ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 85, 86, and 600

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Parts 531, 533, 536, 537 and 538

[EPA–HQ–OAR–2009–0472; FRL–9134–6; NHTSA–2009–0059]

RIN 2060–AP58; RIN 2127–AK50

Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule

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

ACTION: Final rule.

SUMMARY: EPA and NHTSA are issuing this joint Final Rule 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 Final Rule 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 finalizing greenhouse gas emissions standards under the Clean Air Act, and NHTSA is finalizing 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 will 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. NHTSA's final rule also constitutes the agency's Record of Decision for purposes of its National Environmental Policy Act (NEPA) analysis.

DATES: This final rule is effective on July 6, 2010, *sixty days after date of publication in the* **Federal Register.** The incorporation by reference of certain publications listed in this regulation is approved by the Director of the Federal Register as of July 6, 2010.

ADDRESSES: EPA and NHTSA have established dockets for this action under Docket ID No. EPA–HQ–OAR–2009–0472 and NHTSA–2009–0059, respectively. All documents in the docket are listed on the *http://www.regulations.gov* Web site. Although listed in the index, some information is not publicly available, *e.g.,* CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically through *http://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:

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] 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.**

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[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 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.

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 final rules whose benefits will address the urgent and closely intertwined challenges of energy independence and security and global warming. These rules will implement a strong and coordinated Federal greenhouse gas (GHG) 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 rules will achieve substantial reductions of 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. NHTSA's final rule also constitutes the agency's Record of Decision for purposes of its NEPA analysis.

This joint rulemaking 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 GHG emissions and improve fuel economy for all new cars and light-duty trucks sold in the United States.[3] The National Program will deliver additional environmental and energy benefits, cost savings, and administrative efficiencies on a nationwide basis that would likely not be available under a less coordinated approach. The National Program also represents 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. The National Program will allow automakers to produce and sell a single fleet nationally, mitigating 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, 2009[4] and responds to the President's January 26, 2009 memorandum on CAFE standards for model years 2011 and beyond,[5] the details of which can be found in Section IV of this joint notice.

Climate change is widely viewed as a significant long-term threat to the global environment. As summarized in the Technical Support Document for EPA's Endangerment and Cause or Contribute Findings under Section 202(a) of the Clean Air Act, anthropogenic emissions of GHGs are very likely (90 to 99 percent probability) the cause of most of the observed global warming over the last 50 years.[6] The primary GHGs of concern are carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Mobile sources emitted 31 percent of all U.S. GHGs in 2007 (transportation sources, which do not include certain off-highway sources, account for 28 percent) and have been the fastest-growing source of U.S. GHGs since 1990.[7] Mobile sources addressed in the recent endangerment and contribution findings under CAA section 202(a)—light-duty vehicles, heavy-duty trucks, buses, and motorcycles—accounted for 23 percent of all U.S. GHG in 2007.[8] Light-duty vehicles emit CO_2, methane, nitrous oxide, and hydrofluorocarbons and are responsible for nearly 60 percent of all mobile source GHGs and over 70 percent of Section 202(a) mobile source GHGs. For light-duty vehicles in 2007, CO_2 emissions represent about 94 percent of all greenhouse emissions (including HFCs), and the CO_2 emissions measured over the EPA tests used for fuel economy compliance represent about 90 percent of total light-duty vehicle GHG emissions.[9,10]

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.

[3] 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/*. 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/*.

[4] 74 FR 24007 (May 22, 2009).

[5] Available at: *http://www.whitehouse.gov/the_press_office/Presidential_Memorandum_Fuel_Economy/*.

[6] "Technical Support Document for Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act" Docket: EPA–HQ–OAR–2009–0472–11292, *http://epa.gov/climatechange/endangerment.html*.

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

[8] U.S. EPA. 2009 Technical Support Document for Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act. Washington, DC. pp. 180–194. Available at *http://epa.gov/climatechange/endangerment/downloads/Endangerment%20TSD.pdf*.

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

[10] U.S. Environmental Protection Agency. RIA, Chapter 2.

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 historically unprecedented U.S. 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.

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.[11] While there are emission control technologies that reduce the pollutants (*e.g.,* carbon monoxide) produced by imperfect combustion of fuel by capturing or converting them to other compounds, 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 a provision in EPCA as originally enacted in 1975 requires the use of the 1975 passenger car test procedures under which vehicle air conditioners are not turned on during fuel economy testing.[12] 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[13] is then used to calculate the amount of fuel that had to be consumed per mile in order to 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 GHG 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,*[14] a case involving EPA's a 2003 denial of a petition for rulemaking to regulate GHG emissions from motor vehicles under section 202(a) of the Clean Air Act (CAA).[15] The Court held that GHGs fit within the definition of air pollutant in 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."[16] The case was remanded back to the Agency for reconsideration in light of the Court's decision.[17]

On December 15, 2009, EPA published two findings (74 FR 66496): That emissions of GHGs from new motor vehicles and motor vehicle engines contribute to air pollution, and that the air pollution may reasonably be anticipated to endanger public health and welfare.

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.[18] The granting of the waiver permits California and the other states to proceed with implementing the California emission standards.

In addition, to promote the National Program, in May 2009, California announced its commitment to take several actions in support of the National Program, including revising its

[11] 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.

[12] Although EPCA does not require the use of 1975 test procedures for light trucks, those procedures are used for light truck CAFE standard testing purposes.

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

[14] 549 U.S. 497 (2007).

[15] 68 FR 52922 (Sept. 8, 2003).

[16] 549 U.S. at 531–32.

[17] 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. Also see 74 FR 18886, at 1888–90 (April 24, 2009).

[18] 74 FR 32744 (July 8, 2009).

program for MYs 2009–2011 to facilitate compliance by the automakers, and revising its program for MYs 2012–2016 such that compliance with the Federal GHG standards will be deemed to be compliance with California's GHG standards. This will allow the single national fleet produced by automakers to meet the two Federal requirements and to meet California requirements as well. California is proceeding with a rulemaking intended to revise its 2004 regulations to meet its commitments. Several automakers and their trade associations also announced their commitment to take several actions in support of the National Program, including not contesting the final GHG and CAFE standards for MYs 2012–2016, not contesting any grant of a waiver of preemption under the CAA for California's GHG standards for certain model years, and to stay and then dismiss all pending litigation challenging California's regulation of GHG emissions, including litigation concerning preemption under EPCA of California's and other states' GHG standards.

2. Public Participation

The agencies proposed their respective rules on September 28, 2009 (74 FR 49454), and received a large number of comments representing many perspectives on the proposed rule. The agencies received oral testimony at three public hearings in different parts of the country, and received written comments from more than 130 organizations, including auto manufacturers and suppliers, States, environmental and other non-governmental organizations (NGOs), and over 129,000 comments from private citizens.

The vast majority of commenters supported the central tenets of the proposed CAFE and GHG programs. That is, there was broad support from most organizations for a National Program that achieves a level of 250 gram/mile fleet average CO_2, which would be 35.5 miles per gallon if the automakers were to meet this CO_2 level solely through fuel economy improvements. The standards will be phased in over model years 2012 through 2016 which will allow manufacturers to build a common fleet of vehicles for the domestic market. In general, commenters from the automobile industry supported the proposed standards as well as the credit opportunities and other compliance provisions providing flexibility, while also making some recommendations for changes. Environmental and public interest non-governmental organizations (NGOs), as well as most States that commented, were also generally supportive of the National Program standards. Many of these organizations also expressed concern about the possible impact on program benefits, depending on how the credit provisions and flexibilities are designed. The agencies also received specific comments on many aspects of the proposal.

Throughout this notice, the agencies discuss many of the key issues arising from the public comments and the agencies' responses. In addition, the agencies have addressed all of the public comments in the Response to Comments document associated with this final rule.

B. Summary of the Joint Final Rule and Differences From the Proposal

In this joint rulemaking, EPA is establishing GHG emissions standards under the Clean Air Act (CAA), and NHTSA is establishing 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 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.

NHTSA and EPA have coordinated closely and worked jointly in developing their respective final rules. This is reflected in many aspects of this joint rule. 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 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 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 finalizing. Finally, 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 establishing standards that result in a harmonized National Program.

This joint final rule 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 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 finalized in this notice will 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, increased use of hybrid and other advanced technologies, and the initial commercialization of electric vehicles and plug-in hybrids. NHTSA's and EPA's assessments of likely vehicle technologies that manufacturers will employ to meet the standards are discussed in detail below and in the Joint TSD.

The National Program is estimated to result in approximately 960 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 (MYs) 2012 through 2016. In total, the combined EPA and NHTSA 2012–2016 standards will 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 actions also will provide important energy security benefits, as light-duty vehicles are about 95 percent dependent on oil-based fuels. The agencies project that the total benefits of the National Program will be more than $240 billion at a 3% discount rate, or more than $190 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 National Program will be less than $1,000. The average U.S. consumer who purchases a vehicle outright is estimated to 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 will see immediate savings due to their vehicle's lower fuel consumption in the form of a net reduction in annual costs of $130–$180 throughout the duration of the loan (that is, the fuel savings will outweigh the increase in loan payments by $130–$180 per year). Whether a consumer takes out a loan or purchases a new vehicle outright, over the lifetime of a model year 2016 vehicle, the consumer's net savings could be more than $3,000. The average 2016 MY vehicle will emit 16 fewer metric tons of CO_2-equivalent emissions (that is, CO_2 emissions plus HFC air conditioning leakage emissions) during its lifetime. Assumptions that underlie these conclusions are discussed in greater detail in the agencies' respective regulatory impact analyses and in Section III.H.5 and Section IV.

This joint rule also results in important regulatory convergence and certainty to automobile companies. Absent this rule, 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 rule will 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, 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 will be deemed to be compliance with California's GHG standards. This will allow the single national fleet used by automakers to meet the two Federal requirements and to meet California requirements as well. California is proceeding with a rulemaking intended to revise its 2004 regulations to meet its commitments. EPA and NHTSA are confident that these GHG and CAFE standards will successfully harmonize both the Federal and State programs for MYs 2012–2016 and will 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 GHG emissions and high fuel economy vehicles in particular. In this respect, this action will 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 action covers MYs 2012–2016, many stakeholders encouraged EPA and NHTSA to also begin working toward standards for MY 2017 and beyond that would maintain a single nationwide program. The agencies recognize the importance of and are committed to a strong, coordinated national program for light-duty vehicles for model years beyond 2016.

