearest one gram per mile for the classes of motor vehicles identified in paragraph (a)(1) of this section, and the results of such calculations will be reported to the Administrator for use in determining compliance with the applicable CO_2 early credit threshold values.

(i) Credits under this pathway shall be calculated according to the provisions of paragraph (a)(1) of this section, except credits may only be generated by vehicles sold in a model year in States with a section 177 program in effect in that model year. For the purposes of this section, ''section 177 program'' means State regulations or other laws that apply to any of the following categories of motor vehicles: Passenger cars, light-duty trucks up through 6,000 pounds GVWR, and medium-duty vehicles from 6,001 to 14,000 pounds GVWR, as these categories of motor vehicles are defined in the California Code of Regulations, Title 13, Division 3, Chapter 1, Article 1, Section 1900.

(ii) A deficit in any averaging set for any of the 2009–2011 model years must be offset using credits accumulated by any averaging set in any of the 2009–2011 model years before determining the number of credits that may be carried forward to the 2012 model year. Deficit carry forward and credit banking provisions of § 86.1865–12 apply to early credits earned under this paragraph (a)(1), except that deficits may not be carried forward from any of the 2009–2011 model years into the 2012 model year.

(3) *Pathway 3.* Pathway 3 credits are those credits earned under Pathway 2 as described in paragraph (a)(2) of this section and in the section 177 States determined in paragraph (a)(2)(i) of this section, combined with additional credits earned in the set of states that does not include the section 177 States determined in paragraph (a)(2)(i) of this section and calculated according to this paragraph (a)(3).

(i) Manufacturers shall earn additional credits under Pathway 3 by calculating an average carbon-related exhaust emission value to the nearest one gram per mile for the classes of motor vehicles identified in this paragraph (a)(3). The results of such calculations will be reported to the Administrator for use in determining compliance with the applicable CO_2 early credit threshold values.

(ii) Credits may only be generated by vehicles sold in the States not included in the section 177 States determined in paragraph (a)(2)(i) of this section.

(iii) An average carbon-related exhaust emission value calculation will be made for the passenger automobile averaging set. The term ''passenger automobile'' shall have the meaning given by the Department of Transportation at 49 CFR 523.4 for the specific model year for which the calculation is being made.

(iv) An average carbon-related exhaust emission value calculation will be made for the light truck averaging set. The term ''light truck'' shall have the meaning given by the Department of Transportation at 49 CFR 523.5 for the specific model year for which the calculation is being made.

(v) Average carbon-related exhaust emission values shall be determined according to the provisions of 40 CFR 600.510–12, except that:

(A) Total model year sales data will be used, instead of production data, except that vehicles sold in the section 177 States determined in paragraph (a)(2)(i) of this section shall not be included;

(B) The average carbon-related exhaust emissions for alcohol fueled model types shall be calculated according to the provisions of 40 CFR 600.510–12(j)(2)(ii)(B), without the use of the 0.15 multiplicative factor.

(C) The average carbon-related exhaust emissions for natural gas fueled model types shall be calculated according to the provisions of 40 CFR 600.510–12(j)(2)(iii)(B), without the use of the 0.15 multiplicative factor.

(D) The average carbon-related exhaust emissions for alcohol dual fueled model types shall be calculated according to the provisions of 40 CFR 600.510–12(j)(2)(vi), without the use of the 0.15 multiplicative factor and with F=0.

(E) The average carbon-related exhaust emissions for natural gas dual fueled model types shall be calculated according to the provisions of 40 CFR 600.510–12(j)(2)(vii), without the use of the 0.15 multiplicative factor and with F=0.

(F) 40 CFR 600.510–12(j)(3) shall not apply. Electric, fuel cell electric, and plug-in hybrid electric model type carbon-related exhaust emission values shall be included in the fleet average determined under paragraph (a)(1) of this section only to the extent that such vehicles are not being used to generate early advanced technology vehicle credits under paragraph (c) of this section.

(vi) Pathway 3 fleet average CO_2 credit threshold values.

(A) For 2009 and 2010 model year passenger automobiles, the fleet average CO_2 credit threshold value is 323 grams/mile.

(B) For 2009 model year light trucks the fleet average CO_2 credit threshold value is 381 grams/mile, or, if the manufacturer chose to optionally meet an alternative manufacturer-specific light truck fuel economy standard calculated under 49 CFR 533.5 for the 2009 model year, the gram per mile fleet average CO_2 credit threshold shall be the CO_2 value determined by dividing 8887 by that alternative manufacturer-specific fuel economy standard and rounding to the nearest whole gram per mile.

(C) For 2010 model year light trucks the fleet average CO_2 credit threshold value is 376 grams/mile, or, if the manufacturer chose to optionally meet an alternative manufacturer-specific light truck fuel economy standard calculated under 49 CFR 533.5 for the 2010 model year, the gram per mile fleet average CO_2 credit threshold shall be the CO_2 value determined by dividing 8887 by that alternative manufacturer-specific fuel economy standard and rounding to the nearest whole gram per mile.

(D) For 2011 model year passenger automobiles the fleet average CO_2 credit threshold value is the value determined by dividing 8887 by the manufacturer-specific passenger automobile fuel economy standard for the 2011 model year determined under 49 CFR 531.5 and rounding to the nearest whole gram per mile.

(E) For 2011 model year light trucks the fleet average CO_2 credit threshold value is the value determined by dividing 8887 by the manufacturer-specific light truck fuel economy standard for the 2011 model year determined under 49 CFR 533.5 and rounding to the nearest whole gram per mile.

(vii) Credits are earned on the last day of the model year. Manufacturers must calculate, for a given model year, the number of credits or debits it has generated according to the following equation, rounded to the nearest megagram:

$$CO_2 \text{ Credits or Debits (Mg)} = [(CO_2 \text{ Credit Threshold} - \text{Manufacturer's Sales Weighted Fleet Average } CO_2 \text{ Emissions}) \times (\text{Total Number of Vehicles Sold}) \times (\text{Vehicle Lifetime Miles})] \div 1{,}000{,}000$$

Where:

CO_2 Credit Threshold = the applicable credit threshold value for the model year and vehicle averaging set as determined by paragraph (a)(3)(vii) of this section;

Manufacturer's Sales Weighted Fleet Average CO_2 Emissions = average calculated according to paragraph (a)(3)(vi) of this section;

Total Number of Vehicles Sold = The number of vehicles domestically sold as defined in 40 CFR 600.511–80 except that vehicles sold in the section 177 States determined in paragraph (a)(2)(i) of this section shall not be included; and

Vehicle Lifetime Miles is 190,971 for the LDV/LDT1 averaging set and 221,199 for the LDT2/HLDT/MDPV averaging set.

(viii) Deficits in any averaging set for any of the 2009–2011 model years must be offset using credits accumulated by any averaging set in any of the 2009–2011 model years before determining the number of credits that may be carried forward to the 2012. Deficit carry forward and credit banking provisions of 86.1865–12 apply to early credits earned under this paragraph (a)(3), except that deficits may not be carried forward from any of the 2009–2011 model years into the 2012 model year.

(4) *Pathway 4.* Pathway 4 credits are those credits earned under Pathway 3 as described in paragraph (a)(3) of this section in the set of states that does not include the section 177 States determined in paragraph (a)(2)(i) of this section and calculated according to paragraph (a)(3) of this section. Credits may only be generated by vehicles sold in the set of states that does not include the section 177 States determined in paragraph (a)(2)(i) of this section.

(b) *Early air conditioning leakage and efficiency credits.* (1) Manufacturers may optionally generate air conditioning refrigerant leakage credits according to the provisions of paragraph (b) of § 86.1866–12 and/or air conditioning efficiency credits according to the provisions of § 86.1866–12(c) in model years 2009 through 2011. The early credits are subject to five year carry forward limits based on the model year in which the credits are generated. Credits must be tracked by model type and model year.

(2) Manufacturers that select Pathway 4 described in paragraph (a)(4) of this section may not generate early air conditioning credits for vehicles sold in the section 177 States as determined in paragraph (a)(2)(i) of this section.

(c) *Early advanced technology vehicle credits.* Vehicles eligible for this credit are electric vehicles, fuel cell electric vehicles, and plug-in hybrid electric vehicles, as those terms are defined in § 86.1803–01. If a manufacturer chooses to not include electric vehicles, fuel cell electric vehicles, and plug-in hybrid electric vehicles in their fleet averages calculated under any of the options described in paragraph (a) of this section, the manufacturer may generate early advanced technology vehicle credits pursuant to this paragraph (c).

(1) The manufacturer shall record the sales and carbon-related exhaust emission values of eligible vehicles by model type and model year for model years 2009 through 2011 and report these values to the Administrator under paragraph (e) of this section.

(2) Manufacturers may use the 2009 through 2011 eligible vehicles in their fleet average calculations starting with the 2012 model year, subject to a five-year carry-forward limitation.

(i) Eligible 2009 model year vehicles may be used in the calculation of a manufacturer's fleet average carbon-related exhaust emissions in the 2012 through 2014 model years.

(ii) Eligible 2010 model year vehicles may be used in the calculation of a manufacturer's fleet average carbon-related exhaust emissions in the 2012 through 2015 model years.

(iii) Eligible 2011 model year vehicles may be used in the calculation of a manufacturer's fleet average carbon-related exhaust emissions in the 2012 through 2016 model years.

(3) (i) To use advanced technology vehicle credits, the manufacturer will apply the 2009, 2010, and/or 2011 model type sales volumes and their model type emission levels to a manufacturer's fleet average calculation using the credit multiplier specified in § 86.1866–12(a).

(ii) Early advanced technology vehicle credits must be used to offset a deficit in one of the 2012 through 2016 model years, as appropriate under paragraph (c)(2) of this section.

(iii) The advanced technology vehicle sales and emission values may be included in a fleet average calculation for passenger automobiles or light trucks, but may not be used to generate credits in the model year in which they are included or in the averaging set in which they are used. Use of early advanced technology vehicle credits is limited to offsetting a deficit that would otherwise be generated without the use of those credits. Manufacturers shall report the use of such credits in their model year report for the model year in which the credits are used.

(d) *Early off-cycle technology credits.* Manufacturers may optionally generate credits for the implementation of certain CO_2-reducing technologies according to the provisions of § 86.1866–12(d).

(e) *Early credit reporting requirements.* Each manufacturer shall submit a report to the Administrator, known as the early credits report, that reports the credits earned in the 2009 through 2011 model years under this section.

(1) The report shall contain all information necessary for the calculation of the manufacturer's early credits in each of the 2009 through 2011 model years.

(2) The early credits report shall be in writing, signed by the authorized representative of the manufacturer and shall be submitted no later than 90 days after the end of the 2011 model year.

(3) Manufacturers using one of the optional early fleet average CO_2 reduction credit pathways described in paragraph (a) of this section shall report the following information separately for the LDV/LDT1 and LDT2/HLDT/MDPV averaging sets:

(i) The pathway that they have selected (1, 2, 3, or 4).

(ii) A carbon-related exhaust emission value for each model type of the manufacturer's product line calculated according to paragraph (a) of this section.

(iii) The manufacturer's average carbon-related exhaust emission value calculated according to paragraph (a) of this section for the applicable averaging set and region and all data required to complete this calculation.

(iv) The credits earned for each averaging set, model year, and region, as applicable.

(4) Manufacturers calculating early air conditioning leakage and/or efficiency credits under paragraph (b) of this section shall report the following information for each model year separately for passenger automobiles and light trucks and for each air conditioning system used to generate credits:

(i) A description of the air conditioning system.

(ii) The leakage credit value and all the information required to determine this value.

(iii) The total credits earned for each averaging set, model year, and region, as applicable.

(5) Manufacturers calculating early advanced technology vehicle credits under paragraph (c) of this section shall report, for each model year and separately for passenger automobiles and light trucks, the following information:

(i) The number of each model type of eligible vehicle sold.

(ii) The carbon-related exhaust emission value by model type and model year.

(6) Manufacturers calculating early off-cycle technology credits under paragraph (d) of this section shall report, for each model year and separately for passenger automobiles and light trucks, all test results and data required for calculating such credits.

PART 600—FUEL ECONOMY AND CARBON-RELATED EXHAUST EMISSIONS OF MOTOR VEHICLES

29. The authority citation for part 600 continues to read as follows:

Authority: 49 U.S.C. 32901–23919q, Pub. L. 109–58.

30. The heading for Part 600 is revised as set forth above.

Subpart A—Fuel Economy and Carbon-Related Exhaust Emission Regulations for 1977 and Later Model Year Automobiles—General Provisions

31. The heading for subpart A is revised as set forth above.

32. A new § 600.001–12 is added to subpart A to read as follows:

§ 600.001–12 General applicability.

(a) The provisions of this subpart are applicable to 2012 and later model year automobiles and to the manufacturers of 2012 and later model year automobiles.

(b) *Fuel economy and related emissions data.* Unless stated otherwise, references to fuel economy or fuel economy data in this subpart shall also be interpreted to mean the related exhaust emissions of CO_2, HC, and CO, and where applicable for alternative fuel vehicles, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4. References to average fuel economy shall be interpreted to also mean average carbon-related exhaust emissions. References to fuel economy data vehicles shall also be meant to refer to vehicles tested for carbon-related exhaust emissions for the purpose of demonstrating compliance with fleet average CO_2 standards in 40 CFR 86.1818–12.

33. Section 600.002–08 is amended as follows:

a. By adding the definition for ''Base tire.''

b. By adding the definition for ''Carbon-related exhaust emissions.''

c. By adding the definition for ''Electric vehicle.''

d. By adding the definition for ''Footprint.''

e. By adding the definition for ''Fuel cell.''

f. By adding the definition for ''Fuel cell electric vehicle.''

g. By adding the definition for ''Hybrid electric vehicle.''

h. By revising the definition for ''Non-passenger automobile.''

i. By revising the definition for ''Passenger automobile.''

j. By adding the definition for ''Plug-in hybrid electric vehicle.''

§ 600.002–08 Definitions.

* * * * *

Base tire means the tire specified as standard equipment by the manufacturer.

* * * * *

Carbon-related exhaust emissions means the summation of the carbon-containing constituents of the exhaust emissions, with each constituent adjusted by a coefficient representing the carbon weight fraction of each constituent, as specified in § 600.113–08.

* * * * *

Electric vehicle means a vehicle that is powered solely by an electric motor drawing current from a rechargeable energy storage system, such as from storage batteries or other portable electrical energy storage devices, including hydrogen fuel cells, provided that:

(1) Recharge energy must be drawn from a source off the vehicle, such as residential electric service; and

(2) The vehicle must be certified to the emission standards of Bin #1 of Table S04–1 in paragraph (c)(6) of § 86.1811 of this chapter.

* * * * *

Footprint is 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.

* * * * *

Fuel cell means an electrochemical cell that produced electricity via the reaction of a consumable fuel on the anode with an oxidant on the cathode in the presence of an electrolyte.

Fuel cell electric vehicle means a motor vehicle propelled solely by an electric motor where energy for the motor is supplied by a fuel cell.

* * * * *

Hybrid electric vehicle (HEV) means a motor vehicle which draws propulsion energy from onboard sources or stored energy that are both an internal combustion engine or heat engine using consumable fuel, and a rechargeable energy storage system such as a battery, capacitor, or flywheel.

* * * * *

Non-passenger automobile has the meaning given by the Department of Transportation at 49 CFR 523.5. This term is synonymous with ''light truck.''

* * * * *

Passenger automobile has the meaning given by the Department of Transportation at 49 CFR 523.4.

* * * * *

Plug-in hybrid electric vehicle (PHEV) means a hybrid electric vehicle that:

(1) Has the capability to charge the battery from an off-vehicle electric source, such that the off-vehicle source cannot be connected to the vehicle while the vehicle is in motion, and

(2) Has an equivalent all-electric range of no less than 10 miles.

* * * * *

34. Section 600.006–08 is amended as follows:

a. By revising the heading.

b. By revising paragraph (b)(2)(ii).

c. By revising paragraph (b)(2)(iv).

d. By adding paragraph (c)(5).

e. By revising paragraph (e).

f. By revising paragraph (g)(3).

§ 600.006–08 Data and information requirements for fuel economy data vehicles.

* * * * *

(b) * * *

(2) * * *

(ii) In the case of electric vehicles, plug-in hybrid electric vehicles, and hybrid electric vehicles, a description of all maintenance to electric motor, motor controller, battery configuration, or other components performed within 2,000 miles prior to fuel economy testing.

* * * * *

(iv) In the case of electric vehicles, plug-in hybrid electric vehicles, and hybrid electric vehicles, a copy of calibrations for the electric motor, motor controller, battery configuration, or other components on the test vehicle as well as the design tolerances.

* * * * *

(c) * * *

(5) Starting with the 2012 model year, the data submitted according to paragraphs (c)(1) through (c)(4) of this section shall include total HC, CO, CO_2, and, where applicable for alternative fuel vehicles, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4. The fuel economy and CO_2 emission test results shall be adjusted in accordance with paragraph (g) of this section. Round the test results as follows:

* * * * *

(e) In lieu of submitting actual data from a test vehicle, a manufacturer may provide fuel economy values derived from a previously tested vehicle, where the fuel economy and carbon-related exhaust emissions are expected to be equivalent (or less fuel-efficient and with higher carbon-related exhaust emissions). Additionally, in lieu of submitting actual data from a test vehicle, a manufacturer may provide fuel economy and carbon-related exhaust emission values derived from an analytical expression, *e.g.,* regression analysis. In order for fuel economy values derived from analytical methods to be accepted, the expression (form and coefficients) must have been approved by the Administrator.

* * * * *

(g) * * *

(3)(i) The manufacturer shall adjust all fuel economy test data generated by vehicles with engine-drive system combinations with more than 6,200 miles by using the following equation:

$$FE_{4,000mi} = FE_T[0.979 + 5.25 \times 10^{-6}(mi)]^{-1}$$

Where:

$FE_{4,000mi}$ = Fuel economy data adjusted to 4,000-mile test point rounded to the nearest 0.1 mpg.

FE_T = Tested fuel economy value rounded to the nearest 0.1 mpg.

mi = System miles accumulated at the start of the test rounded to the nearest whole mile.

(ii)(A) The manufacturer shall adjust all CO_2 exhaust emission test data generated by vehicles with engine-drive system combinations with more than 6,200 miles by using the following equation:

$$CO2_{4,000mi} = CO_{2T}[0.979 + 5.25 \times 10^{-6}(mi)]$$

Where:

$CO2_{4,000mi}$ = CO_2 emission data adjusted to 4,000-mile test point.

CO_{2T} = Tested emissions value of CO_2 in grams per mile.

mi = System miles accumulated at the start of the test rounded to the nearest whole mile.

(B) Emissions test values and results used and determined in the calculations in paragraph (g)(3)(ii) of this section shall be rounded in accordance with 40 CFR 86.1837–01 as applicable. CO_2 values shall be rounded to the nearest gram per mile.

* * * * *

35. Section 600.007–08 is amended as follows:

a. By revising paragraph (b)(4) through (6).

b. By revising paragraph (c).

c. By revising paragraph (f) introductory text.

§ 600.007–08 Vehicle acceptability.

* * * * *

(b) * * *

(4) Each fuel economy data vehicle must meet the same exhaust emission standards as certification vehicles of the respective engine-system combination during the test in which the city fuel economy test results are generated. This may be demonstrated using one of the following methods:

(i) The deterioration factors established for the respective engine-system combination per § 86.1841–01 of this chapter as applicable will be used; or

(ii) The fuel economy data vehicle will be equipped with aged emission control components according to the provisions of 86.1823–01 of this chapter.

(5) The calibration information submitted under § 600.006(b) must be representative of the vehicle configuration for which the fuel economy and carbon-related exhaust emissions data were submitted.

(6) Any vehicle tested for fuel economy or carbon-related exhaust emissions purposes must be representative of a vehicle which the manufacturer intends to produce under the provisions of a certificate of conformity.

* * * * *

(c) If, based on review of the information submitted under § 600.006(b), the Administrator determines that a fuel economy data vehicle meets the requirements of this section, the fuel economy data vehicle will be judged to be acceptable and fuel economy and carbon-related exhaust emissions data from that fuel economy data vehicle will be reviewed pursuant to § 600.008.

* * * * *

(f) All vehicles used to generate fuel economy and carbon-related exhaust emissions data, and for which emission standards apply, must be covered by a certificate of conformity under part 86 of this chapter before:

* * * * *

36. Section 600.008–08 is amended by revising the heading and paragraph (a)(1) to read as follows:

§ 600.008–08 Review of fuel economy and carbon-related exhaust emission data, testing by the Administrator.

(a) *Testing by the Administrator.* (1)(i) The Administrator may require that any one or more of the test vehicles be submitted to the Agency, at such place or places as the Agency may designate, for the purposes of conducting fuel economy tests. The Administrator may specify that such testing be conducted at the manufacturer's facility, in which case instrumentation and equipment specified by the Administrator shall be made available by the manufacturer for test operations. The tests to be performed may comprise the FTP, highway fuel economy test, US06, SC03, or Cold temperature FTP or any combination of those tests. Any testing conducted at a manufacturer's facility pursuant to this paragraph shall be scheduled by the manufacturer as promptly as possible.

(ii) Starting with the 2012 model year, evaluations, testing, and test data described in this section pertaining to fuel economy shall also be performed for carbon-related exhaust emissions, except that carbon-related exhaust emissions shall be arithmetically averaged instead of harmonically averaged, and in cases where the manufacturer selects the lowest of several fuel economy results to represent the vehicle, the manufacturer shall select the highest of the carbon-related exhaust emissions test results to represent the vehicle.

* * * * *

Subpart B—[Amended]

37. A new § 600.101–12 is added to subpart B to read as follows:

§ 600.101–12 General applicability.

(a) The provisions of this subpart are applicable to 2012 and later model year automobiles and to the manufacturers of 2012 and later model year automobiles.

(b) *Fuel economy and carbon-related emissions data.* Unless stated otherwise, references to fuel economy or fuel economy data in this subpart shall also be interpreted to mean the related exhaust emissions of CO_2, HC, and CO, and where applicable for alternative fuel vehicles, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4. References to average fuel economy shall be interpreted to also mean average carbon-related exhaust emissions.

38. Section 600.113–08 is amended as follows:

a. By revising the introductory text.
b. By revising paragraph (a)(1).
c. By revising paragraph (b)(1) and (2).
d. By revising paragraph (c)(1).
e. By revising paragraph (d)(1) and (2).
f. By revising paragraph (e).
g. By adding paragraph (f)(4).
h. By revising paragraphs (g) through (l).
i. By adding paragraph (m).

§ 600.113–08 Fuel economy calculations for FTP, HFET, US06, SC03 and cold temperature FTP tests.

The Administrator will use the calculation procedure set forth in this paragraph for all official EPA testing of vehicles fueled with gasoline, diesel, alcohol-based or natural gas fuel. The calculations of the weighted fuel economy values require input of the weighted grams/mile values for total hydrocarbons (HC), carbon monoxide (CO), and carbon dioxide (CO_2); and, additionally for methanol-fueled automobiles, methanol (CH_3OH) and formaldehyde (HCHO); and, additionally for ethanol-fueled automobiles, methanol (CH_3OH), ethanol (C_2H_5OH), acetaldehyde (C_2H_4O), and formaldehyde (HCHO); and additionally for natural gas-fueled vehicles non-methane hydrocarbons (NMHC) and methane (CH_4) for the FTP, HFET, US06, SC03 and cold temperature FTP tests. Additionally, the specific gravity, carbon weight fraction and net heating value of the test fuel must be determined. The FTP, HFET, US06, SC03 and cold temperature FTP fuel economy and carbon-related exhaust emission values shall be calculated as specified in this section. An example fuel economy calculation appears in Appendix II of this part.

(a) * * *

(1) Calculate the weighted grams/mile values for the FTP test for CO_2, HC, and CO, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4 as specified in § 86.144(b) of this chapter. Measure and record the test fuel's properties as specified in paragraph (f) of this section.

* * * * *

(b) * * *

(1) Calculate the mass values for the highway fuel economy test for HC, CO and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4 as specified in § 86.144(b) of this chapter. Measure and record the test fuel's properties as specified in paragraph (f) of this section.

(2) Calculate the grams/mile values for the highway fuel economy test for HC, CO and CO_2, and where applicable CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4 by dividing the mass values obtained in paragraph (b)(1) of this section, by the actual distance traveled, measured in miles, as specified in § 86.135(h) of this chapter.

* * * * *

(c) * * *

(1) Calculate the weighted grams/mile values for the cold temperature FTP test for HC, CO and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4 as specified in § 86.144(b) of this chapter. For 2008 through 2010 diesel-fueled vehicles, HC measurement is optional.

* * * * *

(d) * * *

(1) Calculate the total grams/mile values for the US06 test for HC, CO and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4 as specified in § 86.144(b) of this chapter.

(2) Calculate separately the grams/mile values for HC, CO and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4, for both the US06 City phase and the US06 Highway phase of the US06 test as specified in § 86.164 of this chapter. In lieu of directly measuring the emissions of the separate city and highway phases of the US06 test according to the provisions of § 86.159 of this chapter, the manufacturer may, with the advance approval of the Administrator and using good engineering judgment, optionally analytically determine the grams/mile values for the city and highway phases of the US06 test. To analytically determine US06 City and US06 Highway phase emission results, the manufacturer shall multiply the US06 total grams/mile values determined in paragraph (d)(1) of this section by the estimated proportion of fuel use for the city and highway phases relative to the total US06 fuel use. The manufacturer may estimate the proportion of fuel use for the US06 City and US06 Highway phases by using modal CO_2, HC, and CO emissions data, or by using appropriate OBD data (*e.g.,* fuel flow rate in grams of fuel per second), or another method approved by the Administrator.

* * * * *

(e) Calculate the SC03 fuel economy.

(1) Calculate the grams/mile values for the SC03 test for HC, CO and CO_2, and where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4 as specified in § 86.144(b) of this chapter.

(2) Measure and record the test fuel's properties as specified in paragraph (f) of this section.

(f) * * *

(4) Ethanol test fuel shall be analyzed to determine the following fuel properties:

(i) Specific gravity using either:

(A) ASTM D 1298–85 (Reapproved 1990) ''Standard Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method'' for the blend. This 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 obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959. Copies may be inspected at U.S. EPA Headquarters Library, EPA West Building, Constitution Avenue and 14th Street, NW., Room 3340, Washington, DC, 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* or:

(B) ASTM D 1298–85 (Reapproved 1990) ''Standard Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method'' for the gasoline fuel component and also for the methanol fuel component and combining as follows. This 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 obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959. Copies may be inspected at U.S. EPA Headquarters Library, EPA West Building, Constitution Avenue and 14th Street, NW., Room 3340, Washington, DC, 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.*

SG = SGg × volume fraction gasoline + SGm × volume fraction ethanol.

(ii)(A) Carbon weight fraction using the following equation:

CWF = CWFg × MFg+ 0.375 × MFe

Where:

CWFg = Carbon weight fraction of gasoline portion of blend per ASTM D 3343–90 ''Standard Test Method for Estimation of Hydrogen Content of Aviation Fuels.'' This 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 obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959. Copies may be inspected at U.S. EPA Headquarters Library, EPA West Building, Constitution Avenue and 14th Street, NW., Room 3340, Washington, DC, 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.*

MFg = Mass fraction gasoline = (G × SGg)/(G × SGg + E × SGm)

MFe = Mass fraction methanol = (E × SGm)/(G × SGg + E × SGm)

Where:

G = Volume fraction gasoline.

E = Volume fraction ethanol.

SGg = Specific gravity of gasoline as measured by ASTM D 1298–85 (Reapproved 1990) ''Standard Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.'' This 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 obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959. Copies may be inspected at U.S. EPA Headquarters Library, EPA West Building, Constitution Avenue and 14th Street, NW, Room 3340, Washington DC, 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.*

SGm = Specific gravity of methanol as measured by ASTM D 1298–85 (Reapproved 1990) ''Standard Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.'' This 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 obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959. Copies may be inspected at U.S. EPA Headquarters Library, EPA West Building, Constitution Avenue and 14th Street, NW, Room 3340, Washington DC, 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) Upon the approval of the Administrator, other procedures to measure the carbon weight fraction of the fuel blend may be used if the manufacturer can show that the procedures are superior to or equally as accurate as those specified in this paragraph (f)(2)(ii).

(iii) Net heating value (BTU/lb) per ASTM D 240–92 ''Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter.'' This 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 obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959. Copies may be inspected at U.S. EPA Headquarters Library, EPA West Building, Constitution Avenue and 14th Street, NW, Room 3340, Washington DC, 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.*

* * * * *

(g) Calculate separate FTP, highway, US06, SC03 and Cold temperature FTP fuel economy from the grams/mile values for total HC, CO, CO_2 and, where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC and CH_4, and the test fuel's specific gravity, carbon weight fraction, net heating value, and additionally for natural gas, the test fuel's composition.

(1) If the emission values (obtained per paragraph (a) through (e) of this section, as applicable) were obtained from testing with aged exhaust emission control components as allowed under 86.1823–01, then these test values shall be used in the calculations of this section.

(2) If the emission values (obtained per paragraph (a) through (e) of this section, as applicable) were not obtained from testing with aged exhaust emission control components as allowed under 86.1823–01, then these test values shall be adjusted by the appropriate deterioration factor

determined according to 86.1823–01 before being used in the calculations of this section.