Key elements of the National Program finalized today are the level and form of the GHG and CAFE standards, the available compliance mechanisms, and general implementation elements. These elements are summarized in the following section, with more detailed discussions about EPA's GHG program following in Section III, and about NHTSA's CAFE program in Section IV. This joint final rule responds to the wide array of comments that the agencies received on the proposed rule. This section summarizes many of the major comments on the primary elements of the proposal and describes whether and how the final rule has changed, based on the comments and additional analyses. Major comments and the agencies' responses to them are also discussed in more detail in later sections of this preamble. For a full summary of public comments and EPA's and NHTSA's responses to them, please see the Response to Comments document associated with this final rule.

1. Joint Analytical Approach

NHTSA and EPA have worked closely together on nearly every aspect of this joint final rule. The extent and results of this collaboration are reflected in the elements of the respective NHTSA and EPA rules, 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 include the build up of the baseline and reference fleets, the derivation of the shape of the curves that define 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.

EPA and NHTSA have jointly developed attribute curve shapes that each agency is using for its final standards. 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 analysis 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. 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 the new standards. These are the OMEGA and Volpe models for EPA and NHTSA, respectively. The models and their inputs can also be found in the docket. Further description of the model and outputs can be found in Sections III 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 final standards, which are summarized in the sections below.

The vast majority of public comments expressed strong support for the joint analytical work performed for the proposal. Commenters generally agreed with the analytical work and its results, and supported the transparency of the analysis and its underlying data. Where commenters raised specific points, the agencies have considered them and made changes where appropriate. The agencies' further evaluation of various technical issues also led to a limited number of changes. A detailed discussion of these issues can be found in Section II of this preamble, and the Joint TSD.

2. Level of the Standards

In this notice, EPA and NHTSA are establishing two separate sets of standards, each under its respective statutory authorities. EPA is setting national CO_2 emissions standards for light-duty vehicles under section 202(a) of the Clean Air Act. These standards will require these vehicles to meet an estimated combined average emissions level of 250 grams/mile of CO_2 in model year 2016. NHTSA is setting CAFE standards for passenger cars and light trucks under 49 U.S.C. 32902. These standards will require manufacturers of those vehicles to meet an estimated combined average fuel economy level of 34.1 mpg in model year 2016. The 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' standards include some important differences. Under the CO_2 fleet average standards adopted 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 final CO_2 standards. NHTSA did not do so because EPCA does not allow vehicle manufacturers to use air conditioning credits in complying with CAFE standards for passenger cars.[19] 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, improvement in the efficiency of passenger car air conditioners is not 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 for MY 2016. The 250 grams per mile of CO_2 equivalent emissions limit is equivalent to 35.5 mpg[20] 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 setting 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.

The vast majority of public comments expressed strong support for the National Program standards, including the stringency of the agencies' respective standards and the phase-in from model year 2012 through 2016. There were a number of comments supporting standards more stringent than proposed, and a few others supporting less stringent standards, in particular for the 2012–2015 model years. The agencies' consideration of comments and their updated technical analyses led to only very limited changes in the footprint curves and did not change the agencies' projections that the nationwide fleet will achieve a level of 250 grams/mile by 2016 (equivalent to 35.5 mpg). The responses to these comments are discussed in more detail in Sections III and IV, respectively, and in the Response to Comments document.

As proposed, NHTSA and EPA's final standards, like the standards NHTSA promulgated in March 2009 for 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.[21] The standards that must be met by each manufacturer's fleet will be determined by computing the sales-weighted average (harmonic average for CAFE) of the targets applicable to each of the manufacturer's passenger cars and light trucks. Under these footprint-based standards, the levels required of individual manufacturers will depend, as noted above, on the mix of vehicles sold. NHTSA's and EPA's respective standards are shown in the tables below. It is important to note that the standards are the attribute-based curves established by each agency. The values in the tables below reflect the agencies' projection of the corresponding fleet levels that will result from these attribute-based curves.

As a result of public comments and updated economic and future fleet projections, EPA and NHTSA have updated the attribute based curves for this final rule, as discussed in detail in Section II.B of this preamble and Chapter 2 of the Joint TSD. This update in turn affects costs, benefits, and other impacts of the final standards. Thus, the agencies have updated their overall projections of the impacts of the final rule standards, and these results are only slightly different from those presented in the proposed rule.

As shown in Table I.B.2–1, NHTSA's fleet-wide CAFE-required levels for passenger cars under the final standards are projected to increase from 33.3 to 37.8 mpg between MY 2012 and MY 2016. Similarly, fleet-wide CAFE levels for light trucks are projected to increase from 25.4 to 28.8 mpg. 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 numbers do not include the effects of other flexibilities and credits in the program. These standards represent a 4.3 percent average annual rate of increase relative to the MY 2011 standards.[22]

TABLE I.B.2–1—AVERAGE REQUIRED FUEL ECONOMY (mpg) UNDER FINAL CAFE STANDARDS

	2011-base	2012	2013	2014	2015	2016
Passenger Cars	30.4	33.3	34.2	34.9	36.2	37.8
Light Trucks	24.4	25.4	26.0	26.6	27.5	28.8
Combined Cars & Trucks	27.6	29.7	30.5	31.3	32.6	34.1

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

[20] 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.

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

[22] 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 30.4 mpg for passenger cars, 24.4 mpg for light trucks, and 27.6 mpg for the combined fleet.

Accounting for the expectation that some manufacturers could continue to pay civil penalties rather than achieving required CAFE levels, and the ability to use FFV credits,[23] NHTSA estimates that the CAFE standards will 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: [24]

TABLE I.B.2–2—PROJECTED FLEET-WIDE ACHIEVED CAFE LEVELS UNDER THE FINAL FOOTPRINT-BASED CAFE STANDARDS (mpg)

	2012	2013	2014	2015	2016
Passenger Cars	32.3	33.5	34.2	35.0	36.2
Light Trucks	24.5	25.1	25.9	26.7	27.5
Combined Cars & Trucks	28.7	29.7	30.6	31.5	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.* * * "[25]

Based on NHTSA's current market forecast, the agency's estimates of these minimum standards under the MY 2012–2016 CAFE standards (and, for comparison, the final MY 2011 standard) are summarized below in Table I.B.2–3.[26] For eventual compliance calculations, the final calculated minimum standards will be updated to reflect the average fuel economy level required under the final standards.

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

2011	2012	2013	2014	2015	2016
27.8	30.7	31.4	32.1	33.3	34.7

EPA is establishing GHG emissions standards, and Table I.B.2–4 provides EPA's estimates of their projected overall fleet-wide CO_2 equivalent emission levels.[27] The g/mi values are CO_2 equivalent values because they include the projected use of air conditioning (A/C) credits by manufacturers, which include both HFC and CO_2 reductions.

TABLE I.B.2–4—PROJECTED FLEET-WIDE EMISSIONS COMPLIANCE LEVELS UNDER THE FOOTPRINT-BASED CO_2 STANDARDS (g/mi)

	2012	2013	2014	2015	2016
Passenger Cars	263	256	247	236	225
Light Trucks	346	337	326	312	298
Combined Cars & Trucks	295	286	276	263	250

As shown in Table I.B.2–4, fleet-wide CO_2 emission level requirements for cars are projected to increase in stringency from 263 to 225 g/mi between MY 2012 and MY 2016. Similarly, fleet-wide CO_2 equivalent emission level requirements for trucks are projected to increase in stringency from 346 to 298 g/mi. As shown, the overall fleet average CO_2 level requirements are projected to increase in stringency from 295 g/mi in MY 2012 to 250 g/mi in MY 2016.

EPA anticipates that manufacturers will take advantage of program flexibilities such as flexible 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.B.2–4, where full manufacturer compliance without credit trading is assumed. Table I.B.2–5 shows EPA's 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 certain program flexibilities including flex fueled vehicle credits and the temporary lead time allowance alternative standards. The use of optional air conditioning credits is considered both in this analysis of achieved levels and of the

[23] The penalties are similar in function to essentially unlimited, fixed-price allowances.

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

[25] 49 U.S.C. 32902(b)(4).

[26] 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.

[27] 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.

compliance levels described above. As can be seen in Table I.B.2–5, the projected achieved levels are slightly higher for model years 2012–2015 due to EPA's assumptions about manufacturers' use of the regulatory flexibilities, but by model year 2016 the achieved level is projected to be 250 g/mi for the fleet.

TABLE I.B.2–5—PROJECTED FLEET-WIDE ACHIEVED EMISSION LEVELS UNDER THE FOOTPRINT-BASED CO_2 STANDARDS (g/mi)

	2012	2013	2014	2015	2016
Passenger Cars	267	256	245	234	223
Light Trucks	365	353	340	324	303
Combined Cars & Trucks	305	293	280	266	250

Several auto manufacturers stated that the increasingly stringent requirements for fuel economy and GHG emissions in the early years of the program should follow a more linear phase-in. The agencies' consideration of comments and of their updated technical analyses did not lead to changes to the phase-in of the standards discussed above. This issue is discussed in more detail in Sections II.D, and in Sections III and IV.

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. Commenters were in general agreement with this assessment.[28] 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 rolling resistance, 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 assessments are that manufacturers will be able to meet the 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 rule allows 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 rule, 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 also provides 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 will 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. Various commenters stated that the proposed phase-in of the standards should be introduced more aggressively, less aggressively, or in a more linear manner. However, our consideration of these comments about the phase-in, as well as our revised analyses, leads us to conclude that the general rate of introduction of the standards as proposed remains appropriate. This conclusion is also not affected by the slight difference from the proposal in the final footprint-based curves. These issues are addressed further in Sections III and IV.

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

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. Some environmental and other organizations commented that the test procedures should be improved to reflect more real-world driving conditions; auto manufacturers in general do not support such changes to the test procedures at this time. 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 CAFE test procedures. For that reason, EPA is using the current CAFE test procedures for the CO_2 standards and is not changing 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, although 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 continue to evaluate it in the context of a future rulemaking to address standards for model year 2017 and thereafter. This could include consideration of 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 public comments on these issues and the final procedures for determining emissions credits for controls on air conditioners in Section III.

[28] 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.

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 that will be achieved by the 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

NHTSA and EPA proposed attribute-based standards for passenger cars and light trucks. NHTSA adopted an attribute approach based on vehicle footprint in its Reformed CAFE program for light trucks for model years 2008–2011,[29] and recently extended this approach to passenger cars in the CAFE rule for MY 2011 as required by EISA.[30] The agencies also proposed using vehicle footprint as the attribute for the GHG 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. Most commenters that expressed a view on this topic supported basing the standards on an attribute, and almost all of these supported the proposed choice of vehicle footprint as an appropriate attribute. The agencies continue to believe that the standards are best expressed in terms of an attribute, and that the footprint attribute is the most appropriate attribute on which to base the standards. These issues are further discussed later in this notice and in Chapter 2 of the Joint TSD.

Under the footprint-based standards, each manufacturer will have a GHG and CAFE target unique to its fleet, depending on the footprints of the vehicle models produced by that manufacturer. A manufacturer will have separate footprint-based standards for cars and for trucks. Generally, larger vehicles (*i.e.,* vehicles with larger footprints) will 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 lower levels of CO_2 and higher levels of fuel economy 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 will be based on its final model year production figures. A manufacturer's calculation of fleet average emissions at the end of the model year will thus be based on the production-weighted average emissions of each model in its fleet.

The final footprint-based standards are very similar in shape to those proposed. NHTSA and EPA include more discussion of the development of the final curves in Section II below, with a full discussion in the Joint TSD. 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.B.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 rule, footprint). The manufacturers' fleet average performance is determined by the production-weighted[31] average (for CAFE, harmonic average) of those targets. NHTSA and EPA are setting CAFE and CO_2 emissions standards defined by constrained linear functions and, equivalently, piecewise linear functions.[32] 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 establishing 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 will 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.B.3–1 below illustrates the passenger car CAFE standard curves for model years 2012 through 2016 while Figure I.B.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.

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[29] 71 FR 17566 (Apr. 6, 2006).

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

[31] Based on vehicles produced for sale in the United States.

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

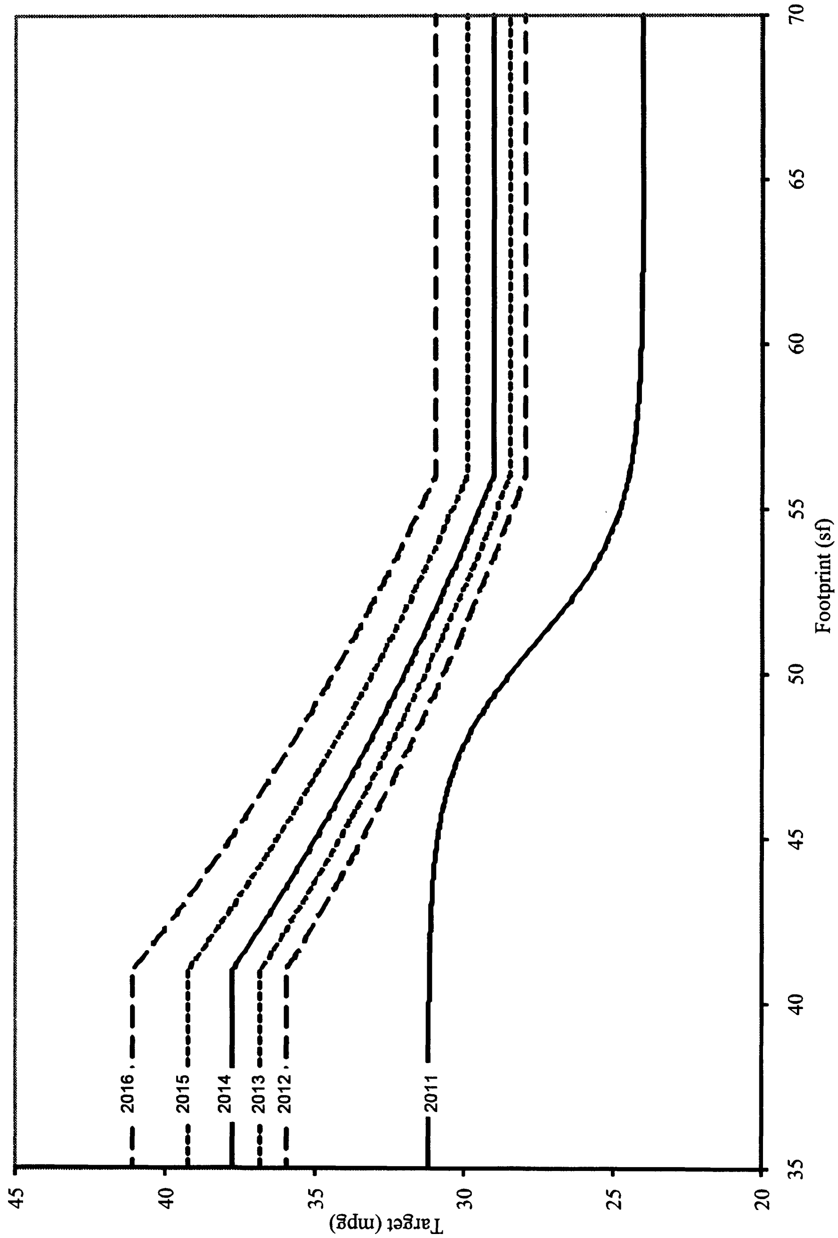

Figure I.B.3-1. MY 2011 and MY 2012-2016 Passenger Car Fuel Economy Targets

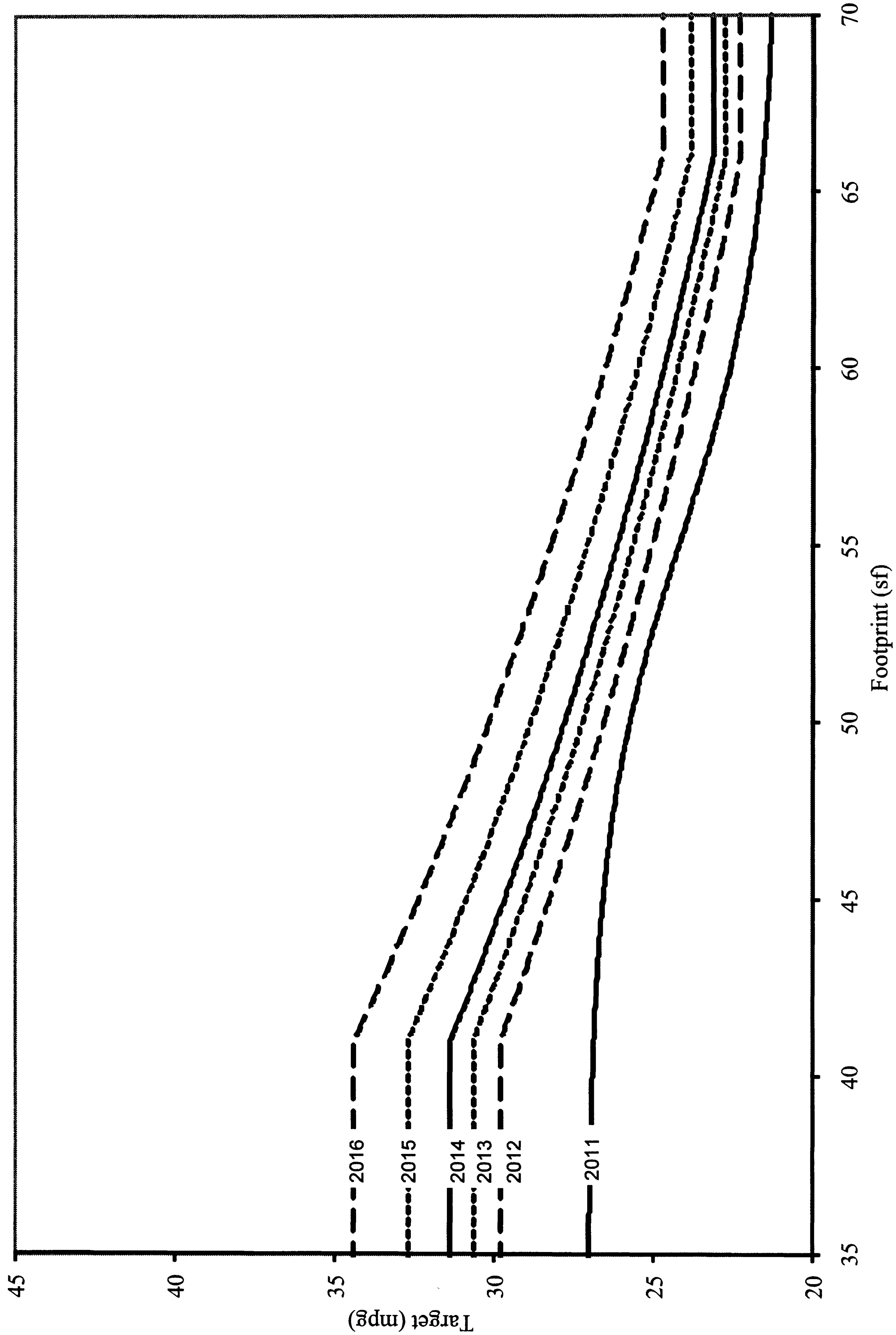

Figure I.B.3-2. MY 2011 and MY 2012-2016 Light Truck Fuel Economy Targets

EPA is establishing 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 will be production weighted to determine each manufacturer's fleet average standard for cars and trucks. As with the CAFE curves above, the general form of the equation is the same for each vehicle category and each year, but the parameters of the equation differ for cars and trucks. Again, each parameter also changes on an annual basis, resulting in the yearly increases in stringency. Figure I.B.3–3 below illustrates the CO_2 car standard curves for model years 2012 through 2016 while Figure I.B.3–4 shows the CO_2 truck standard curves for model years 2012–2016.