(3) The emission values determined in paragraph (g)(1) or (2) of this section shall be rounded in accordance with § 86.094–26(a)(6)(iii) or § 86.1837–01 of this chapter as applicable. The CO_2 values (obtained per this section, as applicable) used in each calculation of this section shall be rounded to the nearest gram/mile. The specific gravity and the carbon weight fraction (obtained per paragraph (f) of this section) shall be recorded using three places to the right of the decimal point. The net heating value (obtained per paragraph (f) of this section) shall be recorded to the nearest whole Btu/lb.

(h)(1) For gasoline-fueled automobiles tested on test fuel specified in § 86.113–04(a), the fuel economy in miles per gallon is to be calculated using the following equation and rounded to the nearest 0.1 miles per gallon:

$$mpg = (5174 \times 10^4 \times CWF \times SG)/[((CWF \times HC) + (0.429 \times CO) + (0.273 \times CO_2)) \times ((0.6 \times SG \times NHV) + 5471)]$$

Where:

HC = Grams/mile HC as obtained in paragraph (g) of this section.
CO = Grams/mile CO as obtained in paragraph (g) of this section.
CO_2 = Grams/mile CO_2 as obtained in paragraph (g) of this section.
CWF = Carbon weight fraction of test fuel as obtained in paragraph (g) of this section.
NHV = Net heating value by mass of test fuel as obtained in paragraph (g) of this section.
SG = Specific gravity of test fuel as obtained in paragraph (g) of this section.

(2) For 2012 and later model year gasoline-fueled automobiles tested on test fuel specified in § 86.113–04(a), the carbon-related exhaust emissions in grams per mile is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = CWF*HC + 1.571*CO + CO_2$$

Where:

CREE means the carbon-related exhaust emissions as defined in § 600.002–08.
HC = Grams/mile HC as obtained in paragraph (g) of this section.
CO = Grams/mile CO as obtained in paragraph (g) of this section.
CO_2 = Grams/mile CO_2 as obtained in paragraph (g) of this section.
CWF = Carbon weight fraction of test fuel as obtained in paragraph (g) of this section.

(i)(1) For diesel-fueled automobiles, calculate the fuel economy in miles per gallon of diesel fuel by dividing 2778 by the sum of three terms and rounding the quotient to the nearest 0.1 mile per gallon:

(i)(A) 0.866 multiplied by HC (in grams/miles as obtained in paragraph (g) of this section), or

(B) Zero, in the case of cold FTP diesel tests for which HC was not collected, as permitted in § 600.113–08(c);

(ii) 0.429 multiplied by CO (in grams/mile as obtained in paragraph (g) of this section); and

(iii) 0.273 multiplied by CO_2 (in grams/mile as obtained in paragraph (g) of this section).

(2) For 2012 and later model year diesel-fueled automobiles, the carbon-related exhaust emissions in grams per mile is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = 0.866*HC + 1.571*CO + CO_2$$

Where:

CREE means the carbon-related exhaust emissions as defined in § 600.002–08.
HC = Grams/mile HC as obtained in paragraph (g) of this section.
CO = Grams/mile CO as obtained in paragraph (g) of this section.
CO_2 = Grams/mile CO_2 as obtained in paragraph (g) of this section.

(j)(1) For methanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and methanol, the fuel economy in miles per gallon is to be calculated using the following equation:

$$mpg = (CWF \times SG \times 3781.8)/((CWF_{exHC} \times HC) + (0.429 \times CO) + (0.273 \times CO_2) + (0.375 \times CH_3OH) + (0.400 \times HCHO))$$

Where:

CWF = Carbon weight fraction of the fuel as determined in paragraph (f)(2)(ii) of this section.
SG = Specific gravity of the fuel as determined in paragraph (f)(2)(i) of this section.
CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons = CWF_g as determined in (f)(2)(ii) of this section (for M100 fuel, CWF_{exHC}= 0.866).
HC = Grams/mile HC as obtained in paragraph (g) of this section.
CO = Grams/mile CO as obtained in paragraph (g) of this section.
CO_2 = Grams/mile CO_2 as obtained in paragraph (g) of this section.
CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (d) of this section.
HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g) of this section.

(2) For 2012 and later model year methanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and methanol, the carbon-related exhaust emissions in grams per mile is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = (CWF_{exHC} \times HC) + (1.571 \times CO) + (1.374 \times CH_3OH) + (1.466 \times HCHO) + CO_2$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002–08.
CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons = CWF_g as determined in (f)(2)(ii) of this section (for M100 fuel, CWF_{exHC} = 0.866).
HC = Grams/mile HC as obtained in paragraph (g) of this section.
CO = Grams/mile CO as obtained in paragraph (g) of this section.
CO_2 = Grams/mile CO_2 as obtained in paragraph (g) of this section.
CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (d) of this section.
HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g) of this section.

(k)(1) For automobiles fueled with natural gas, the fuel economy in miles per gallon of natural gas is to be calculated using the following equation:

$$mpg_e = \frac{CWF_{HC/NG} \times D_{NG} \times 121.5}{(0.749 \times CH_4) + (CWF_{NMHC} \times NMHC) + (0.429 \times CO) + (0.273 \times (CO_2 - CO_{2NG}))}$$

Where:

mpg_e = miles per equivalent gallon of natural gas.
$CWF_{HC/NG}$ = carbon weight fraction based on the hydrocarbon constituents in the natural gas fuel as obtained in paragraph (g) of this section.
D_{NG} = density of the natural gas fuel [grams/ft^3 at 68 °F (20 °C) and 760 mm Hg (101.3 kPa)] pressure as obtained in paragraph (g) of this section.
CH_4, NMHC, CO, and CO_2 = weighted mass exhaust emissions [grams/mile] for methane, non-methane HC, carbon monoxide, and carbon dioxide as calculated in § 600.113.
CWF_{NMHC} = carbon weight fraction of the non-methane HC constituents in the fuel as determined from the speciated fuel composition per paragraph (f)(3) of this section.

CO_{2NG} = grams of carbon dioxide in the natural gas fuel consumed per mile of travel.

$CO_{2NG} = FC_{NG} \times D_{NG} \times WF_{CO2}$

Where:

$$FC_{NG} = \text{cubic feet of natural gas fuel consumed per mile} = \frac{(0.749 \bullet CH_4) + (CWF_{NMHC} \bullet NMHC) + (0.429 \bullet CO) + (0.273 \bullet CO_2)}{CWF_{NG} \bullet D_{NG}}$$

Where:

CWF_{NG} = the carbon weight fraction of the natural gas fuel as calculated in paragraph (f) of this section.

WF_{CO2} = weight fraction carbon dioxide of the natural gas fuel calculated using the mole fractions and molecular weights of the natural gas fuel constituents per ASTM D 1945–91 ''Standard Test Method for Analysis of Natural Gas by Gas Chromatography.'' This 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 obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959. Copies may be inspected at U.S. EPA Headquarters Library, EPA West Building, Constitution Avenue and 14th Street, NW., Room 3340, Washington, DC, 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*.

(2) For automobiles fueled with natural gas, the carbon-related exhaust emissions in grams per mile is to be calculated for 2012 and later model year vehicles using the following equation and rounded to the nearest 1 gram per mile:

$CREE = 10.916 \times CH_4 + CWF_{NMHC} \times NMHC + 1.571 \times CO + CO_2$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002–08.

CH_4 = Grams/mile CH4 as obtained in paragraph (g) of this section.

NMHC = Grams/mile NMHC as obtained in paragraph (g) of this section.

CO = Grams/mile CO as obtained in paragraph (g) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g) of this section.

CWF_{NMHC} = carbon weight fraction of the non-methane HC constituents in the fuel as determined from the speciated fuel composition per paragraph (f)(3) of this section.

(l)(1) For ethanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and ethanol, the fuel economy in miles per gallon is to be calculated using the following equation:

$mpg = (CWF \times SG \times 3781.8)/((CWF_{exHC} \times HC) + (0.429 \times CO) + (0.273 \times CO_2) + (0.375 \times CH_3OH) + (0.400 \times HCHO) + (0.521 \times C_2H_5OH) + (0.545 \times C_2H_4O))$

Where:

CWF = Carbon weight fraction of the fuel as determined in paragraph (f)(4) of this section.

SG = Specific gravity of the fuel as determined in paragraph (f)(4) of this section.

CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons = CWF_g as determined in (f)(4) of this section.

HC = Grams/mile HC as obtained in paragraph (g) of this section.

CO = Grams/mile CO as obtained in paragraph (g) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g) of this section.

CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (d) of this section.

HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g) of this section.

C_2H_5OH = Grams/mile CH_3OH (ethanol) as obtained in paragraph (d) of this section.

C_2H_4O = Grams/mile C_2H_4O (acetaldehyde) as obtained in paragraph (d) of this section.

(2) For 2012 and later model year ethanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and ethanol, the carbon-related exhaust emissions in grams per mile is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$CREE = (CWF_{exHC} \times HC) + (1.571 \times CO) + (1.374 \times CH_3OH) + (1.466 \times HCHO) + (0.955 \times C_2H_5OH) + (0.999 \times C_2H_4O) + CO_2$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002–08.

CWF_{exHC}= Carbon weight fraction of exhaust hydrocarbons = CWF_g as determined in (f)(4) of this section.

HC = Grams/mile HC as obtained in paragraph (g) of this section.

CO = Grams/mile CO as obtained in paragraph (g) of this section.

CO_2= Grams/mile CO_2as obtained in paragraph (g) of this section.

CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (d) of this section.

HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g) of this section.

C_2H_5OH = Grams/mile CH_3OH (ethanol) as obtained in paragraph (d) of this section.

C_2H_4O = Grams/mile C_2H_4O (acetaldehyde) as obtained in paragraph (d) of this section.

(m) Equations for fuels other than those specified in paragraphs (h) through (l) of this section may be used with advance EPA approval. Alternate calculation methods may be used if shown to yield equivalent or superior results and if approved in advance by the Administrator.

39. Section 600.114–08 is amended as follows:

a. By revising the heading.

b. By revising the introductory text.

c. By adding paragraphs (d) through (f).

§ 600.114–08 Vehicle-specific 5-cycle fuel economy and carbon-related exhaust emission calculations.

Paragraphs (a) through (c) of this section apply to data used for fuel economy labeling under Subpart D of this part. Paragraphs (d) through (f) of this section are used to calculate 5-cycle carbon-related exhaust emissions values for the purpose of determining optional technology-based CO_2 emissions credits under the provisions of paragraph (d) of § 86.1866–12 of this title.

* * * * *

(d) *City carbon-related exhaust emission value.* For each vehicle tested, determine the 5-cycle city carbon-related exhaust emissions using the following equation:

(1) CityCREE = 0.905 × (StartCREE + RunningCREE)

Where:

(i) StartCREE =

$$0.33 \times \left(\frac{(0.76 \times StartCREE_{75} + 0.24 \times StartCREE_{20})}{4.1} \right)$$

Where:

$StartCREE_{\times} = 3.6 \times (Bag1CREE_{\times} - Bag3CREE_{\times})$

Where:

Bag Y $CREE_{\times}$ = the carbon-related exhaust emissions in grams per mile during the specified bag of the FTP test conducted at an ambient temperature of 75 °F or 20 °F.

(ii) Running CREE=

$0.82 \times [(0.48 \times Bag2_{75}CREE) + (0.41 \times Bag3_{75}CREE) + 0.11 \times US06CityCREE)] + 0.18 \times [(0.5 \times Bag2_{20}CREE) + (0.5 \times Bag3_{20}CREE)] + 0.144 \times [SC03CREE - ((0.61 \times Bag3_{75}CREE) + (0.39 \times Bag2_{75}CREE))]$

Where:

$BagY_XCREE$ = carbon-related exhaust emissions in grams per mile over Bag Y at temperature X.

US06 City CREE = carbon-related exhaust emissions in grams per mile over the ''city'' portion of the US06 test.

SC03 CREE = carbon-related exhaust emissions in grams per mile over the SC03 test.

(e) *Highway carbon-related exhaust emissions.* (1) For each vehicle tested, determine the 5-cycle highway carbon-related exhaust emissions using the following equation:

HighwayCREE = 0.905 × (StartCREE + RunningCREE)

Where:

(1) StartCREE =

$$= 0.33 \times \left(\frac{(0.76 \times \text{StartCREE}_{75} + 0.24 \times \text{StartCREE}_{20})}{60} \right)$$

Where:

$StartCREE_{\times} = 3.6 \times (Bag1CREE_{\times} - Bag3CREE_{\times})$

(ii) Running CREE =

$1.007 \times [(0.79 \times US06\ Highway\ CREE) + (0.21 \times HFET\ CREE)] + 0.045 \times [SC03CREE - ((0.61 \times Bag3_{75}CREE) + (0.39 \times Bag2_{75}CREE))]$

Where:

$BagY_XCREE$ =carbon-related exhaust emissions in grams per mile over Bag Y at temperature X,

US06 Highway CREE = carbon-related exhaust emissions in grams per mile over the highway portion of the US06 test,

HFET CREE = carbon-related exhaust emissions in grams per mile over the HFET test,

SC03 CREE = carbon-related exhaust emissions in grams per mile over the SC03 test.

(f) *Carbon-related exhaust emissions calculations for hybrid electric vehicles.* Hybrid electric vehicles shall be tested according to California test methods which require FTP emission sampling for the 75 °F FTP test over four phases (bags) of the UDDS (cold-start, transient, warm-start, transient). Optionally, these four phases may be combined into two phases (phases 1 + 2 and phases 3 + 4). Calculations for these sampling methods follow.

(1) *Four-bag FTP equations.* If the 4-bag sampling method is used, manufacturers may use the equations in paragraphs (a) and (b) of this section to determine city and highway carbon-related exhaust emissions values. If this method is chosen, it must be used to determine both city and highway carbon-related exhaust emissions. Optionally, the following calculations may be used, provided that they are used to determine both city and highway carbon-related exhaust emissions values:

(i) *City carbon-related exhaust emissions.*

CityCREE = 0.905 × (StartCREE + RunningCREE)

Where:

(A) StartCREE =

$$0.33 \times \left(\frac{(0.76 \times \text{StartCREE}_{75} + 0.24 \times \text{StartCREE}_{20})}{4.1} \right)$$

Where:

(*1*) $StartCREE_{75}$ =

$3.6 \times (Bag1CREE_{75} - Bag3CREE_{75}) + 3.9 \times (Bag2CREE_{75} - Bag4CREE_{75})$

and

(*2*) $StartCREE_{20}$ =

$= 3.6 \times (Bag1CREE_{20} - Bag3CREE_{20})$

(B) RunningCREE =

$0.82 \times [(0.48 \times Bag4_{75}CREE) + (0.41 \times Bag3_{75}CREE) + (0.11 \times US06CityCREE)] + 0.18 \times [(0.5 \times Bag2_{20}\ CREE) + (0.5 \times Bag3_{75}\ CREE)] + 0.144 \times [(SC03CREE - ((0.61 \times Bag3_{75}\ CREE) + (0.39 \times Bag4_{75}\ CREE))]$

Where:

US06 Highway CREE = carbon-related exhaust emissions in grams per mile over the city portion of the US06 test.