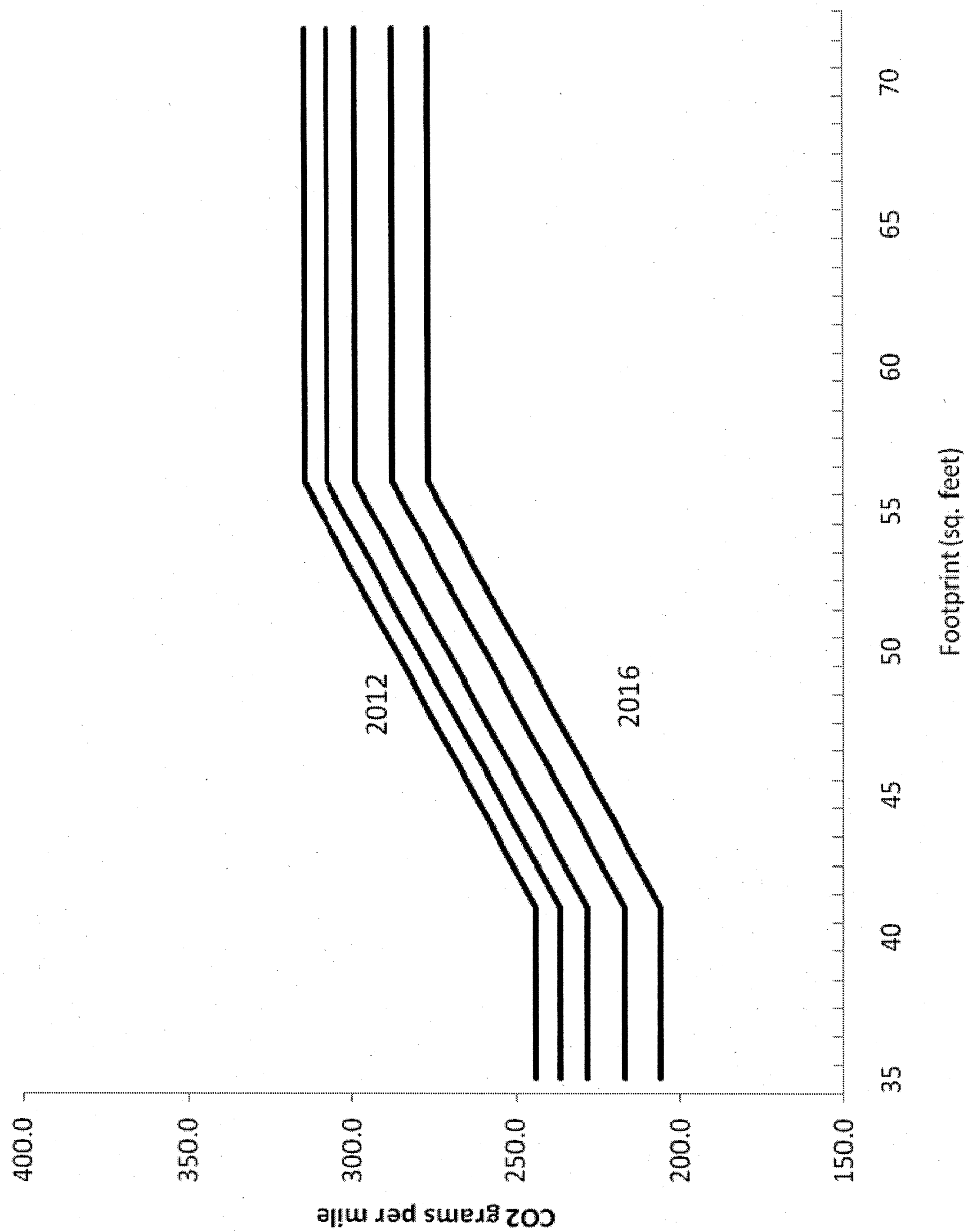

Figure I.B.3-3 CO_2 (g/mi) Car Standard Curves

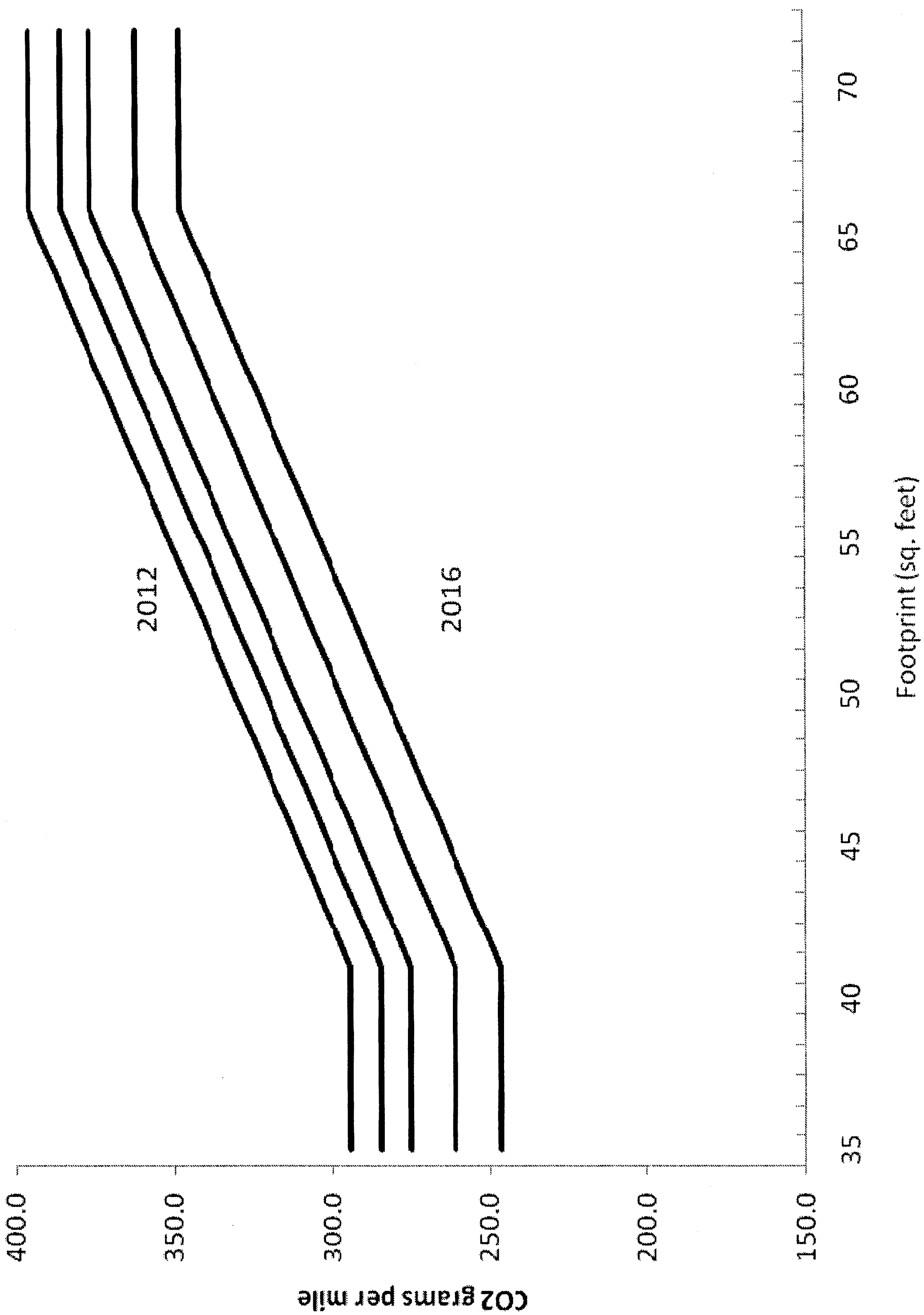

Figure I.B.3-4 CO_2 (g/mi) Truck Standard Curves

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NHTSA and EPA received a number of comments about the shape of the car and truck curves. We address these comments further in Section II.C below as well as in Sections III and IV.

As proposed, NHTSA and EPA will use the same vehicle category definitions for determining which vehicles are subject to the car curve standards versus the truck curve standards. In other words, a vehicle classified as a car under the NHTSA CAFE program will also be classified as a car under the EPA GHG program, and likewise for trucks. Auto industry commenters generally agreed with this approach and believe it is an important aspect of harmonization across the two agencies' programs. Some other commenters expressed concern about potential consequences, especially in how cars and trucks are distinguished. However, EPA and NHTSA are employing 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.[33] This issue is further discussed for the EPA standards in Section III, and for the NHTSA standards in Section IV. This approach of using CAFE definitions allows EPA's CO_2 standards and the CAFE standards to be harmonized across all vehicles for this program. However, EPA is not changing the car/truck definition for the purposes of any other previous rules.

Generally speaking, a smaller footprint vehicle will have higher fuel economy and lower CO_2 emissions relative to a larger footprint vehicle when both have the same degree of fuel efficiency improvement technology. In this final rule, the standards apply to a manufacturers overall fleet, not an individual vehicle, thus a manufacturers fleet which is dominated by small footprint vehicles will have a higher fuel economy requirement (lower CO_2 requirement) than a manufacturer whose fleet is dominated by large footprint vehicles. A footprint-based CO_2 or CAFE 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 or improve fuel economy, 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. While targets are manufacturer specific, rather than vehicle specific, Table I.B.3–1 illustrates the fact that different vehicle sizes will have varying CO_2 emissions and fuel economy targets under the final standards.

TABLE I.B.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	206	41.1
Midsize car	Ford Fusion	46	230	37.1
Fullsize car	Chrysler 300	53	263	32.6
Example Light-duty Trucks				
Small SUV	4WD Ford Escape	44	259	32.9
Midsize crossover	Nissan Murano	49	279	30.6
Minivan	Toyota Sienna	55	303	28.2
Large pickup truck	Chevy Silverado	67	348	24.7

4. Program Flexibilities

EPA's and NHTSA's programs as established in this rule 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' standards includes preserving manufacturers' flexibilities in meeting the standards, to the extent appropriate and required by law. The following section provides an overview of this final rule's flexibility provisions. Many auto manufacturers commented in support of these provisions as critical to meeting the standards in the lead time provided. Environmental groups, some States, and others raised concerns about the possibility for windfall credits and loss of program benefits. The provisions in the final rule are in most cases the same as those proposed. However consideration of the issues raised by commenters has led to modifications in certain provisions. These comments and the agencies' response are discussed in Sections III and IV below and in the Response to Comments document.

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

Under this NHTSA and EPA final rule, the fleet average standards that apply to a manufacturer's car and truck fleets are 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 will 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 can generate credits. Conversely, if the fleet average CO_2/CAFE level does not meet the standard, the fleet would incur debits (also referred to as a shortfall).

Under the final 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

[33] 49 CFR 523.

other mobile source standards issued by EPA under the CAA. The manufacturer will be able to carry back credits to offset a deficit that had accrued in a prior model year and was subsequently carried over to the current model year. EPCA also provides for this. EPCA restricts the carry-back of CAFE credits to three years, and as proposed EPA is establishing the same limitation, in keeping with the goal of harmonizing both sets of standards.

After satisfying any need to offset pre-existing deficits, remaining credits can 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.[34] As proposed, under the GHG program, EPA is also allowing 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. As proposed for purposes of this rule, EPA allows unlimited credit transfers across a manufacturer's car-truck fleet to meet the GHG standard. This is based on the expectation that this flexibility will facilitate manufacturers' ability to comply with the GHG standards in the lead time provided, and will allow the required GHG emissions reductions to be achieved in the most cost effective way. Under the CAA, unlike under EISA, there is no statutory limitation on car-truck credit transfers. Therefore, EPA is not constraining car-truck credit transfers, as doing so would reduce the flexibility for lead time, and would increase costs with no corresponding environmental benefit. For the CAFE program, however, EISA limits the amount of credits that may be transferred, which has the effects of limiting the extent to which a manufacturer can rely upon credits in lieu of making fuel economy improvements to a particular portion of its vehicle fleet, but also of potentially increasing the costs of improving the manufacturer's overall fleet. EISA also prohibits the use of transferred credits to meet the statutory minimum level for the domestic car fleet standard.[35] These and other statutory limits will continue to apply to the determination of compliance with the CAFE standards.

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. As proposed, EPA allows 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.[36] Comments discussing these provisions supported the proposed approach. These final provisions are the same as proposed.

As further discussed in Section IV of this preamble, NHTSA sought to find a way to provide credits for improving the efficiency of light truck air conditioners (A/Cs) and solicited public comments to that end. The agency did so because the power necessary to operate an A/C compressor places a significant additional load on the engine, thus reducing fuel economy and increasing CO_2 tailpipe emissions. *See* Section III.C.1 below. The agency would have made a similar effort regarding cars, but a 1975 statutory provision made it unfruitful even to explore the possibility of administratively proving such credits for cars. The agency did not identify a workable way of providing such credits for light trucks in the context of this rulemaking.

b. Air Conditioning Credits Under the EPA Final Rule

Air conditioning (A/C) systems contribute to GHG emissions in two ways. Hydrofluorocarbon (HFC) refrigerants, which are powerful GHGs, can leak from the A/C system (direct A/C emissions). As just noted, operation of the A/C system also places an additional load on the engine, which results in additional CO_2 tailpipe emissions (indirect A/C related emissions). EPA is allowing manufacturers to generate credits by reducing either or both types of GHG emissions related to A/C systems. Specifically, EPA is establishing a method to calculate CO_2 equivalent reductions for the vehicle's 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 that 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 generate 11 g/mi GHG credit toward meeting the 250 g/mi by 2016 (though some companies may generate more). EPA will also allow manufacturers to earn early A/C credits starting in MY 2009 through 2011, as discussed further in a later section. There were many comments on the proposed A/C provisions. Nearly every one of these was supportive of EPA including A/C control as part of this rule, though there was some disagreement on some of the details of the program. The HFC crediting scheme was widely supported. The comments mainly were concentrated on indirect A/C related credits. The auto manufacturers and suppliers had some technical comments on A/C technologies, and there were many concerns with the proposed idle test. EPA has made some minor adjustments in both of these areas that we believe are responsive to these concerns. EPA addresses A/C issues in greater detail in Section III of this preamble and in Chapter 2 of EPA's RIA.

c. Flexible-Fuel and Alternative Fuel Vehicle Credits

EPCA authorizes a compliance flexibility 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 E85 capable vehicles, which can run on either gasoline or a mixture of up to 85 percent ethanol and 15 percent gasoline (E85). 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.[37] Although NHTSA

[34] 49 U.S.C. 32903(a)(2).

[35] 49 U.S.C. 32903(g)(4).

[36] 49 U.S.C. 32903(f)(2).

[37] 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

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expressed concern about the non-use of alternative fuel by FFVs in a 2002 report to Congress (Effects of the Alternative Motor Fuels Act CAFE Incentives Policy), EISA 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, no FFV credits will be available for CAFE compliance after MY 2019.[38] For dedicated alternative fuel vehicles, there are no limits or phase-out of the credits. As required by the statute, NHTSA will continue to allow the use of FFV credits for purposes of compliance with the CAFE standards until the end of the EISA phase-out period.

For the GHG program, as proposed, EPA will allow FFV credits in line with EISA limits, but only during the period from MYs 2012 to 2015. After MY 2015, EPA will only allow FFV credits based on a manufacturer's demonstration that the alternative fuel is actually being used in the vehicles and based on the vehicle's actual performance. EPA discusses this in more detail in Section III.C of the preamble, including a summary of key comments. These provisions are being finalized as proposed, with further discussion in Section III.C of how manufacturers can demonstrate that the alternative fuel is being used.

d. Temporary Lead-Time Allowance Alternative Standards Under the EPA Final Rule

Manufacturers with limited product lines may be especially challenged in the early years of the National Program, and need additional lead time. 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 manufacturer fleets consist entirely of vehicles with very high baseline CO_2 emissions. Their vehicles are 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 meet the applicable CAFE standard. EPA believes that these technological circumstances call for more lead time in the form of a more gradual phase-in of standards.

EPA is finalizing a temporary lead-time allowance for manufacturers that sell vehicles in the U.S. in MY 2009 and for which U.S. vehicle sales in that model year are below 400,000 vehicles. This allowance will be available only during the MY 2012–2015 phase-in years of the program. A manufacturer that satisfies the threshold criteria will be able to treat a limited number of vehicles as a separate averaging fleet, which will be subject to a less stringent GHG standard.[39] Specifically, a standard of 25 percent above the vehicle's otherwise applicable foot-print target level will 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 setting 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 will no longer be eligible for a different standard). EPA discusses this in more detail in Section III.B of the preamble.

EPA received comments from several smaller manufacturers that the TLAAS program was insufficient to allow manufacturers with very limited product lines to comply. These manufacturers commented that they need additional lead time to meet the standards, because their CO_2 baselines are significantly higher and their vehicle product lines are even more limited, reducing their ability to average across their fleets compared even to other TLAAS manufacturers. EPA fully summarizes the public comments on the TLAAS program, including comments not supporting the program, in Section III.B. In summary, in response to the lead time issues raised by manufacturers, EPA is modifying the TLAAS program that applies to manufacturers with between 5,000 and 50,000 U.S. vehicle sales in MY 2009. EPA believes these provisions are necessary given that, compared with other TLAAS manufacturers, these manufacturers have even more limited product offerings across which to average and higher baseline CO_2 emissions, and thus need additional lead-time to meet the standards. These manufacturers would have an increased allotment of vehicles, a total of 250,000, compared to 100,000 vehicles (for other TLAAS-eligible manufacturers). In addition, the TLAAS program for these manufacturers would be extended by one year, through MY 2016 for these vehicles, for a total of five years of eligibility. The other provisions of the TLAAS program would continue to apply, such as the restrictions on credit trading and the level of the standard. Additional restrictions would also apply to these vehicles, as discussed in Section III. In addition, for the smallest volume manufacturers, those with below 5,000 U.S. vehicle sales, EPA is not setting standards at this time but is instead deferring standards until a future rulemaking. This is essentially the same approach we are using for small businesses, which are exempted from this rule. The unique issues involved with these manufacturers will be addressed in that future rulemaking. Further discussion of the public comment on these issues and details on these changes from the proposed program are included in Section III.

e. Additional Credit Opportunities Under the Clean Air Act (CAA)

EPA is establishing additional opportunities for early credits in MYs 2009–2011 through over-compliance with a baseline standard. The baseline standard is set to be equivalent, on a national level, to the California standards. Credits can 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 providing for 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 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 early credits provisions are designed to ensure that there would be no double counting of early credits. 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 received comments from some environmental organizations and States expressing concern that these early credits were inappropriate windfall credits because they provided credits for actions that were not surplus, that is above what would otherwise be required for compliance with either State or Federal motor vehicle standards. This focused on the credits

otherwise occur. This is typically referred to as an FFV credit.

[38] *Id.*

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

for over-compliance with the California standards generated during model years 2009 and perhaps 2010, where according to commenters the CAFE requirements were in effect more stringent than the California standards. EPA believes that early credits provide a valuable incentive for manufacturers that have implemented fuel efficient technologies in excess of their CAFE compliance obligations prior to MY 2012. With appropriate restrictions, these credits, reflecting over-compliance over a three model year time frame (MY 2009–2011) and not just over one or two model years, will be surplus reductions and not otherwise required by law. Therefore, EPA is finalizing these provisions largely as proposed, but in response to comments, with an additional restriction on the trading of MY 2009 credits. The overall structure of this early credit program addresses concerns about the potential for windfall credits in the first one or two model years. This issue is fully discussed in Section III.C.

EPA is providing an additional temporary incentive to encourage the commercialization of advanced GHG/fuel economy control technologies—including electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs)—for model years 2012–2016. EPA's proposal included an emissions compliance value of zero grams/mile for EVs and FCVs, and the electric portion of PHEVs, and a multiplier in the range of 1.2 to 2.0, so that each advanced technology vehicle would count as greater than one vehicle in a manufacturer's fleetwide compliance calculation. EPA received many comments on the proposed incentives. Many State and environmental organization commenters believed that the combination of these incentives could undermine the GHG benefits of the rule, and believed the emissions compliance values should take into account the net upstream GHG emissions associated with electrified vehicles compared to vehicles powered by petroleum based fuel. Auto manufacturers generally supported the incentives, some believing the incentives to be a critical part of the National Program. Most auto makers supported both the zero grams/mile emissions compliance value and the higher multipliers.

Upon considering the public comments on this issue, EPA is finalizing an advanced technology vehicle incentive program that includes a zero gram/mile emissions compliance value for EVs and FCVs, and the electric portion of PHEVs, for up to the first 200,000 EV/PHEV/FCV vehicles produced by a given manufacturer during MY 2012–2016 (for a manufacturer that produces less than 25,000 EVs, PHEVs, and FCVs in MY 2012), or for up to the first 300,000 EV/PHEV/FCV vehicles produced during MY 2012–2016 (for a manufacturer that produces 25,000 or more EVs, PHEVs, and FCVs in MY 2012). For any production greater than this amount, the compliance value for the vehicle will be greater than zero gram/mile, set at a level that reflects the vehicle's net increase in upstream GHG emissions in comparison to the gasoline vehicle it replaces. In addition, EPA is not finalizing a multiplier. EPA will also allow this early advanced technology incentive program beginning in MYs 2009–2011. The purpose of these provisions is to provide a temporary incentive to promote technologies which have the potential to produce very large GHG reductions in the future. The tailpipe GHG emissions from EVs, FCVs, and PHEVs operated on grid electricity are zero, and traditionally the emissions of the vehicle itself are all that EPA takes into account for purposes of compliance with standards set under section 202(a). This has not raised any issues for criteria pollutants, as upstream emissions associated with production and distribution of the fuel are addressed by comprehensive regulatory programs focused on the upstream sources of those emissions. At this time, however, there is no such comprehensive program addressing upstream emissions of GHGs, and the upstream GHG emissions associated with production and distribution of electricity are higher than the corresponding upstream GHG emissions of gasoline or other petroleum based fuels. In the future, vehicle fleet electrification combined with advances in low-carbon technology in the electricity sector have the potential to transform the transportation sector's contribution to the country's GHG emissions. EPA will reassess the issue of how to address EVs, PHEVs, and FCVs in rulemakings for model years 2017 and beyond, based on the status of advanced vehicle technology commercialization, the status of upstream GHG control programs, and other relevant factors. Further discussion of the temporary advanced technology vehicle incentives, including more detail on the public comments and EPA's response, is found in Section III.C.