US06 Highway CREE = carbon-related exhaust emissions in miles per gallon over the Highway portion of the US06 test.

HFET CREE = carbon-related exhaust emissions in grams per mile over the HFET test.

SC03 CREE = carbon-related exhaust emissions in grams per mile over the SC03 test.

(ii) *Highway carbon-related exhaust emissions.*

HighwayCREE = 0.905 × (StartCREE + RunningCREE)

Where:

(A) StartCREE =

$$= 0.33 \times \left(\frac{(0.76 \times \text{StartCREE}_{75} + 0.24 \times \text{StartCREE}_{20})}{60} \right)$$

Where:

$StartCREE_{75} = 3.6 \times (Bag1CREE_{75} - Bag3CREE_{75}) + 3.9 \times (Bag2CREE_{75} - Bag4CREE_{75})$

and

$StartCREE_{20} = 3.6 \times (Bag1CREE_{20} - Bag3CREE_{20})$

(B) RunningCREE =

$1.007 \times [(0.79 \times US06\ HighwayCREE) + (0.21 \times HFET\ CREE)] + 0.045 \times [SC03CREE = ((0.61 \times Bag3_{75}CREE) + (0.39 \times Bag4_{75}CREE))]$

Where:

US06 Highway CREE = carbon-related exhaust emissions in grams per mile over the Highway portion of the US06 test,

HFET CREE = carbon-related exhaust emissions in grams per mile over the HFET test,

SC03 CREE = carbon-related exhaust emissions in grams per mile over the SC03 test.

(2) *Two-bag FTP equations.* If the 2-bag sampling method is used for the 75 °F FTP test, it must be used to determine both city and highway carbon-related exhaust emissions. The following calculations must be used to determine both city and highway carbon-related exhaust emissions:

(i) *City carbon-related exhaust emissions.*

CityCREE = 0.905 × (StartCREE + RunningCREE)

Where:

(A) StartCREE =

$$= 0.33 \times \left(\frac{(0.76 \times \text{StartCREE}_{75} + 0.24 \times \text{StartCREE}_{20})}{4.1} \right)$$

Where:

$\text{StartCREE}_{75} = 3.6 \times (\text{Bag}1/2\text{CREE}_{75} - \text{Bag}3/4\text{CREE}_{75})$

and

$\text{StartCREE}_{20} = 3.6 \times (\text{Bag1CREE}_{20} - \text{Bag3CREE}_{20})$

Where:

Bag Y FE_{20}= the carbon-related exhaust emissions in grams per mile of fuel during Bag 1 or Bag 3 of the 20 °F FTP test, and

Bag X/Y FE_{75} = carbon-related exhaust emissions in grams per mile of fuel during combined phases 1 and 2 or phrases 3 and 4 of the FTP test conducted at an ambient temperature of 75 °F.

(B) RunningCREE =

$0.82 \times [(0.90 \times \text{Bag}3/4_{75}\text{CREE}) + (0.10 \times \text{US06CityCREE})] + (0.18 \times [(0.5 \times \text{Bag}2_{20}\text{ CREE}) + (0.5 \times \text{Bag}3_{20}\text{ CREE})] + 0.144 \times [(\text{SC03CREE} - ((\text{Bag}3/4_{75}\text{ CREE})]$

Where:

US06 City CREE = carbon-related exhaust emissions in grams per mile over the city portion of the US06 test, and

SC03 CREE = carbon-related exhaust emissions in grams per mile over the SC03 test, and

Bag X/Y FE_{75} = carbon-related exhaust emissions in grams per mile of fuel during combined phases 1 and 2 or phrases 3 and 4 of the FTP test conducted at an ambient temperature of 75 °F.

(ii) *Highway carbon-related exhaust emissions.*

HighwayCREE = 0.905 × (StartCREE + RunningCREE)

Where:

(A) StartCREE =

$$0.33 \times \left(\frac{(0.76 \times \text{StartCREE}_{75} + 0.24 \times \text{StartCREE}_{20})}{60} \right)$$

Where:

$\text{StartCREE}_{75} = 7.5 \times (\text{Bag}1/2\text{CREE}_{75} - \text{Bag}3/4\text{CREE}_{75})$

and

$\text{StartCREE}_{20} = 3.6 \times (\text{Bag1CREE}_{20} - \text{Bag3CREE}_{20})$

(B) RunningCREE =

$1.007 \times [(0.79 \times \text{US06 HighwayCREE}) + (0.21 \times \text{HFET CREE})] + 0.045 \times [\text{SC03CREE} - \text{Bag}3/4_{75}\text{CREE})$

Where:

US06 City CREE = carbon-related exhaust emissions in grams per mile over the city portion of the US06 test, and

SC03 CREE = carbon-related exhaust emissions in grams per mile over the SC03 test, and

Bag Y FE_{20} = the carbon-related exhaust emissions in grams per mile of fuel during Bag 1 or 3 of the 20 °F FTP test, and

Bag X/Y FE_{75} = carbon-related exhaust emissions in grams per mile of fuel during phases 1 and 2 or phases 3 and 4 of the FTP test conducted at an ambient temperature of 75 °F.

40. Section 600.115–08 is amended by revising the introductory text to read as follows:

§ 600.115–08 Criteria for determining the fuel economy label calculation method for 2011 and later model year vehicles.

This section provides the criteria to determine if the derived 5-cycle method for determining fuel economy label values, as specified in § 600.210–08 (a)(2) or (b)(2), as applicable, may be used to determine label values for 2011 and later model year vehicles. Separate criteria apply to city and highway fuel economy for each test group. The provisions of this section are optional. If this option is not chosen, or if the criteria provided in this section are not met, fuel economy label values for 2011 and later model year vehicles must be determined according to the vehicle-specific 5-cycle method specified in § 600.210–08(a)(1) or (b)(1), as applicable. However, dedicated alternative-fuel vehicles, dual fuel vehicles when operating on alternative fuel, and MDPVs may use the derived 5-cycle method for determining fuel economy labels for 2011 and later model years whether or not the criteria provided in this section are met.

* * * * *

Subpart C—Procedures for Calculating Fuel Economy and Carbon-related Exhaust Emission Values for 1977 and Later Model Year Automobiles

41. The heading for subpart C is revised as set forth above.

42. A new § 600.201–12 is added to subpart C to read as follows:

§ 600.201–12 General applicability.

The provisions of this subpart are applicable to 2012 and later model year automobiles and to the manufacturers of 2012 and later model year automobiles.

43. A new § 600.206–12 is added to subpart C to read as follows:

§ 600.206–12 Calculation and use of FTP-based and HFET-based fuel economy and carbon-related exhaust emission values for vehicle configurations.

(a) Fuel economy and carbon-related exhaust emissions values determined for each vehicle under § 600.113(a) and (b) and as approved in § 600.008–08 (c), are used to determine FTP-based city, HFET-based highway, and combined FTP/Highway-based fuel economy and carbon-related exhaust emission values for each vehicle configuration for which data are available.

(1) If only one set of FTP-based city and HFET-based highway fuel economy values is accepted for a vehicle configuration, these values, rounded to the nearest tenth of a mile per gallon, comprise the city and highway fuel economy values for that configuration. If only one set of FTP-based city and HFET-based highway carbon-related exhaust emission values is accepted for a vehicle configuration, these values, rounded to the nearest gram per mile, comprise the city and highway carbon-related exhaust emission values for that configuration.

(2) If more than one set of FTP-based city and HFET-based highway fuel economy and/or carbon-related exhaust emission values are accepted for a vehicle configuration:

(i) All data shall be grouped according to the subconfiguration for which the data were generated using sales projections supplied in accordance with § 600.208(a)(3).

(ii) Within each group of data, all fuel economy values are harmonically averaged and rounded to the nearest 0.0001 of a mile per gallon and all carbon-related exhaust emission values are arithmetically averaged and rounded to the nearest tenth of a gram per mile in order to determine FTP-based city and HFET-based highway fuel economy and carbon-related exhaust emission values for each subconfiguration at which the vehicle configuration was tested.

(iii) All FTP-based city fuel economy and carbon-related exhaust emission values and all HFET-based highway fuel economy and carbon-related exhaust emission values calculated in paragraph (a)(2)(ii) of this section are (separately for city and highway) averaged in proportion to the sales fraction (rounded to the nearest 0.0001) within the vehicle configuration (as provided to the Administrator by the manufacturer) of vehicles of each tested subconfiguration. Fuel economy values shall be harmonically averaged and carbon-related exhaust emission values shall be arithmetically averaged. The resultant fuel economy values, rounded to the nearest 0.0001 mile per gallon, are the FTP-based city and HFET-based highway fuel economy values for the vehicle configuration. The resultant carbon-related exhaust emission values, rounded to the nearest tenth of a gram per mile, are the FTP-based city and HFET-based highway carbon-related exhaust emission values for the vehicle configuration.

(3)(i) For the purpose of determining average fuel economy under § 600.510–08, the combined fuel economy value for a vehicle configuration is calculated by harmonically averaging the FTP-based city and HFET-based highway fuel economy values, as determined in § 600.206(a)(1) or (2) of this section, weighted 0.55 and 0.45 respectively, and rounded to the nearest 0.0001 mile per gallon. A sample of this calculation appears in Appendix II of this part.

(ii) For the purpose of determining average carbon-related exhaust emissions under § 600.510–08, the combined carbon-related exhaust emission value for a vehicle configuration is calculated by arithmetically averaging the FTP-based city and HFET-based highway carbon-related exhaust emission values, as determined in § 600.206(a)(1) or (2) of this section, weighted 0.55 and 0.45 respectively, and rounded to the nearest tenth of gram per mile.

(4) For alcohol dual fuel automobiles and natural gas dual fuel automobiles the procedures of paragraphs (a)(1) or (2) of this section, as applicable, shall be used to calculate two separate sets of FTP-based city, HFET-based highway, and combined fuel economy and carbon-related exhaust emission values for each configuration.

(i) Calculate the city, highway, and combined fuel economy and carbon-related exhaust emission values from the tests performed using gasoline or diesel test fuel.

(ii) Calculate the city, highway, and combined fuel economy and carbon-related exhaust emission values from the tests performed using alcohol or natural gas test fuel.

(b) If only one equivalent petroleum-based fuel economy value exists for an electric vehicle configuration, that value, rounded to the nearest tenth of a mile per gallon, will comprise the petroleum-based fuel economy for that configuration. The carbon-related exhaust emission value for that configuration shall be 0 grams per mile.

(c) If more than one equivalent petroleum-based fuel economy value exists for an electric vehicle configuration, all values for that vehicle configuration are harmonically averaged and rounded to the nearest 0.0001 mile per gallon for that configuration. The carbon-related exhaust emission value for that configuration shall be 0 grams per mile.

44. A new § 600.208–12 is added to subpart C to read as follows:

§ 600.208–12 Calculation of FTP-based and HFET-based fuel economy and carbon-related exhaust emission values for a model type.

(a) Fuel economy and carbon-related exhaust emission values for a base level are calculated from vehicle configuration fuel economy and carbon-related exhaust emission values as determined in § 600.206–08(a), (b), or (c) as applicable, for low-altitude tests.

(1) If the Administrator determines that automobiles intended for sale in the State of California are likely to exhibit significant differences in fuel economy and carbon-related exhaust emission values from those intended for sale in other states, she will calculate fuel economy and carbon-related exhaust emission values for each base level for vehicles intended for sale in California and for each base level for vehicles intended for sale in the rest of the States.

(2) In order to highlight the fuel efficiency and carbon-related exhaust emission values of certain designs otherwise included within a model type, a manufacturer may wish to subdivide a model type into one or more additional model types. This is accomplished by separating subconfigurations from an existing base level and placing them into a new base level. The new base level is identical to the existing base level except that it shall be considered, for the purposes of this paragraph, as containing a new basic engine. The manufacturer will be permitted to designate such new basic engines and base level(s) if:

(i) Each additional model type resulting from division of another model type has a unique car line name and that name appears on the label and on the vehicle bearing that label;

(ii) The subconfigurations included in the new base levels are not included in any other base level which differs only by basic engine (*i.e.,* they are not included in the calculation of the original base level fuel economy values); and

(iii) All subconfigurations within the new base level are represented by test data in accordance with § 600.010–08(c)(1)(ii).

(3) The manufacturer shall supply total model year sales projections for each car line/vehicle subconfiguration combination.

(i) Sales projections must be supplied separately for each car line-vehicle subconfiguration intended for sale in California and each car line/vehicle subconfiguration intended for sale in the rest of the States if required by the Administrator under paragraph (a)(1) of this section.

(ii) Manufacturers shall update sales projections at the time any model type value is calculated for a label value.

(iii) The provisions of paragraph (a)(3) of this section may be satisfied by providing an amended application for certification, as described in § 86.1844–01.

(4) Vehicle configuration fuel economy and carbon-related exhaust emission values, as determined in § 600.206–08 (a), (b) or (c), as applicable, are grouped according to base level.

(i) If only one vehicle configuration within a base level has been tested, the fuel economy and carbon-related exhaust emission values from that vehicle configuration will constitute the fuel economy and carbon-related exhaust emission values for that base level.

(ii) If more than one vehicle configuration within a base level has been tested, the vehicle configuration fuel economy values are harmonically averaged in proportion to the respective sales fraction (rounded to the nearest 0.0001) of each vehicle configuration and the resultant fuel economy value rounded to the nearest 0.0001 mile per gallon; and the vehicle configuration carbon-related exhaust emission values are arithmetically averaged in proportion to the respective sales fraction (rounded to the nearest 0.0001) of each vehicle configuration and the resultant carbon-related exhaust emission value rounded to the nearest gram per mile.

(5) The procedure specified in paragraph (a)(1) through (4) of this section will be repeated for each base level, thus establishing city, highway, and combined fuel economy and carbon-related exhaust emission values for each base level.

(6) For the purposes of calculating a base level fuel economy or carbon-related exhaust emission value, if the only vehicle configuration(s) within the base level are vehicle configuration(s) which are intended for sale at high altitude, the Administrator may use fuel economy and carbon-related exhaust emission data from tests conducted on these vehicle configuration(s) at high altitude to calculate the fuel economy or carbon-related exhaust emission value for the base level.

(7) For alcohol dual fuel automobiles and natural gas dual fuel automobiles, the procedures of paragraphs (a)(1) through (6) of this section shall be used to calculate two separate sets of city, highway, and combined fuel economy and carbon-related exhaust emission values for each base level.

(i) Calculate the city, highway, and combined fuel economy and carbon-related exhaust emission values from the tests performed using gasoline or diesel test fuel.

(ii) Calculate the city, highway, and combined fuel economy and carbon-related exhaust emission values from the tests performed using alcohol or natural gas test fuel.

(b) For each model type, as determined by the Administrator, a city, highway, and combined fuel economy value and a carbon-related exhaust emission value will be calculated by using the projected sales and fuel economy and carbon-related exhaust emission values for each base level within the model type. Separate model type calculations will be done based on the vehicle configuration fuel economy and carbon-related exhaust emission values as determined in § 600.206–08 (a), (b) or (c), as applicable.

(1) If the Administrator determines that automobiles intended for sale in the State of California are likely to exhibit significant differences in fuel economy and carbon-related exhaust emission values from those intended for sale in other States, she will calculate fuel economy and carbon-related exhaust emission values for each model type for vehicles intended for sale in California and for each model type for vehicles intended for sale in the rest of the States.

(2) The sales fraction for each base level is calculated by dividing the projected sales of the base level within the model type by the projected sales of the model type and rounding the quotient to the nearest 0.0001.

(3)(i) The FTP-based city fuel economy values of the model type (calculated to the nearest 0.0001 mpg) are determined by dividing one by a sum of terms, each of which corresponds to a base level and which is a fraction determined by dividing:

(A) The sales fraction of a base level; by

(B) The FTP-based city fuel economy value for the respective base level.

(ii) The FTP-based city carbon-related exhaust emission value of the model type (calculated to the nearest gram per mile) are determined by a sum of terms, each of which corresponds to a base level and which is a product determined by multiplying:

(A) The sales fraction of a base level; by

(B) The FTP-based city carbon-related exhaust emission value for the respective base level.

(4) The procedure specified in paragraph (b)(3) of this section is repeated in an analogous manner to determine the highway and combined fuel economy and carbon-related exhaust emission values for the model type.

(5) For alcohol dual fuel automobiles and natural gas dual fuel automobiles, the procedures of paragraphs (b)(1) through (4) of this section shall be used to calculate two separate sets of city, highway, and combined fuel economy values and two separate sets of city, highway, and combined carbon-related exhaust emission values for each model type.

(i) Calculate the city, highway, and combined fuel economy and carbon-related exhaust emission values from the tests performed using gasoline or diesel test fuel.

(ii) Calculate the city, highway, and combined fuel economy and carbon-related exhaust emission values from the tests performed using alcohol or natural gas test fuel.

Subpart D—Fuel Economy Regulations for 1977 and Later Model Year Automobiles—Labeling

45. A new § 600.301–12 is added to subpart D to read as follows:

§ 600.301–12 General applicability.

(a) Unless otherwise specified, the provisions of this subpart are applicable to 2012 and later model year automobiles.

(b) [Reserved]

Subpart F—Fuel Economy Regulations for Model Year 1978 Passenger Automobiles and for 1979 and Later Model Year Automobiles (Light Trucks and Passenger Automobiles)—Procedures for Determining Manufacturer's Average Fuel Economy and Manufacturer's Average Carbon-related Exhaust Emissions

46. The heading for subpart F is revised as set forth above.

47. A new § 600.501–12 is added to subpart F to read as follows:

§ 600.501–12 General applicability.

The provisions of this subpart are applicable to 2012 and later model year passenger automobiles and light trucks and to the manufacturers of 2012 and later model year passenger automobiles and light trucks.

48. A new § 600.507–12 is added to subpart F to read as follows:

§ 600.507–12 Running change data requirements.

(a) Except as specified in paragraph (d) of this section, the manufacturer shall submit additional running change fuel economy and carbon-related exhaust emissions data as specified in paragraph (b) of this section for any running change approved or implemented under §§ 86.079–32, 86.079–33, or 86.082–34 or 86.1842–01 as applicable, which:

(1) Creates a new base level or,

(2) Affects an existing base level by:

(i) Adding an axle ratio which is at least 10 percent larger (or, optionally, 10 percent smaller) than the largest axle ratio tested.

(ii) Increasing (or, optionally, decreasing) the road-load horsepower for a subconfiguration by 10 percent or more for the individual running change or, when considered cumulatively, since original certification (for each cumulative 10 percent increase using the originally certified road-load horsepower as a base).

(iii) Adding a new subconfiguration by increasing (or, optionally, decreasing) the equivalent test weight for any previously tested subconfiguration in the base level.

(iv) Revising the calibration of an electric vehicle, fuel cell electric vehicle, hybrid electric vehicle, plug-in hybrid electric vehicle or other advanced technology vehicle in such a way that the city or highway fuel economy of the vehicle (or the energy consumption of the vehicle, as may be applicable) is expected to become less fuel efficient (or optionally, more fuel efficient) by 4.0 percent or more as compared to the original fuel economy label values for fuel economy and/or energy consumption, as applicable.

(b)(1) The additional running change fuel economy and carbon-related exhaust emissions data requirement in paragraph (a) of this section will be determined based on the sales of the vehicle configurations in the created or affected base level(s) as updated at the time of running change approval.

(2) Within each newly created base level as specified in paragraph (a)(1) of this section, the manufacturer shall submit data from the highest projected total model year sales subconfiguration within the highest projected total model year sales configuration in the base level.

(3) Within each base level affected by a running change as specified in paragraph (a)(2) of this section, fuel economy and carbon-related exhaust emissions data shall be submitted for the vehicle configuration created or affected by the running change which has the highest total model year projected sales. The test vehicle shall be of the subconfiguration created by the running change which has the highest projected total model year sales within the applicable vehicle configuration.

(c) The manufacturer shall submit the fuel economy data required by this section to the Administrator in accordance with § 600.314(b).

(d) For those model types created under § 600.208–08(a)(2), the manufacturer shall submit fuel economy and carbon-related exhaust emissions data for each subconfiguration added by a running change.

49. A new § 600.509–12 is added to subpart F to read as follows:

§ 600.509–12 Voluntary submission of additional data.

(a) The manufacturer may optionally submit data in addition to the data required by the Administrator.

(b) Additional fuel economy and carbon-related exhaust emissions data may be submitted by the manufacturer for any vehicle configuration which is to be tested as required in § 600.507 or for which fuel economy and carbon-related exhaust emissions data were previously submitted under paragraph (c) of this section.

(c) Within a base level, additional fuel economy and carbon-related exhaust emissions data may be submitted by the manufacturer for any vehicle configuration which is not required to be tested by § 600.507.

50. A new § 600.510–12 is added to subpart F to read as follows:

§ 600.510–12 Calculation of average fuel economy and average carbon-related exhaust emissions.

(a)(1) Average fuel economy will be calculated to the nearest 0.1 mpg for the classes of automobiles identified in this section, and the results of such calculations will be reported to the Secretary of Transportation for use in determining compliance with the applicable fuel economy standards.

(i) An average fuel economy calculation will be made for the category of passenger automobiles that is domestically manufactured as defined in § 600.511(d)(1).

(ii) An average fuel economy calculation will be made for the category of passenger automobiles that is not domestically manufactured as defined in § 600.511(d)(2).

(iii) An average fuel economy calculation will be made for the category of light trucks that is domestically manufactured as defined in § 600.511(e)(1).

(iv) An average fuel economy calculation will be made for the category of light trucks that is not domestically manufactured as defined in § 600.511(e)(2).

(2) Average carbon-related exhaust emissions will be calculated to the nearest one gram per mile for the classes of automobiles identified in this section, and the results of such calculations will be reported to the Administrator for use in determining compliance with the applicable CO_2 emission standards.

(i) An average carbon-related exhaust emissions calculation will be made for passenger automobiles.

(ii) An average carbon-related exhaust emissions calculation will be made for light trucks.

(b) For the purpose of calculating average fuel economy under paragraph (c) of this section and for the purpose of calculating average carbon-related exhaust emissions under paragraph (j) of this section:

(1) All fuel economy and carbon-related exhaust emissions data submitted in accordance with § 600.006(e) or § 600.512(c) shall be used.

(2) The combined city/highway fuel economy and carbon-related exhaust emission values will be calculated for each model type in accordance with § 600.208–08 of this section except that:

(i) Separate fuel economy values will be calculated for model types and base levels associated with car lines that are:

(A) Domestically produced; and

(B) Nondomestically produced and imported;

(ii) Total model year production data, as required by this subpart, will be used instead of sales projections;

(iii) [Reserved]

(iv) The fuel economy value will be rounded to the nearest 0.1 mpg;

(v) The carbon-related exhaust emission value will be rounded to the nearest gram per mile; and

(vi) At the manufacturer's option, those vehicle configurations that are self-compensating to altitude changes may be separated by sales into high-altitude sales categories and low-altitude sales categories. These separate sales categories may then be treated (only for the purpose of this section) as separate configurations in accordance with the procedure of § 600.208–08(a)(4)(ii).

(3) The fuel economy and carbon-related exhaust emission values for each vehicle configuration are the combined fuel economy and carbon-related exhaust emissions calculated according to § 600.206–08(a)(3) except that:

(i) Separate fuel economy values will be calculated for vehicle configurations associated with car lines that are:

(A) Domestically produced; and

(B) Nondomestically produced and imported;

(ii) Total model year production data, as required by this subpart will be used instead of sales projections; and

(iii) The fuel economy value of diesel-powered model types will be multiplied by the factor 1.0 to convert gallons of diesel fuel to equivalent gallons of gasoline.

(c) Except as permitted in paragraph (d) of this section, the average fuel economy will be calculated individually for each category identified in paragraph (a) of this section as follows:

(1) Divide the total production volume of that category of automobiles; by

(2) A sum of terms, each of which corresponds to a model type within that category of automobiles and is a fraction determined by dividing the number of automobiles of that model type produced by the manufacturer in the model year; by

(i) For gasoline-fueled and diesel-fueled model types, the fuel economy calculated for that model type in accordance with paragraph (b)(2) of this section; or

(ii) For alcohol-fueled model types, the fuel economy value calculated for that model type in accordance with paragraph (b)(2) of this section divided by 0.15 and rounded to the nearest 0.1 mpg; or

(iii) For natural gas-fueled model types, the fuel economy value calculated for that model type in accordance with paragraph (b)(2) of this section divided by 0.15 and rounded to the nearest 0.1 mpg; or

(iv) For alcohol dual fuel model types, for model years 1993 through 2019, the harmonic average of the following two terms; the result rounded to the nearest 0.1 mpg:

(A) The combined model type fuel economy value for operation on gasoline or diesel fuel as determined in § 600.208(b)(5)(i); and

(B) The combined model type fuel economy value for operation on alcohol fuel as determined in § 600.208(b)(5)(ii) divided by 0.15 provided the requirements of § 600.510(g) are met; or

(v) For natural gas dual fuel model types, for model years 1993 through 2019, the harmonic average of the following two terms; the result rounded to the nearest 0.1 mpg:

(A) The combined model type fuel economy value for operation on gasoline or diesel as determined in § 600.208(b)(5)(i); and

(B) The combined model type fuel economy value for operation on natural gas as determined in § 600.208(b)(5)(ii) divided by 0.15 provided the requirements of paragraph (g) of this section are met.

(d) The Administrator may approve alternative calculation methods if they are part of an approved credit plan under the provisions of 15 U.S.C. 2003.

(e) For passenger categories identified in paragraphs (a)(1) and (2) of this section, the average fuel economy calculated in accordance with paragraph (c) of this section shall be adjusted using the following equation:

$$AFE_{adj} = AFE[((0.55 \times a \times c) + (0.45 \times c) + (0.5556 \times a) + 0.4487)/((0.55 \times a) + 0.45)] + IW$$

Where:

AFE_{adj} = Adjusted average combined fuel economy, rounded to the nearest 0.1 mpg;

AFE = Average combined fuel economy as calculated in paragraph (c) of this section, rounded to the nearest 0.0001 mpg;

a = Sales-weight average (rounded to the nearest 0.0001 mpg) of all model type highway fuel economy values (rounded to the nearest 0.1 mpg) divided by the sales-weighted average (rounded to the nearest 0.0001 mpg) of all model type city fuel economy values (rounded to the nearest 0.1 mpg). The quotient shall be rounded to 4 decimal places. These average fuel economies shall be determined using the methodology of paragraph (c) of this section.

c = 0.0014;

$IW = (9.2917 \times 10^{-3} \times SF_{3IWC} \times FE_{3IWC}) - (3.5123 \times 10^{-3} \times SF_{4ETW} \times FE_{4IWC})$.

Note: Any calculated value of IW less than zero shall be set equal to zero.

SF_{3IWC} = The 3000 lb. inertia weight class sales divided by total sales. The quotient shall be rounded to 4 decimal places.

SF_{4ETW} = The 4000 lb. equivalent test weight category sales divided by total sales. The quotient shall be rounded to 4 decimal places.

FE_{4IWC} = The sales-weighted average combined fuel economy of all 3000 lb. inertia weight class base levels in the compliance category. Round the result to the nearest 0.0001 mpg.

FE_{4IWC} = The sales-weighted average combined fuel economy of all 4000 lb. inertia weight class base levels in the compliance category. Round the result to the nearest 0.0001 mpg.

(f) The Administrator shall calculate and apply additional average fuel economy adjustments if, after notice and opportunity for comment, the Administrator determines that, as a result of test procedure changes not previously considered, such correction is necessary to yield fuel economy test results that are comparable to those obtained under the 1975 test procedures. In making such determinations, the Administrator must find that:

(1) A directional change in measured fuel economy of an average vehicle can be predicted from a revision to the test procedures;

(2) The magnitude of the change in measured fuel economy for any vehicle or fleet of vehicles caused by a revision to the test procedures is quantifiable from theoretical calculations or best available test data;

(3) The impact of a change on average fuel economy is not due to eliminating the ability of manufacturers to take advantage of flexibility within the existing test procedures to gain measured improvements in fuel economy which are not the result of actual improvements in the fuel economy of production vehicles;

(4) The impact of a change on average fuel economy is not solely due to a greater ability of manufacturers to reflect in average fuel economy those design changes expected to have comparable effects on in-use fuel economy;

(5) The test procedure change is required by EPA or is a change initiated by EPA in its laboratory and is not a change implemented solely by a manufacturer in its own laboratory.

(g)(1) Alcohol dual fuel automobiles and natural gas dual fuel automobiles must provide equal or greater energy efficiency while operating on alcohol or natural gas as while operating on gasoline or diesel fuel to obtain the CAFE credit determined in paragraphs (c)(2)(iv) and (v) of this section or to obtain the carbon-related exhaust emissions credit determined in paragraphs (j)(2)(ii) and (iii). The following equation must hold true:

$E_{alt}/E_{pet} >$ or = 1

Where:

$E_{alt} = [FE_{alt}/(NHV_{alt} \times D_{alt})] \times 10^6$ = energy efficiency while operating on alternative fuel rounded to the nearest 0.01 miles/million BTU.