EPA is also providing an option for manufacturers to generate credits for employing new and innovative technologies that achieve GHG reductions that are not reflected on current test procedures, as proposed. Examples of such "off-cycle" technologies might include solar panels on hybrids, adaptive cruise control, and active aerodynamics, among other technologies. These three credit provisions are discussed in more detail in Section III.

5. 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 have developed 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 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 compliance 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 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 National 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 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.

Several stakeholders commented on the proposed coordinated compliance approach. The comments indicated broad support for the overall approach EPA proposed. In particular, both regulated industry and the public interest community appreciated the attempt to streamline compliance by adopting current practice where possible and by coordinating EPA and NHTSA compliance requirements. Thus the final compliance program design is largely unchanged from the proposal. Some commenters requested additional detail or clarification in certain areas and others suggested some relatively narrow technical changes, and EPA has responded to these suggestions. EPA and NHTSA summarize these comments and the agencies' responses in Sections III and IV, respectively, below. The Response to Comments document associated with this document includes all of the comments and responses received during the comment period.

C. Summary of Costs and Benefits of the National Program

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

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 standards would require slightly different fuel efficiency improvements. EPA's 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. NHTSA was unable to make assumptions about manufacturers' improving the efficiency of air conditioners due to statutory limitations. In addition, the CAFE and GHG standards offer different program flexibilities, and the agencies' analyses differ in their accounting for these flexibilities (for example, FFVs), 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.

NHTSA performed two analyses: a primary analysis that shows the estimates of costs, fuel savings, and related benefits that the agency considered for purposes of establishing new CAFE standards, and a supplemental analysis that reflects the agency's best estimate of the potential real-world effects of the CAFE standards, including manufacturers' potential use of FFV credits in accordance with the provisions of EISA concerning their availability. Because EPCA prohibits NHTSA from considering the ability of manufacturers to use of FFV credits to increase their fleet average fuel economy when *establishing* CAFE standards, the agency's primary analysis 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's supplemental analysis of the effect of FFV credits on benefits and costs from its CAFE standards, demonstrates 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 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 increase their average fuel economy through the use of 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 possibility that some manufacturers might utilize the opportunity under EPCA to transfer some CAFE credits between the passenger car and light truck fleets, but determined that in NHTSA's year-by-year analysis, manufacturers' credit transfers cannot be reasonably estimated at this time.[40]

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 GHG standards reflect these assumptions. However, under the GHG standards, FFV credits would be available through MY 2015; starting in MY 2016, EPA will only allow FFV credits based on a manufacturer'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 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 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

[40] 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 reasonable 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.

both the costs and benefits of its CAFE standards. In contrast, the CAA does not allow for fine payment (civil penalties) in lieu of compliance with emission standards, and EPA's analysis of benefits from its standard thus assumes full compliance. This assumption results in higher estimates of fuel savings, of reductions in GHG emissions, and of manufacturers' compliance costs to sell fleets that comply with both NHTSA's CAFE program and EPA's GHG program.

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

A number of stakeholders commented on NHTSA's and EPA's analytical assumptions in estimating costs and benefits of the program. These comments and any changes from the proposed values are summarized in Section II.F, and further in Sections III (for EPA) and IV (for NHTSA); the Response to Comments document presents the detailed responses to each of the comments.

1. Summary of Costs and Benefits of NHTSA's CAFE Standards

NHTSA has analyzed in detail the costs and benefits of the final CAFE standards. Table I.C.1–1 presents the total costs, benefits, and net benefits for NHTSA's final CAFE standards. The values in Table I.C.1–1 display the total costs for all MY 2012–2016 vehicles and the benefits and net benefits represent the impacts of the standards over the full lifetime of the vehicles projected to be sold during model years 2012–2016. It is important to note that there is significant overlap in costs and benefits for NHTSA's CAFE program and EPA's GHG program and therefore combined program costs and benefits, which together comprise the National Program, are not a sum of the two individual programs.

TABLE I.C.1–1—NHTSA'S ESTIMATED 2012–2016 MODEL YEAR COSTS, BENEFITS, AND NET BENEFITS UNDER THE CAFE STANDARDS BEFORE FFV CREDITS

[2007 dollars]

3% Discount Rate:	$billions
Costs	51.8
Benefits	182.5
Net Benefits	130.7
7% Discount Rate:	
Costs	51.8
Benefits	146.3
Net Benefits	94.5

NHTSA estimates that these new CAFE standards will lead to fuel savings totaling 61 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 $143 billion. At a 7% discount rate, the present value of the economic benefits resulting from those fuel savings is $112 billion.[41]

The agency further estimates that these new CAFE standards will lead to corresponding reductions in CO_2 emissions totaling 655 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 $14.5 billion, based on a global social cost of carbon value of approximately $21 per metric ton (in 2010, and growing thereafter).[42] 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.C.1–2—NHTSA FUEL SAVED (BILLION GALLONS) AND CO_2 EMISSIONS AVOIDED (mmt) UNDER CAFE STANDARDS (WITHOUT FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Fuel (b. gal.)	4.2	8.9	12.5	16.0	19.5	61.0
CO_2 (mmt)	44	94	134	172	210	655

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 final standards:

TABLE I.C.1–3—NHTSA FUEL SAVED (BILLION GALLONS) AND CO_2 EMISSIONS AVOIDED (MILLION METRIC TONS, MMT) UNDER CAFE STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Fuel (b. gal.)	4.9	8.2	11.3	15.0	19.1	58.6

[41] These figures do not account for the compliance flexibilities that NHTSA is prohibited from considering when determining the level of new CAFE standards, because manufacturers' decisions to use those flexibilities are voluntary.

[42] NHTSA also estimated the benefits associated with three more estimates of a one ton GHG reduction in 2010 ($5, $35, and $65), which will likewise grow thereafter. *See* Section II for a more detailed discussion of the social cost of carbon.

TABLE I.C.1–3—NHTSA FUEL SAVED (BILLION GALLONS) AND CO_2 EMISSIONS AVOIDED (MILLION METRIC TONS, MMT) UNDER CAFE STANDARDS (WITH FFV CREDITS)—Continued

	2012	2013	2014	2015	2016	Total
CO_2 (mmt)	53	89	123	163	208	636

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 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 $180 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. Note that the benefit calculation in Tables I.C.1–4 through 1–7 includes the benefits of reducing CO_2 emissions,[43] but not the benefits of reducing other GHG emissions.

TABLE I.C.1–4—NHTSA DISCOUNTED BENEFITS ($BILLION) UNDER THE CAFE STANDARDS (BEFORE FFV CREDITS, USING 3 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	6.8	15.2	21.6	28.7	35.2	107.5
Light Trucks	5.1	10.7	15.5	19.4	24.3	75.0
Combined	11.9	25.8	37.1	48.0	59.5	182.5

Using a 7% discount rate, NHTSA estimates that the present value of these benefits would total more than $145 billion over the same time period.

TABLE I.C.1–5—NHTSA DISCOUNTED BENEFITS ($BILLION) UNDER THE CAFE STANDARDS (BEFORE FFV CREDITS, USING 7 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	5.5	12.3	17.5	23.2	28.6	87.0
Light Trucks	4.0	8.4	12.2	15.3	19.2	59.2
Combined	9.5	20.7	29.7	38.5	47.8	146.2

NHTSA estimates that FFV credits could reduce achieved benefits by about 3.8%:

TABLE I.C.1–6A—NHTSA DISCOUNTED BENEFITS ($BILLION) UNDER THE CAFE STANDARDS (WITH FFV CREDITS, USING A 3 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	7.6	13.7	19.1	25.6	34.0	100.0
Light Trucks	6.4	10.4	14.6	19.8	24.4	75.6
Combined	14.0	24.1	33.7	45.4	58.4	175.6

TABLE I.C.1–6B—NHTSA DISCOUNTED BENEFITS ($BILLION) UNDER THE CAFE STANDARDS (WITH FFV CREDITS, USING A 7 PERCENT DISCOUNT RATE)

	2012	2013	2014	2015	2016	Total
Passenger Cars	6.1	11.1	15.5	20.7	27.6	80.9
Light Trucks	5.0	8.2	11.5	15.6	19.3	59.7

[43] CO_2 benefits for purposes of these tables are calculated using the $21/ton SCC values. Note that net present value of reduced GHG emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5, 3, and 2.5 percent) is used to calculate net present value of SCC for internal consistency.

TABLE I.C.1–6B—NHTSA DISCOUNTED BENEFITS ($BILLION) UNDER THE CAFE STANDARDS (WITH FFV CREDITS, USING A 7 PERCENT DISCOUNT RATE)—Continued

	2012	2013	2014	2015	2016	Total
Combined	11.2	19.3	27.0	36.4	46.9	140.7

NHTSA attributes most of these benefits—about $143 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 (AEO's) reference case forecast from the Annual Energy Outlook (AEO) 2010 Early Release. NHTSA's Final Regulatory Impact Analysis (FRIA) accompanying this rule presents a detailed analysis of specific benefits of the rule.

TABLE I.C.1–7—SUMMARY OF BENEFITS FUEL SAVINGS AND CO_2 EMISSIONS REDUCTION DUE TO THE RULE (BEFORE FFV CREDITS)

	Amount	Monetized value (discounted)	
		3% discount rate	7% discount rate
Fuel savings	61.0 billion gallons	$143.0 billion	$112.0 billion.
CO_2 emissions reductions	655 mmt	$14.5 billion	$14.5 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 standards—that is, outlays by vehicle manufacturers over and above those required to comply with the MY 2011 CAFE standards—will total about $52 billion (*i.e.,* during MYs 2012–2016).