$E_{pet} = [FE_{pet}/(NHV_{pet} \times D_{pet})] \times 10^6$ = energy efficiency while operating on gasoline or diesel (petroleum) fuel rounded to the nearest 0.01 miles/million BTU.

FE_{alt} is the fuel economy [miles/gallon for liquid fuels or miles/100 standard cubic feet for gaseous fuels] while operated on the alternative fuel as determined in § 600.113–08(a) and (b);

FE_{pet} is the fuel economy [miles/gallon] while operated on petroleum fuel (gasoline or diesel) as determined in § 600.113(a) and (b);

NHV_{alt} is the net (lower) heating value [BTU/lb] of the alternative fuel;

NHV_{pet} is the net (lower) heating value [BTU/lb] of the petroleum fuel;

D_{alt} is the density [lb/gallon for liquid fuels or lb/100 standard cubic feet for gaseous fuels] of the alternative fuel;

D_{pet} is the density [lb/gallon] of the petroleum fuel.

(i) The equation must hold true for both the FTP city and HFET highway fuel economy values for each test of each test vehicle.

(ii)(A) The net heating value for alcohol fuels shall be determined per

ASTM D 240–92 ''Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter.'' This 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 obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959. Copies may be inspected at U.S. EPA Headquarters Library, EPA West Building, Constitution Avenue and 14th Street, NW., Room 3340, Washington, DC, 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) The density for alcohol fuels shall be determined per ASTM D 1298–85 (Reapproved 1990) ''Standard Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.'' This 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 obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959. Copies may be inspected at U.S. EPA Headquarters Library, EPA West Building, Constitution Avenue and 14th Street, NW., Room 3340, Washington, DC, 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.*

(iii) The net heating value and density of gasoline are to be determined by the manufacturer in accordance with § 600.113(f).

(2) [Reserved]

(3) Alcohol dual fuel passenger automobiles and natural gas dual fuel passenger automobiles manufactured during model years 1993 through 2019 must meet the minimum driving range requirements established by the Secretary of Transportation (49 CFR part 538) to obtain the CAFE credit determined in paragraphs (c)(2)(iv) and (v) of this section.

(h) [Reserved]

(i) For model years 2012 through 2015, and for each category of automobile identified in paragraph (a)(2) of this section, the maximum decrease in average carbon-related exhaust emissions determined in paragraph (c) of this section attributable to alcohol dual fuel automobiles and natural gas dual fuel automobiles shall be as follows:

Model year	Maximum decrease—passenger automobiles (g/mi)	Maximum decrease—light trucks (g/mi)
2012	9.8	17.9
2013	9.3	17.1
2014	8.9	16.3
2015	6.9	12.6

(1) The Administrator shall calculate the decrease in average carbon-related exhaust emissions to determine if the maximum decrease provided in paragraph (i) of this section has been reached. The Administrator shall calculate the average carbon-related exhaust emissions for each category of automobiles specified in paragraph (a)(2) of this section by subtracting the average carbon-related exhaust emission values determined in paragraphs (b)(2)(vi), (b)(2)(vii), and (c) of this section from the average carbon-related exhaust emission values calculated in accordance with this section by assuming all alcohol dual fuel and natural gas dual fuel automobiles are operated exclusively on gasoline (or diesel) fuel. The difference is limited to the maximum decrease specified in paragraph (i) of this section.

(2) [Reserved]

(j) The average carbon-related exhaust emissions will be calculated individually for each category identified in paragraph (a)(2) of this section as follows:

(1) Divide the total production volume of that category of automobiles into:

(2) A sum of terms, each of which corresponds to a model type within that category of automobiles and is a product determined by multiplying the number of automobiles of that model type produced by the manufacturer in the model year by:

(i) For gasoline-fueled and diesel-fueled model types, the carbon-related exhaust emissions value calculated for that model type in accordance with paragraph (b)(2) of this section; or

(ii)(A) For alcohol-fueled model types, for model years 2012 through 2015, the carbon-related exhaust emissions value calculated for that model type in accordance with paragraph (b)(2) of this section multiplied by 0.15 and rounded to the nearest gram per mile; or

(B) For alcohol-fueled model types, for model years 2016 and later, the carbon-related exhaust emissions value calculated for that model type in accordance with paragraph (b)(2) of this section; or

(iii)(A) For natural gas-fueled model types, for model years 2012 through 2015, the carbon-related exhaust emissions value calculated for that model type in accordance with paragraph (b)(2) of this section multiplied by 0.15 and rounded to the nearest gram per mile; or

(B) For natural gas-fueled model types, for model years 2016 and later, the carbon-related exhaust emissions value calculated for that model type in accordance with paragraph (b)(2) of this section; or

(iv) For alcohol dual fuel model types, for model years 2012 through 2015, the arithmetic average of the following two terms, the result rounded to the nearest gram per mile:

(A) The combined model type carbon-related exhaust emissions value for operation on gasoline or diesel fuel as determined in § 600.208(b)(5)(i); and

(B) The combined model type carbon-related exhaust emissions value for operation on alcohol fuel as determined in § 600.208(b)(5)(ii) multiplied by 0.15 provided the requirements of § 600.510(g) are met; or

(v) For natural gas dual fuel model types, for model years 2012 through 2015, the arithmetic average of the following two terms; the result rounded to the nearest gram per mile:

(A) The combined model type carbon-related exhaust emissions value for operation on gasoline or diesel as determined in § 600.208(b)(5)(i); and

(B) The combined model type carbon-related exhaust emissions value for operation on natural gas as determined in § 600.208(b)(5)(ii) multiplied by 0.15 provided the requirements of paragraph (g) of this section are met.

(vi) For alcohol dual fuel model types, for model years 2016 and later, the combined model type carbon-related exhaust emissions value determined according to the following formula and rounded to the nearest gram per mile:

$$CREE = (F \times CREE_{alt}) + ((1 - F) \times CREE_{gas})$$

Where:

F = 0.00 unless otherwise approved by the Administrator according to the provisions of paragraph (k) of this section;

$CREE_{alt}$ = The combined model type carbon-related exhaust emissions value for operation on alcohol fuel as determined in § 600.208(b)(5)(ii); and

$CREE_{gas}$ = The combined model type carbon-related exhaust emissions value for operation on gasoline or diesel fuel as determined in § 600.208(b)(5)(i).

(vii) For natural gas dual fuel model types, for model years 2016 and later, the combined model type carbon-related exhaust emissions value determined according to the following formula and rounded to the nearest gram per mile:

$$CREE = (F \times CREE_{alt}) + ((1 - F) \times CREE_{gas})$$

Where:

F = 0.00 unless otherwise approved by the Administrator according to the provisions of paragraph (k) of this section;

$CREE_{alt}$ = The combined model type carbon-related exhaust emissions value for operation on natural gas as determined in § 600.208(b)(5)(ii); and

$CREE_{gas}$ = The combined model type carbon-related exhaust emissions value for operation on gasoline or diesel fuel as determined in § 600.208(b)(5)(i).

(3) The production volume of electric, fuel cell electric and plug-in hybrid electric model types for model years 2012 through 2016 may be adjusted by the multiplier specified in 40 CFR 86.1866–12(a) and in accordance with the provisions of 40 CFR 86.1866–12(a). The adjusted production volumes shall be accounted for both in the total production volume specified in paragraph (j)(1) of this section and in the model type production volume specified in paragraph (j)(2) of this section.

(k) *Alternative in-use weighting factors for dual fuel model types.* Using one of the methods in either paragraph (k)(1) or (2) of this section, manufacturers may request the use of alternative values for the weighting factor F in the equations in paragraphs (j)(2)(vi) and (vii) of this section. Unless otherwise approved by the Administrator, the manufacturer must use the value of F that is in effect in paragraphs (j)(2)(vi) and (vii) of this section.

(1) Upon written request from a manufacturer, the Administrator will determine and publish by written guidance an appropriate value of F for each requested alternative fuel based on the Administrator's assessment of real-world use of the alternative fuel. Such published values would be available for any manufacturer to use. The Administrator will periodically update these values upon written request from a manufacturer.

(2) The manufacturer may optionally submit to the Administrator its own demonstration regarding the real-world use of the alternative fuel in their vehicles and its own estimate of the appropriate value of F in the equations in paragraphs (j)(2)(vi) and (vii) of this section. Depending on the nature of the analytical approach, the manufacturer could provide estimates of F that are model type specific or that are generally applicable to the manufacturer's dual fuel fleet. The manufacturer's analysis could include use of data gathered from on-board sensors and computers, from dual fuel vehicles in fleets that are centrally fueled, or from other sources. The analysis must be based on sound statistical methodology and must account for analytical uncertainty. Any approval by the Administrator will pertain to the use of values of F for the model types specified by the manufacturer.

51. A new § 600.512–12 is added to subpart F to read as follows:

§ 600.512–12 Model year report.

(a) For each model year, the manufacturer shall submit to the Administrator a report, known as the model year report, containing all information necessary for the calculation of the manufacturer's average fuel economy and all information necessary for the calculation of the manufacturer's average carbon-related exhaust emissions.

(1) The results of the manufacturer calculations and summary information of model type fuel economy values which are contained in the average fuel economy calculation shall also be submitted to the Secretary of the Department of Transportation, National Highway and Traffic Safety Administration.

(2) The results of the manufacturer calculations and summary information of model type carbon-related exhaust emission values which are contained in the average calculation shall be submitted to the Administrator.

(b)(1) The model year report shall be in writing, signed by the authorized representative of the manufacturer and shall be submitted no later than 90 days after the end of the model year.

(2) The Administrator may waive the requirement that the model year report be submitted no later than 90 days after the end of the model year. Based upon a request by the manufacturer, if the Administrator determines that 90 days is insufficient time for the manufacturer to provide all additional data required as determined in § 600.507, the Administrator shall establish an alternative date by which the model year report must be submitted.

(3) Separate reports shall be submitted for passenger automobiles and light trucks (as identified in § 600.510).

(c) The model year report must include the following information:

(1)(i) All fuel economy data used in the FTP/HFET-based model type calculations under § 600.208–12, and subsequently required by the Administrator in accordance with § 600.507;

(ii) All carbon-related exhaust emission data used in the FTP/HFET-based model type calculations under § 600.208–12, and subsequently required by the Administrator in accordance with § 600.507;

(2)(i) All fuel economy data for certification vehicles and for vehicles tested for running changes approved under § 86.1842–01 of this chapter;

(ii) All carbon-related exhaust emission data for certification vehicles and for vehicles tested for running changes approved under § 86.1842–01 of this chapter;

(3) Any additional fuel economy and carbon-related exhaust emission data submitted by the manufacturer under § 600.509;

(4)(i) A fuel economy value for each model type of the manufacturer's product line calculated according to § 600.510(b)(2);

(ii) A carbon-related exhaust emission value for each model type of the manufacturer's product line calculated according to § 600.510(b)(2);

(5)(i) The manufacturer's average fuel economy value calculated according to § 600.510(c);

(ii) The manufacturer's average carbon-related exhaust emission value calculated according to § 600.510(j);

(6) A listing of both domestically and nondomestically produced car lines as

determined in § 600.511 and the cost information upon which the determination was made; and

(7) The authenticity and accuracy of production data must be attested to by the corporation, and shall bear the signature of an officer (a corporate executive of at least the rank of vice-president) designated by the corporation. 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. The signature of the designated officer shall constitute a representation by the required attestation.

52. A new § 600.514–12 is added to subpart F to read as follows:

§ 600.514–12 Reports to the Environmental Protection Agency.

This section establishes requirements for automobile manufacturers to submit reports to the Environmental Protection Agency regarding their efforts to reduce automotive greenhouse gas emissions.

(a) *General Requirements.* (1) For each current model year, each manufacturer shall submit a pre-model year report, and, as required by paragraph (d) of this section, supplementary reports.

(2)(i) The pre-model year report required by this section for each model year must be submitted during the month of December *(e.g.,* the pre-model year report for the 2012 model year must be submitted during December, 2011).

(ii) Each supplementary report must be submitted in accordance with paragraph (e)(3) of this section.

(3) Each report required by this section must:

(i) Identify the report as a pre-model year report or supplementary report as appropriate;

(ii) Identify the manufacturer submitting the report;

(iii) State the full name, title, and address of the official responsible for preparing the report;

(iv) Be submitted to: Director, Compliance and Innovative Strategies Division, U.S. Environmental Protection Agency, 2000 Traverwood, Ann Arbor, Michigan 48105;

(v) Identify the current model year;

(vi) Be written in the English language; and

(vii)(A) Specify any part of the information or data in the report that the manufacturer believes should be withheld from public disclosure as trade secret or other confidential business information.

(B) With respect to each item of information or data requested by the manufacturer to be withheld, the manufacturer shall:

(*1*) Show that disclosure of the item would result in significant competitive damage;

(*2*) Specify the period during which the item must be withheld to avoid that damage; and

(*3*) Show that earlier disclosure would result in that damage.

(4) Each report required by this section must be based upon all information and data available to the manufacturer 30 days before the report is submitted to the Administrator.

(b) *General content of reports.* (1) Pre-model year report. Except as provided in paragraph (b)(3) of this section, each pre-model year report for each model year must contain the information required by paragraph (c)(1) of this section.

(2) *Supplementary report.* Each supplementary report must contain the information required by paragraph (e)(2)(i), (ii), or (iii), as appropriate.

(3) *Exceptions.* (i) The pre-model year report is not required to contain the information specified in paragraphs (c)(2), (c)(3)(i) and (i), or (c)(3)(iv)(N) and (S) of this section if that report is required to be submitted before the fifth day after the date by which the manufacturer must submit the preliminary determination of its average fuel economy for the current model year to the Environmental Protection Agency under 40 CFR 600.506, when such determination is required. Each manufacturer that does not include information under the exception in the immediately preceding sentence shall indicate in its report the date by which it must submit that preliminary determination.

(ii) The pre-model year report submitted by an incomplete automobile manufacturer for any model year is not required to contain the information specified in paragraphs (c)(3)(iv)(O) through (Q) and (c)(3)(v) of this section. The information provided by the incomplete automobile manufacturer under (c)(3) shall be according to base level instead of model type or carline.

(c) *Pre-model year reports.* (1) Provide the information required by paragraphs (c)(2) and (3) of this section for the manufacturer's passenger automobiles and light trucks for the current model year.

(2) *Projected average and required carbon-related exhaust emissions.* (i) State the projected average carbon-related exhaust emissions for the manufacturer's automobiles determined in accordance with § 600.510–12 and based upon the carbon-related exhaust emission values and projected sales figures provided under paragraph (c)(3)(ii) of this section.

(ii) State the projected final average carbon-related exhaust emissions value that the manufacturer anticipates having if changes implemented during the model year will cause that average to be different from the average carbon-related exhaust emissions projected under paragraph (c)(2)(i) of this section.

(iii) State the projected required carbon-related exhaust emissions value for the manufacturer's passenger automobiles and light trucks determined in accordance with 40 CFR 86.1818–12 and based upon the projected sales figures provided under paragraph (c)(3)(ii) of this section.

(iv) State the projected final required carbon-related exhaust emissions value that the manufacturer anticipates having if changes implemented during the model year will cause the targets to be different from the target carbon-related exhaust emissions projected under paragraph (c)(2)(iii) of this section.

(v) State whether the manufacturer believes that the projections it provides under paragraphs (c)(2)(ii) and (c)(2)(iv) of this section, or if it does not provide an average or target under those paragraphs, the projections it provides under paragraphs (c)(2)(i) and (c)(2)(iii) of this section, sufficiently represent the manufacturer's average and target carbon-related exhaust emissions for the current model year. In the case of a manufacturer that believes that the projections are not sufficiently representative for those purposes, state the specific nature of any reason for the insufficiency and the specific additional testing or derivation of carbon-related exhaust emission values by analytical methods believed by the manufacturer necessary to eliminate the insufficiency and any plans of the manufacturer to undertake that testing or derivation voluntarily and submit the resulting data to the Environmental Protection Agency under 40 CFR 600.509.

(vi) State the number of credits, if any, projected to be earned under the provisions of § 86.1866–12 and the sources and calculations of such credits.

(3) *Model type and configuration fuel economy and technical information.* (i) For each model type of the manufacturer's passenger cars and light trucks, provide the information specified in paragraph (c)(3)(ii) of this section in tabular form. List the model types in order of increasing average inertia weight from top to bottom down the left side of the table and list the

information categories in the order specified in paragraph (c)(3)(ii) of this section from left to right across the top of the table.

(ii)(A) Combined carbon-related exhaust emissions value; and

(B) Projected sales for the current model year and total sales of all model types.

(iii) For each vehicle configuration whose carbon-related exhaust emission value was used to calculate the carbon-related exhaust emission values for a model type under paragraph (c)(3)(ii) of this section, provide the information specified in paragraph (c)(3)(iv) of this section in tabular form. If a tabular form is used then list the vehicle configurations, by model type in the order listed under paragraph (c)(3)(ii) of this section, from top to bottom down the left of the table and list the information categories across the top of the table from left to right in the order specified in paragraph (c)(3)(iv) of this section. Other formats (such as copies of EPA reports) which contain all the required information in a readily identifiable form are also acceptable.

(iv)(A) Loaded vehicle weight;

(B) Equivalent test weight;

(C) Engine displacement, liters;

(D) SAE net rated power, kilowatts;

(E) SAE net horsepower;

(F) Engine code;

(G) Fuel system (number of carburetor barrels or, if fuel injection is used, so indicate);

(H) Emission control system;

(I) Transmission class;

(J) Number of forward speeds;

(K) Existence of overdrive (indicate yes or no);

(L) Total drive ratio (N/V);

(M) Axle ratio;

(N) Combined fuel economy;

(O) Projected sales for the current model year;

(P) In the case of passenger automobiles:

(*1*) Interior volume index, determined in accordance with subpart D of 40 CFR part 600,

(*2*) Body style,

(*3*) Beginning model year 2012, base tire as defined in § 600.002–08,

(*4*) Beginning model year 2012, track width as defined in § 600. 002–08,

(*5*) Beginning model year 2012, wheelbase as defined in § 600. 002–08, and

(*6*) Beginning model year 2012, footprint as defined in § 600. 002–08.

(Q) In the case of light trucks:

(*1*) Passenger-carrying volume,

(*2*) Cargo-carrying volume,

(*3*) Beginning model year 2012, base tire as defined in § 600.002–08,

(*4*) Beginning model year 2012, track width as defined in § 600.002–08,

(*5*) Beginning model year 2012, wheelbase as defined in § 600.002–08, and

(*6*) Beginning model year 2012, footprint as defined in § 600.002–08.

(R) Frontal area;

(S) Road load power at 50 miles per hour, if determined by the manufacturer for purposes other than compliance with this part to differ from the road load setting prescribed in 40 CFR 86.177–11(d);

(T) Optional equipment that the manufacturer is required under 40 CFR parts 86 and 600 to have actually installed on the vehicle configuration, or the weight of which must be included in the curb weight computation for the vehicle configuration, for fuel economy and CO_2 emission testing purposes.

(v) For each model type of automobile which is classified as an automobile capable of off-highway operation under 49 CFR 523, provide the following data:

(A) Approach angle;

(B) Departure angle;

(C) Breakover angle;

(D) Axle clearance;

(E) Minimum running clearance; and

(F) Existence of 4-wheel drive (indicate yes or no).

(vi) The CO_2 emission values provided under paragraphs (c)(3)(ii) and (iv) of this section shall be determined in accordance with § 600.208–12.

(d) *Supplementary reports.* (1)(i) Except as provided in paragraph (d)(4) of this section, each manufacturer whose most recently submitted report contained an average carbon-related exhaust emissions projection under (c)(2)(ii) of this section, or, if no average carbon-related exhaust emission value was projected under that paragraph, under paragraph (c)(2)(i), that was not greater than the applicable average CO_2 emissions standard and who now projects an average carbon-related exhaust emissions value which is greater than the applicable standard shall file a supplementary report containing the information specified in paragraph (d)(2)(i) of this section.

(ii) Except as provided in paragraph (d)(4) of this section, each manufacturer that determines that its average carbon-related exhaust emissions for the current model year as projected under paragraph (c)(2)(ii) of this section or, if no average carbon-related exhaust emissions value was projected under that paragraph, as projected under paragraph (c)(2)(i) of this section, is less representative than the manufacturer previously reported it to be under paragraph (c)(2)(iii) of this section, this paragraph (d), or both, shall file a supplementary report containing the information specified in paragraph (d)(2)(ii) of this section.

(iii) Each manufacturer whose pre-model year report omits any of the information specified in (c)(2), (c)(3)(i) and (ii), or (c)(3)(iv)(P) and (Q) shall file a supplementary report containing the information specified in paragraph (d)(2)(iii) of this section.

(2)(i) The supplementary report required by paragraph (d)(1)(i) of this section must contain:

(A) Such revisions of and additions to the information previously submitted by the manufacturer under this part regarding the automobiles whose projected average carbon-related exhaust emissions value has increased as specified in paragraph (d)(1)(i) of this section as are necessary—

(*1*) To reflect the increase and its cause;

(*2*) To indicate a new projected average carbon-related exhaust emissions value based upon these additional measures.

(B) An explanation of the cause of the increase in average carbon-related exhaust emissions that led to the manufacturer's having to submit the supplementary report required by paragraph (d)(1)(i) of this section.

(ii) The supplementary report required by paragraph (d)(1)(ii) of this section must contain:

(A) A statement of the specific nature of and reason for the insufficiency in the representativeness of the projected average carbon-related exhaust emissions;

(B) A statement of specific additional testing or derivation of carbon-related exhaust emissions values by analytical methods believed by the manufacturer necessary to eliminate the insufficiency; and

(C) A description of any plans of the manufacturer to undertake that testing or derivation voluntarily and submit the resulting data to the Environmental Protection Agency under 40 CFR 600.509.

(iii) The supplementary report required by paragraph (d)(1)(iii) of this section must contain:

(A) All of the information omitted from the pre-model year report under paragraph (b)(3)(ii); and

(B) Such revisions of and additions to the information submitted by the manufacturer in its pre-model year report regarding the automobiles produced during the current model year as are necessary to reflect the information provided under paragraph (b)(3)(i) of this section.

(3)(i) Each report required by paragraph (d)(1)(i) or (ii) of this section must be submitted in accordance with paragraph (a)(3) not more than 45 days after the date on which the manufacturer determined, or could have, with reasonable diligence, determined that a report is required under paragraph (d)(1)(i) or (ii) of this section.

(ii) Each report required by paragraph (d)(1)(iii) of this section must be submitted in accordance with paragraph (a)(3) of this section not later than five days after the day by which the manufacturer is required to submit a preliminary calculation of its average fuel economy for the current model year to the Environmental Protection Agency under 40 CFR 600.506.

(4) A supplementary report is not required to be submitted by the manufacturer under paragraph (d)(1)(i) or (ii) of this section:

(i) With respect to information submitted under this part before the most recent report submitted by the manufacturer under this part, or

(ii) When the date specified in paragraph (d)(3) of this section occurs after the day by which the pre-model year report for the model year immediately following the current model year must be submitted by the manufacturer under this part.

(e) *Determination of carbon-related exhaust emission values and average carbon-related exhaust emissions.*

(1) *Vehicle configuration carbon-related exhaust emission values.* (i) For each vehicle configuration for which a carbon-related exhaust emission value is required under paragraph (e)(3) of this section and has been determined and approved under 40 CFR part 600, the manufacturer shall submit that carbon-related exhaust emission value.

(ii) For each vehicle configuration specified in paragraph (e)(1)(i) of this section for which a carbon-related exhaust emissions value approved under 40 CFR part 600, does not exist, but for which a carbon-related exhaust emissions value determined under that part exists, the manufacturer shall submit that carbon-related exhaust emissions value.

(iii) For each vehicle configuration specified in paragraph (e)(1)(i) of this section for which a carbon-related exhaust emissions value has been neither determined nor approved under 40 CFR part 600, the manufacturer shall submit a carbon-related exhaust emissions value based on tests or analyses comparable to those prescribed or permitted under 40 CFR part 600 and a description of the test procedures or analytical methods used.

(2) *Base level and model type carbon-related exhaust emission values.* For each base level and model type, the manufacturer shall submit a carbon-related exhaust emission value based on the values submitted under paragraph (e)(1) of this section and calculated in the same manner as base level and model type carbon-related exhaust emission values are calculated for use under subpart F of 40 CFR part 600.

(3) *Average carbon-related exhaust emissions.* Average carbon-related exhaust emissions must be based upon carbon-related exhaust emission values calculated under paragraph (e)(2) of this section for each model type and must be calculated in accordance with 40 CFR 600.506, using the configurations specified in 40 CFR 600.506(a)(2), except that carbon-related exhaust emission values for running changes and for new base levels are required only for those changes made or base levels added before the average carbon-related exhaust emission value is required to be submitted under this section.

In consideration of the foregoing, under the authority of 49 U.S.C. 32901, 32902, 32903, and 32907, and delegation of authority at 49 CFR 1.50, NHTSA proposes to amend 49 CFR Chapter V as follows:

PART 531—PASSENGER AUTOMOBILE AVERAGE FUEL ECONOMY STANDARDS

1. The authority citation for part 531 continues to read as follows:

Authority: 49 U.S.C. 32902; delegation of authority at 49 CFR 1.50.

2. Amend § 531.5 by redesignating paragraph (d) as paragraph (e), revising the introductory text of paragraph (a), revising paragraph (c), and adding a new paragraph (d) to read as follows:

§ 531.5 Fuel economy standards.

(a) Except as provided in paragraph (e) of this section, each manufacturer of passenger automobiles shall comply with the average fuel economy standards in Table I, expressed in miles per gallon, in the model year specified as applicable:

* * * * *

(c) For model years 2012–2016, a manufacturer's passenger automobile fleet shall comply with the fuel economy level calculated for that model year according to Figure 2 and the appropriate values in Table III.

Figure 2 : $$CAFE_{required} = \frac{\sum_i SALES_i}{\sum_i \frac{SALES_i}{TARGET_i}}$$

Where:

$CAFE_{required}$ is the required level for a given fleet,

$SALES_i$ is the number of units of model i produced for sale in the United States,

$TARGET_i$ is the fuel economy target applicable to model i (according to the equation shown in Figure 3 and based on the footprint of model i),

and the summations in the numerator and denominator are both performed over all models in the fleet in question.

Figure 3 : $$TARGET = \frac{1}{MIN\left[MAX\left(c \times FOOTPRINT + d, \frac{1}{a}\right), \frac{1}{b}\right]}$$

Where:

TARGET is the fuel economy target (in mpg) applicable to vehicles of a given footprint (*FOOTPRINT*, in square feet),

Parameters *a, b, c,* and *d* are defined in Table III, and

The *MIN* and *MAX* functions take the minimum and maximum, respectively of the included values.

TABLE III—PARAMETERS FOR THE PASSENGER AUTOMOBILE FUEL ECONOMY TARGETS

Model year	Parameters			
	a	*b*	*c*	*d*
2012	36.23	28.12	0.0005308	0.005842
2013	37.15	28.67	0.0005308	0.005153
2014	38.08	29.22	0.0005308	0.004498
2015	39.55	30.08	0.0005308	0.003520
2016	41.38	31.12	0.0005308	0.002406

(d) In addition to the requirement of paragraphs (b) and (c) of this section, each manufacturer shall also meet the minimum standard for domestically manufactured passenger automobiles expressed in Table IV:

TABLE IV

Model year	Minimum standard
2011	28.0
2012	30.9
2013	31.6
2014	32.4
2015	33.5
2016	34.9

* * * * *

3. Add Appendix A to Part 531 to read as follows:

Appendix A to Part 531—Example of Calculating Compliance Under § 531.5 Paragraph (b)

Assume a hypothetical manufacturer (Manufacturer X) produces a fleet of passenger automobiles in MY 2011 as follows:

Appendix A, Table 1

Model	Carline	Desc	Eng/Trans	Drive system	Fuel econ mpg	Production volume	Footprint (ft^2)
A	PC A	2DS	1.8L, A5	FWD	32.5	1,500	39.2
B	PC B	2DS	1.8L, M6	FWD	33.1	2,000	39.2
C	PC C	2DCv	1.8L, A5	FWD	32.3	2,000	39.1
D	PC D	2DCv	1.8L, M6	FWD	32.9	1,000	39.1
E1	PC E	4DS	2.5L, A6	FWD	31.5	3,000	47.1
E2		SUV			30.4	1,000	
F	PC F	4DW	2.5L, A6	AWD	30.2	8,000	47.1
G1	PC G	4DS	2.5L, A7	FWD	31.7	2,000	48.4
G2		SUV			30.6	5,000	
H	PC H	4DS	3.2L, A7	RWD	29.3	5,000	48.4
						30,500	

Abbreviations: 2DS = two door sedan, 2DCv = two door convertible, SUV = sport utility vehicle, 4DW = four door station wagon, 1.8L = 1.8 liter displacement engine, A5 = five speed automatic transmission, M6 = six speed manual transmission, FWD = front wheel drive, AWD = all wheel drive, and RWD = rear wheel drive.

Note to Appendix A Table 1. Manufacturer X's required corporate average fuel economy level under section 531.5(b) would first be calculated by determining the fuel economy targets applicable to each model type (A through H) as illustrated in Appendix A, Table 2.