TABLE I.C.1–8—NHTSA INCREMENTAL TECHNOLOGY OUTLAYS ($BILLION) UNDER THE CAFE STANDARDS (BEFORE FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	4.1	5.4	6.9	8.2	9.5	34.2
Light Trucks	1.8	2.5	3.7	4.3	5.4	17.6
Combined	5.9	7.9	10.5	12.5	14.9	51.7

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

TABLE I.C.1–9—NHTSA INCREMENTAL TECHNOLOGY OUTLAYS ($BILLION) UNDER CAFE STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.6	3.6	4.8	6.1	7.5	24.6
Light Trucks	1.1	1.5	2.5	3.4	4.4	12.9
Combined	3.7	5.1	7.3	9.5	11.9	37.5

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 standards would lead to increases in average new vehicle prices ranging from $457 per vehicle in MY 2012 to $985 per vehicle in MY 2016:

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

	2012	2013	2014	2015	2016
Passenger Cars	505	573	690	799	907
Light Trucks	322	416	621	752	961

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

	2012	2013	2014	2015	2016
Combined	434	513	665	782	926

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

TABLE I.C.1–11—NHTSA INCREMENTAL INCREASES IN AVERAGE NEW VEHICLE COSTS ($) UNDER CAFE STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016
Passenger Cars	303	378	481	593	713
Light Trucks	194	260	419	581	784
Combined	261	333	458	589	737

NHTSA estimates, therefore, that the total benefits of these CAFE standards will be more than three times the magnitude of the corresponding costs. As a consequence, its standards would produce net benefits of $130.7 billion at a 3 percent discount rate (with FFV credits, $138.2 billion) or $94.5 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 EPA's GHG Standards

EPA has analyzed in detail the costs and benefits of the final GHG standards. Table I.C.2–1 shows EPA's estimated lifetime discounted cost, benefits and net benefits for all vehicles projected to be sold in model years 2012–2016. It is important to note that there is significant overlap in costs and benefits for NHTSA's CAFE program and EPA's GHG program and therefore combined program costs and benefits are not a sum of the individual programs.

TABLE I.C.2–1—EPA'S ESTIMATED 2012–2016 MODEL YEAR LIFETIME DISCOUNTED COSTS, BENEFITS, AND NET BENEFITS ASSUMING THE $21/TON SCC VALUE [a b c d]

[2007 dollars]

3% Discount rate	$Billions
Costs	51.5
Benefits	240
Net Benefits	189
7% Discount rate	
Costs	51.5
Benefits	192
Net Benefits	140

[a] Although EPA estimated the benefits associated with four different values of a one ton GHG reduction ($5, $21, $35, $65), for the purposes of this overview presentation of estimated costs and benefits EPA is showing the benefits associated with the marginal value deemed to be central by the interagency working group on this topic: $21 per ton of CO2e, in 2007 dollars and 2010 emissions. The $21/ton value applies to 2010 CO_2 emissions and grows over time.

[b] As noted in Section III.H, SCC increases over time. The $21/ton value applies to 2010 CO_2 emissions and grows larger over time.

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

[d] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

Table I.C.2–2 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.C.2–2 are projected lifetime totals for each model year and are not discounted. As documented in EPA's Final RIA, 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 reductions in CO_2 emissions. The two agencies' 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.C.2–2—EPA'S ESTIMATED 2012–2016 MODEL YEAR LIFETIME FUEL SAVED AND GHG EMISSIONS AVOIDED

		2012	2013	2014	2015	2016	Total
Cars	Fuel (billion gallons)	4.0	5.5	7.3	10.5	14.3	41.6
	Fuel (billion barrels)	0.10	0.13	0.17	0.25	0.34	0.99
	CO_2 EQ (mmt)	49.3	68.5	92.7	134	177	521

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

		2012	2013	2014	2015	2016	Total
Light Trucks	Fuel (billion gallons)	3.3	5.0	6.6	9.0	12.2	36.1
	Fuel (billion barrels)	0.08	0.12	0.16	0.21	0.29	0.86
	CO_2 EQ (mmt)	39.6	61.7	81.6	111	147	441
Combined	Fuel (billion gallons)	7.3	10.5	13.9	19.5	26.5	77.7
	Fuel (billion barrels)	0.17	0.25	0.33	0.46	0.63	1.85
	CO_2 EQ (mmt)	88.8	130	174	244	325	962

Table I.C.2–3 shows EPA's estimated lifetime discounted benefits for all vehicles sold in model years 2012–2016. Although EPA estimated the benefits associated with four different values of a one ton GHG reduction ($5, $21, $35, $65), for the purposes of this overview presentation of estimated benefits EPA is showing the benefits associated with one of these marginal values, $21 per ton of CO_2, in 2007 dollars and 2010 emissions. Table I.C.2–3 presents benefits based on the $21 value. Section III.H presents the four marginal values used to estimate monetized benefits of GHG reductions and Section III.H presents the program benefits using each of the four marginal values, which represent only a partial accounting of total benefits due to omitted climate change impacts and other factors that are not readily monetized. The values in the table are discounted values for each model year of vehicles throughout their projected lifetimes. The 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 four different social cost of carbon (SCC) values considered by EPA. The values in Table I.C.2–3 do not include costs associated with new technology required to meet the GHG standard.

TABLE I.C.2–3—EPA'S ESTIMATED 2012–2016 MODEL YEAR LIFETIME DISCOUNTED BENEFITS ASSUMING THE $21/TON SCC VALUE [a] [b] [c]

[Billions of 2007 dollars]

Discount rate	Model year					
	2012	2013	2014	2015	2016	Total
3%	$21.8	$32.0	$42.8	$60.8	$83.3	$240
7%	17.4	25.7	34.2	48.6	66.4	192

[a] The benefits include all benefits considered by EPA such as the economic value of reduced fuel consumption and accompanying savings in refueling time, climate-related economic benefits from reducing emissions of CO_2 (but not other GHGs), economic benefits from reducing emissions of PM and other air pollutants that contribute to its formation, and reductions in energy security externalities caused by U.S. petroleum consumption and imports. The analysis also includes disbenefits stemming from additional vehicle use, such as the economic damages caused by accidents, congestion and noise.

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

[c] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses. Also, as noted in Section III.H, SCC increases over time. The $21/ton value applies to 2010 emissions and grows larger over time.

Table I.C.2–4 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.C.2–4 are totals for the five model years throughout their projected lifetime and are not discounted. The monetized values shown in Table I.C.2–4 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.C.2–4 reflect both a 3 percent and a 7 percent discount rate as noted.

TABLE I.C.2–4—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	$182, 3% discount rate. $142, 7% discount rate.

TABLE I.C.2–4—EPA'S ESTIMATED 2012–2016 MODEL YEAR LIFETIME FUEL SAVINGS, CO_2 EMISSION REDUCTIONS, AND DISCOUNTED MONETIZED BENEFITS AT A 3% DISCOUNT RATE—Continued

[Monetized values in 2007 dollars]

	Amount	$ value (billions)
CO_{2e} emission reductions (CO_2 portion valued assuming $21/ton CO_2 in 2010).	962 MMT CO_{2e}	$17 [a b].

[a] $17 billion for 858 MMT of reduced CO_2 emissions. As noted in Section III.H, the $21/ton value applies to 2010 emissions and grows larger over time. Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

[b] Note that net present value of reduced CO_2 emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5, 3, and 2.5 percent) is used to calculate net present value of SCC for internal consistency. Refer to Section III.H for more detail.

Table I.C.2–5 shows EPA's estimated incremental and total technology outlays for cars and trucks for each of the model years 2012–2016. The technology outlays shown in Table I.C.2–5 are for the industry as a whole and do not account for fuel savings associated with the program.

TABLE I.C.2–5—EPA'S ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS

[Billions of 2007 dollars]

	2012	2013	2014	2015	2016	Total
Cars	$3.1	$5.0	$6.5	$8.0	$9.4	$31.9
Trucks	1.8	3.0	3.9	4.8	6.2	19.7
Combined	4.9	8.0	10.3	12.7	15.6	51.5

Table I.C.2–6 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 $342 relative to a 2012 model year car absent the National Program. The estimated increase for a 2013 model year car is $507 relative to a 2013 model year car absent the National Program (not $342 plus $507).

TABLE I.C.2–6—EPA'S ESTIMATED INCREMENTAL INCREASE IN AVERAGE NEW VEHICLE COST

[2007 dollars per unit]

	2012	2013	2014	2015	2016
Cars	$342	$507	$631	$749	$869
Trucks	314	496	652	820	1,098
Combined	331	503	639	774	948

D. Background and Comparison of NHTSA and EPA Statutory Authority

Section I.C of the proposal contained a detailed overview discussion of the NHTSA and EPA statutory authorities. In addition to the discussion in the proposal, each agency discusses comments pertaining to its statutory authority and the agency's responses in Sections III and IV of this notice, respectively.

II. Joint Technical Work Completed for This Final Rule

A. Introduction

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

B. Developing the Future Fleet for Assessing Costs, Benefits, and Effects

1. Why did the agencies establish a baseline and reference vehicle fleet?

In order to calculate the impacts of the EPA and NHTSA regulations, it is necessary to estimate the composition of the future vehicle fleet absent these regulations, to provide a reference point relative to which costs, benefits, and effects of the regulations are assessed. As in the proposal, EPA and NHTSA have developed this 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 model years 2011–2016. This is called the reference fleet.

The third step was to modify that MY 2011–2016 reference fleet such that it had sufficient technology to meet the MY 2011 CAFE standards. This final version of the reference fleet is the light-duty fleet estimated to exist in MY 2012–2016 in the absence of today's standards, based on the assumption that manufacturers would continue to meet the MY 2011 CAFE standards (or pay civil penalties allowed under EPCA [44]) in the absence of further increases in the stringency of CAFE standards. Each agency used this approach to develop 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.

EPA and NHTSA proposed a transparent approach to developing the baseline and reference fleets, largely working from publicly available data. This proposed approach differed from previous CAFE rules, which relied on confidential manufacturers' product plan information to develop the baseline. Most of the public comments to the NPRM addressing this issue supported this methodology for developing the inputs to the rule's analysis. Because the input sheets can be made public, stakeholders can verify and check EPA's and NHTSA's modeling, and perform their own analyses with these datasets. In this final rulemaking, EPA and NHTSA are using an approach very similar to that proposed, continuing to rely on publicly available data as the basis for the baseline and reference fleets.

2. How did the agencies develop the baseline vehicle fleet?

At proposal, EPA and NHTSA developed a baseline fleet comprised of model year 2008 data gathered from EPA's emission certification and fuel economy database. MY 2008 was used as the basis for the baseline vehicle fleet because it was the most recent model year for which a complete set of data is publicly available. This remains the case. Manufacturers are not required to submit final sales and mpg figures for MY 2009 until April 2010,[45] after the CAFE standard's mandated promulgation date. Consequently, in this final rule, EPA and NHTSA made no changes to the method or the results of the MY 2008 baseline fleet used at proposal, except for some specific corrections to engineering inputs for some vehicle models reflected in the market forecast input to NHTSA's CAFE model. More details about how the agencies constructed this baseline fleet can be found in Chapter 1.2 of the Joint TSD. Corrections to engineering inputs for some vehicle models in the market forecast input to NHTSA's CAFE model are discussed in Chapter 2 of the Joint TSD.