Appendix A, Table 2

Manufacturer X calculates target fuel economy values for each model.

Model	Carline	Base tire	Wheel base (in)	Track width			Foot print (ft^2)	Prod vol	Target fuel econ (mpg)
				Front (in)	Rear (in)	Avg (in)			
A	PC A	205/75R14	96.0	58.8	58.8	58.8	39.2	1,500	31.19
B	PC B	215/70R15	96.0	58.8	58.8	58.8	39.2	2,000	31.19
C	PC C	215/70R15	96.1	58.5	58.7	58.6	39.1	2,000	31.19
D	PC D	235/60R15	96.1	58.5	58.7	58.6	39.1	1,000	31.19
E1	PC E	225/65R16	105.0	64.7	64.5	64.6	47.1	3,000	30.52
E2								1,000	
F	PC F	235/65R16	105.0	64.6	64.6	64.6	47.1	8,000	30.52
G1	PC G	235/65R17	107.0	65.1	65.3	65.2	48.4	2,000	29.34
G2								5,000	
H	PC H	265/55R18	107.0	65.2	65.2	65.2	48.4	5,000	29.34
								30,500	

Note to Appendix A Table 2. Accordingly, vehicle models A, B, C, D, E, F, G and H would be compared to fuel economy values of 31.19, 31.19, 31.19, 31.19, 30.52, 30.52, 29.34 and 29.34 mpg, respectively. With the appropriate fuel economy targets calculated, Manufacturer X's required fuel economy would be calculated as illustrated in "Appendix A Figure 1."

Appendix A, Figure 1

Calculation of Manufacturer X's target fuel economy standard.

$$\frac{\text{Manufacturer's Passenger Automobile Production for Applicable Model Year}}{\frac{\text{Volume A}}{\text{Target A}}+\frac{\text{Volume B}}{\text{Target B}}+\frac{\text{Volume C}}{\text{Target C}}+\frac{\text{Volume D}}{\text{Target D}}+\frac{\text{Volume E}}{\text{Target E}}+\frac{\text{Volume F}}{\text{Target F}}+\frac{\text{Volume G}}{\text{Target G}}+\frac{\text{Volume H}}{\text{Target H}}}$$

$$\frac{30{,}500}{\frac{1{,}500}{31.19}+\frac{2{,}000}{31.19}+\frac{2{,}000}{31.19}+\frac{1{,}000}{31.19}+\frac{4{,}000}{30.52}+\frac{8{,}000}{30.52}+\frac{7{,}000}{29.34}+\frac{5{,}000}{29.34}}$$

Manufacturer X's passenger car fleet target fuel economy standard = 30.2 mpg

Appendix A, Figure 2

Calculation of Manufacturer X's actual fuel economy.

$$\frac{\text{Manufacturer's Passenger Automobile Production for Applicable Model Year}}{\frac{\text{Volume A}}{\text{Mpg A}}+\frac{\text{Volume B}}{\text{Mpg B}}+\frac{\text{Volume C}}{\text{Mpg C}}+\frac{\text{Volume D}}{\text{Mpg D}}+\frac{\text{Volume E}}{\text{Mpg E}}+\frac{\text{Volume F}}{\text{Mpg F}}+\frac{\text{Volume G}}{\text{Mpg G}}+\frac{\text{Volume H}}{\text{Mpg H}}}$$

$$\frac{30{,}500}{\frac{1{,}500}{32.5}+\frac{2{,}000}{33.1}+\frac{2{,}000}{32.3}+\frac{1{,}000}{32.9}+\frac{3{,}000}{31.5}+\frac{1{,}000}{30.4}+\frac{8{,}000}{30.2}+\frac{2{,}000}{31.7}+\frac{5{,}000}{30.6}+\frac{5{,}000}{29.3}}$$

Manufacturer X's passenger car fleet actual fuel economy performance = 31.2 mpg

Note to Appendix A Figure 2. Since the actual average fuel economy of Manufacturer X's fleet is 31.2 mpg, as compared to its required fuel economy level of 30.2 mpg, Manufacturer X complied with the CAFE standard for MY 2011 as set forth in section 531.5(b).

PART 533—LIGHT TRUCK FUEL ECONOMY STANDARDS

4. The authority citation for part 533 continues to read as follows:

Authority: 49 U.S.C. 32902; delegation of authority at 49 CFR 1.50.

5. Amend § 533.5 by adding Figures 2 and 3 and Table VI at the end of paragraph (a), and adding paragraph (i), to read as follows:

§ 533.5 Requirements.

(a) * * *

* * * * *

Figure 2:

$$CAFE_{required} = \frac{\sum_i SALES_i}{\sum_i \frac{SALES_i}{TARGET_i}}$$

Where:

$CAFE_{required}$ is the required level for a given fleet,

$SALES_i$ is the number of units of model i produced for sale in the United States,

$TARGET_i$ is the fuel economy target applicable to model i (according to the equation shown in Figure 3 and based on the footprint of model i), and the summations in the numerator and denominator are both performed over all models in the fleet in question.

Figure 3:

$$TARGET = \frac{1}{MIN\left[MAX\left(c \times FOOTPRINT + d, \frac{1}{a}\right), \frac{1}{b}\right]}$$

Where:

TARGET is the fuel economy target (in mpg) applicable to vehicles of a given footprint (*FOOTPRINT*, in square feet),

Parameters *a*, *b*, *c*, and *d* are defined in Table VI, and

The *MIN* and *MAX* functions take the minimum and maximum, respectively of the included values.

TABLE VI—PARAMETERS FOR THE LIGHT TRUCK FUEL ECONOMY TARGETS

Model year	Parameters			
	A	*b*	*c*	*d*
2012	29.44	22.06	0.0004546	0.01533

TABLE VI—PARAMETERS FOR THE LIGHT TRUCK FUEL ECONOMY TARGETS—Continued

Model year	Parameters			
	A	*b*	*c*	*d*
2013	30.32	22.55	0.0004546	0.01434
2014	31.30	23.09	0.0004546	0.01331
2015	32.70	23.84	0.0004546	0.01194
2016	34.38	24.72	0.0004546	0.01045

* * * * *

(i) For model years 2012–2016, a manufacturer's light truck fleet shall comply with the fuel economy level calculated for that model year according to Figures 2 and 3 and the appropriate values in Table VI.

6. Revise Appendix A to Part 533 to read as follows:

Appendix A to Part 533—Example of Calculating Compliance Under § 533.5 Paragraph (h)

Assume a hypothetical manufacturer (Manufacturer X) produces a fleet of light trucks in MY 2011 as follows:

Appendix A, Table 1

Model	Carline	Desc	Eng/Trans	Drive system	Fuel econ mpg	Production volume	Footprint (ft²)
A	PU A	RC, MB	4.0L, A5	2WD	27.1	800	47.8
B	PU B	RC, MB	4.0L, M5	2WD	27.6	200	47.8
C1	PU C	RC, LB	4.5L, A5	2WD	23.9	300	59.7
C2		EC,MB			23.7	400	
C3		CC, SB			23.5	400	
D	PU D	CC, SB	4.5L, A6	2WD	23.6	400	59.7
E1	PU E	EC, LB	5.0L, A6	2WD	22.7	500	71.8
E2		CC, MB			22.5	500	
F1	PU F	RC, LB	4.5L, A5	4WD	22.5	1,600	59.8
F2		EC, MB			22.3	800	
F3		CC, SB			22.2	800	
G	PU G	CC, SB	5.0L, A6	4WD	22.3	800	59.8
H1	PU H	EC, LB	5.0L, A6	4WD	22.2	1,000	71.9
H2		CC, MB			22.1	1,000	
						9,500	

Abbreviations: PU = pickup truck, RC = regular cab, EC = extended cab, CC = crew cab, SB = short cargo bed, MB = medium cargo bed, LB = long cargo bed, 4.0L = 4.0 liter engine, A5 = five speed automatic transmission, M5 = five speed manual transmission, 2WD = two wheel drive, 4WD = four wheel drive.

Appendix A, Table 2

Manufacturer X calculates target fuel economy values for each model.

Model	Carline	Base tire	Wheel base (in)	Track width			Foot print (ft²)	Prod vol	Target fuel econ (mpg)
				Front (in)	Rear (in)	Avg (in)			
A	PU A	235/75R15	100.0	68.6	69.0	68.8	47.8	800	30.26
B	PU B	235/75R15	100.0	68.6	69.0	68.8	47.8	200	30.26
C1								300	
C2	PU C	255/70R17	125.0	68.7	68.9	68.8	59.7	400	24.09
C3								400	
D	PU D	255/70R17	125.0	68.7	68.9	68.8	59.7	400	24.09
E1	PU E	275/70R17	150.0	68.9	68.9	68.9	71.8	500	24.00
E2								500	
F1								1,600	
F2	PU F	255/70R17	125.0	69.0	68.8	68.9	59.8	800	24.09
F3								800	
G	PU G	255/70R17	125.0	69.0	68.8	68.9	59.8	800	24.09
H1	PU H	275/70R17	150.0	68.9	69.1	69.0	71.9	1,000	24.00
H2								1,000	
								9,500	

Note to Appendix A Table 2. Accordingly, vehicle models A, B, C, D, E, F, G and H would be compared to fuel economy values of 30.26, 30.26, 24.09, 24.09, 24.00, 24.09, 24.09 and 24.00 mpg, respectively. With the appropriate fuel economy targets calculated, Manufacturer X's required fuel economy would be calculated as illustrated in "Appendix A Figure 1."

Appendix A, Figure 1

Calculation of Manufacturer X's target fuel economy standard.

$$\frac{\text{Manufacturer's Light Truck Production for Applicable Model Year}}{\frac{\text{Volume A}}{\text{Target A}}+\frac{\text{Volume B}}{\text{Target B}}+\frac{\text{Volume C}}{\text{Target C}}+\frac{\text{Volume D}}{\text{Target D}}+\frac{\text{Volume E}}{\text{Target E}}+\frac{\text{Volume F}}{\text{Target F}}+\frac{\text{Volume G}}{\text{Target G}}+\frac{\text{Volume H}}{\text{Target H}}}$$

$$\frac{9{,}500}{\frac{800}{30.26}+\frac{200}{20.26}+\frac{1{,}100}{24.09}+\frac{400}{24.09}+\frac{1{,}000}{24.00}+\frac{3{,}200}{24.09}+\frac{800}{24.09}+\frac{2{,}000}{24.00}}$$

Manufacturer X's light truck fleet target fuel economy standard = 24.6 mpg

Appendix A, Figure 2

Calculation of Manufacturer X's actual fuel economy.

$$\frac{\text{Manufacturer's Light Truck Production for Applicable Model Year}}{\frac{\text{Volume A}}{\text{Mpg A}}+\frac{\text{Volume B}}{\text{Mpg B}}+\frac{\text{Volume C}}{\text{Mpg C}}+\frac{\text{Volume D}}{\text{Mpg D}}+\frac{\text{Volume E}}{\text{Mpg E}}+\frac{\text{Volume F}}{\text{Mpg F}}+\frac{\text{Volume G}}{\text{Mpg G}}+\frac{\text{Volume H}}{\text{Mpg H}}}$$

$$\frac{9{,}500}{\frac{800}{27.1}+\frac{200}{27.6}+\frac{300}{23.9}+\frac{400}{23.7}+\frac{400}{23.5}+\frac{400}{23.6}+\frac{500}{22.7}+\frac{500}{22.5}+\frac{1{,}600}{22.5}+\frac{800}{22.3}+\frac{800}{22.2}+\frac{800}{22.3}+\frac{1{,}000}{22.2}+\frac{1{,}000}{22.1}}$$

Manufacturer X's light truck fleet actual fuel economy performance = 23.0 mpg

Note to Appendix A Figure 2. Since the actual average fuel economy of Manufacturer X's fleet is 23.0 mpg, as compared to its required fuel economy level of 24.6 mpg, Manufacturer X did not comply with the CAFE standard for MY 2011 as set forth in section 533.5(h).

PART 537—AUTOMOTIVE FUEL ECONOMY REPORTS

7. The authority citation for part 537 continues to read as follows:

Authority: 49 U.S.C. 32907, delegation of authority at 49 CFR 1.50.

8. Amend § 537.5 by revising paragraph (c)(4) to read as follows:

§ 537.5 General requirements for reports.

* * * * *

(c) * * *

(4) Be submitted in 5 copies to: Administrator, National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE., Washington, DC 20590, or submitted electronically to the following secure e-mail address: *cafe@dot.gov*. Electronic submissions should be provided in a pdf format.

* * * * *

9. Amend § 537.7 by revising paragraphs (c)(4)(xvi)(A)(*4*) and (c)(4)(xvi)(B)(*4*) to read as follows:

§ 537.7 Pre-model year and mid-model year reports.

* * * * *

(c) * * *

(4) * * *

(xvi)(*A*) * * *

(*4*) Beginning model year 2010, front axle, rear axle and average track width as defined in 49 CFR 523.2,

* * * * *

(*B*) * * *

(*4*) Beginning model year 2010, front axle, rear axle and average track width as defined in 49 CFR 523.2,

* * * * *

PART 538—MANUFACTURING INCENTIVES FOR ALTERNATIVE FUEL VEHICLES

10. The authority citation for part 538 continues to read as follows:

Authority: 49 U.S.C. 32901, 32905, and 32906; delegation of authority at 49 CFR 1.50.

11. Revise § 538.1 to read as follows:

§ 538.1 Scope.

This part establishes minimum driving range criteria to aid in identifying passenger automobiles that are dual-fueled automobiles. It also establishes gallon equivalent measurements for gaseous fuels other than natural gas.

12. Revise § 538.2 to read as follows:

§ 538.2 Purpose.

The purpose of this part is to specify one of the criteria in 49 U.S.C. chapter 329 ''Automobile Fuel Economy'' for identifying dual-fueled passenger automobiles that are manufactured in model years 1993 through 2019. The fuel economy of a qualifying vehicle is calculated in a special manner so as to encourage its production as a way of facilitating a manufacturer's compliance with the Corporate Average Fuel Economy standards set forth in part 531 of this chapter. The purpose is also to establish gallon equivalent measurements for gaseous fuels other than nautral gas.

13. Revise § 538.7(b)(1) to read as follows:

§ 538.7 Petitions for reduction of minimum driving range.

* * * * *

(b) * * *

(1) Be addressed to: Administrator, National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE., Washington, DC 20590.

* * * * *

Dated: September 15, 2009.

Ray LaHood,

Secretary, Department of Transportation.

Dated: September 15, 2009.

Lisa P. Jackson,

Administrator, Environmental Protection Agency.

[FR Doc. E9–22516 Filed 9–17–09; 4:15 pm]

BILLING CODE 4910–59–P; 6560–50–P