3. How did the agencies develop the projected MY 2011–2016 vehicle fleet?

EPA and NHTSA have based the projection of total car and total light truck sales for MYs 2011–2016 on projections made by the Department of Energy's Energy Information Administration (EIA). EIA publishes a mid-term projection of national energy use called the Annual Energy Outlook (AEO). 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. In the proposal, the agencies used the three reports published by EIA as part of the AEO 2009. We also stated that updated versions of these reports could be used in the final rules should AEO timely issue a new version. EIA published an early version of its AEO 2010 in December 2009, and the agencies are making use of it in this final rulemaking. The differences in projected sales in the 2009 report (used in the NPRM) and the early 2010 report are very small, so NHTSA and EPA have decided to simply scale the NPRM volumes for cars and trucks (in the aggregate) to match those in the 2010 report. We thus employ the sales projections from the scaled updated 2009 Annual Energy Outlook, which is equivalent to AEO 2010 Early Release, for the final rule. The scaling factors for each model year are presented in Chapter 1 of the Joint TSD for this final rule.

The agencies recognize that AEO 2010 Early Release does include some impacts of future projected increases in CAFE stringency. We have closely examined the difference between AEO 2009 and AEO 2010 Early Release and we believe the differences in total sales and the car/truck split attributed to considerations of the standard in the final rule are small.[46]

In the AEO 2010 Early Release, EIA projects that total light-duty vehicle sales will gradually recover from their currently depressed levels by around 2013. In 2016, car sales are projected to be 9.4 million (57 percent) and truck sales are projected to be 7.1 million (43 percent). Although the total level of sales of 16.5 million units is similar to pre-2008 levels, the fraction of car sales is projected to be higher than that existing in the 2000–2007 timeframe. This projection reflects the impact of higher fuel prices, as well as EISA's requirement that the new vehicle fleet average at least 35 mpg by MY 2020. The agencies note that AEO does not represent the fleet at a level of detail sufficient to explicitly account for the reclassification—promulgated as part of NHTSA's final rule for MY 2011 CAFE standards—of a number of 2-wheel drive sport utility vehicles from the truck fleet to the car fleet for MYs 2011 and after. Sales projections of cars and trucks for future model years can be found in the Joint TSD for these final rules.

In addition to a shift towards more car sales, sales of segments within both the car and truck markets have been changing and are expected to continue to change. Manufacturers are introducing more crossover models which offer much of the utility of SUVs but use more car-like designs. The AEO 2010 report does not, however, distinguish such changes within the car and truck classes. In order to reflect these changes in fleet makeup, EPA and NHTSA considered several other available forecasts. 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, modified as described below, for several reasons presented in the NPRM preamble [47] and draft Joint TSD. 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. Noting this, and lacking a credible forecast of company and segment shares after 2015, the agencies assumed 2016 market share and market segments to be the same as for 2015.

[44] That is, the manufacturers who have traditionally paid fines under EPCA instead of complying with the CAFE standards were "allowed," for purposes of the reference fleet, to reach only the CAFE level at which paying fines became more cost-effective than adding technology, even if that fell short of the MY 2011 standards.

[45] 40 CFR 600.512–08, Model Year Report.

[46] The agencies have also looked at the impact of the rule in EIA's projection, and concluded that the impact was small. EPA and NHTSA have evaluated the differences between the AEO 2010 (early draft) and AEO 2009 and found little difference in the fleet projections (or fuel prices). This analysis can be found in the memo to the docket: Kahan, A. and Pickrell, D. Memo to Docket EPA–HQ–OAR–2009–0472 and Docket NHTSA–2009–0059. "Energy Information Administration's Annual Energy Outlook 2009 and 2010." March 24, 2010.

[47] See, *e.g.,* 74 FR 49484.

CSM Worldwide provides quarterly sales forecasts for the automotive industry. In the NPRM, the agencies identified a concern with the 2nd quarter CSM forecast that was used as a basis for the projection. CSM projections at that time were based on an industry that was going through a significant financial transition, and as a result the market share forecasts for some companies were impacted in surprising ways. As the industry's situation has settled somewhat over the past year, the 4th quarter projection appears to address this issue—for example, it shows nearly a two-fold increase in sales for Chrysler compared to significant loss of market share shown for Chrysler in the 2nd quarter projection. Additionally, some commenters, such as GM, recognized that the fleet appeared to include an unusually high number of large pickup trucks.[48] In fact, the agencies discovered (independently of the comments) that CSM's standard forecast included all vehicles below 14,000 GVWR, including class 2b and 3 heavy duty vehicles, which are not regulated by this final rule.[49] The commenters were thus correct that light duty reference fleet projections at proposal had more full size trucks and vans due to the mistaken inclusion of the heavy duty versions of those vehicles. The agencies requested a separate data forecast from CSM that filtered their 4th quarter projection to exclude these heavy duty vehicles. The agencies then used this filtered 4th quarter forecast for the final rule. A detailed comparison of the market by manufacturer can be found in the final TSD. For the public's reference, copies of the 2nd, 3rd, and 4th quarter CSM forecasts have been placed in the docket for this rulemaking.[50]

We then projected the CSM forecasts for relative sales of cars and trucks by manufacturer and by market segment onto the total sales estimates of AEO 2010. Tables II.B.3–1 and II.B.3–2 show the resulting projections for the reference 2016 model year and compare these to actual sales that occurred in baseline 2008 model year. Both tables show sales using the traditional definition of cars and light trucks.

TABLE II.B.3–1—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	424,923	61,324	171,560	353,120	596,482
Chrysler	537,808	340,908	1,119,397	525,128	1,657,205	866,037
Daimler	208,052	272,252	79,135	126,880	287,187	399,133
Ford	709,583	1,118,727	1,158,805	1,363,256	1,868,388	2,481,983
General Motors	1,370,280	1,283,937	1,749,227	1,585,828	3,119,507	2,869,766
Honda	899,498	811,214	612,281	671,437	1,511,779	1,482,651
Hyundai	270,293	401,372	120,734	211,996	391,027	613,368
Kia	145,863	455,643	135,589	210,717	281,452	666,360
Mazda	191,326	350,055	111,220	144,992	302,546	495,047
Mitsubishi	76,701	49,914	24,028	88,754	100,729	138,668
Porsche	18,909	33,471	18,797	16,749	37,706	50,220
Nissan	653,121	876,677	370,294	457,114	1,023,415	1,333,790
Subaru	149,370	230,705	49,211	95,054	198,581	325,760
Suzuki	68,720	97,466	45,938	26,108	114,658	123,574
Tata	9,596	65,806	55,584	42,695	65,180	108,501
Toyota	1,143,696	2,069,283	1,067,804	1,249,719	2,211,500	3,319,002
Volkswagen	290,385	586,011	26,999	124,703	317,384	710,011
Total	7,034,997	9,468,365	6,806,367	7,112,689	13,841,364	16,580,353

TABLE II.B.3–2—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	829,896	530,945	Full-Size Pickup	1,331,989	1,379,036
Luxury Car	1,048,341	1,548,242	Mid-Size Pickup	452,013	332,082
Mid-Size Car	2,166,849	2,550,561	Full-Size Van	33,384	65,650
Mini Car	617,902	1,565,373	Mid-Size Van	719,529	839,194
Small Car	1,912,736	2,503,566	Mid-Size MAV *	110,353	116,077
Specialty Car	459,273	769,679	Small MAV	231,265	62,514
			Full-Size SUV *	559,160	232,619
			Mid-Size SUV	436,080	162,502
			Small SUV	196,424	108,858
			Full-Size CUV *	264,717	260,662
			Mid-Size CUV	923,165	1,372,200
			Small CUV	1,548,288	2,181,296

[48] GM argued that the unusually large volume of large pickups led to higher overall requirements for those vehicles. As discussed below, the agencies' analysis for the final rule corrects the number of large pickups. With this correction and other updates to the agencies' market forecast and other analytical inputs, the target functions defining the final standards (and achieving the average required performance levels defining the national program) are very similar to those from the NPRM, especially for light trucks, as illustrated below in Figures II.C–7 and II.C–8.

[49] These include the Ford F–250 & F–350, Econoline E–250, & E–350; Chevy Express, Silverado 2500, & 3500; GMC Savana, Dodge 2500, & 3500; among others.

[50] The CSM Sales Forecast Excel file ("CSM North America Sales Forecasts 2Q09 3Q09 4Q09 for the Docket") is available in the docket (Docket EPA–HQ–OAR–2009–0472).

TABLE II.B.3–2—ANNUAL SALES OF LIGHT-DUTY VEHICLES BY MARKET SEGMENT IN 2008 AND ESTIMATED FOR 2016—Continued

Cars			Light trucks		
	2008 MY	2016 MY		2008 MY	2016 MY
Total Sales **	7,034,997	9,468,365		6,806,367	7,079,323

* MAV—Multi-Activity Vehicle, SUV—Sport Utility Vehicle, CUV—Crossover Utility Vehicle.
** Total Sales are based on the classic Car/Truck definition.

Determining which traditionally-defined trucks will be defined as cars for purposes of this final rule using the revised definition established by NHTSA for MYs 2011 and beyond requires more detailed information about each vehicle model. This is described in greater detail in Chapter 1 of the final TSD.

The forecasts obtained from CSM provided estimates of car and truck sales by segment and by manufacturer, but not by manufacturer for each market segment. Therefore, NHTSA and EPA needed other information on which to base these more detailed projected market splits. For this task, the agencies used as a starting point each manufacturer's sales by market segment from model year 2008, which is the baseline fleet. Because of the larger number of segments in the truck market, the agencies 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, the agencies found that Ford's [51] cars sales in 2008 were broken down as shown in Table II.B.3–3:

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

Full-size cars	160,857 units.
Mid-size Cars	170,399 units.
Small/Compact Cars	180,249 units.
Subcompact/Mini Cars	None.
Luxury cars	87,272 units.
Specialty cars	110,805 units.

EPA and NHTSA 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 AEO and CSM forecasts. For example, as indicated in Table II.B.3–1, Ford's total car sales in 2008 were 709,583 units, while the agencies project that they will increase to 1,113,333 units by 2016. This represents an increase of 56.9 percent. Thus, the agencies increased the 2008 sales of each Ford car segment by 56.9 percent. This produced estimates of future sales which matched total car and truck sales per AEO and the manufacturer breakdowns per CSM. However, the sales splits by market segment would not necessarily match those of CSM (shown for 2016 in Table II.B.3–2).

In order to adjust the market segment mix for cars, the agencies 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, and so on? The agencies have assumed that any changes in the sales of cars within these three segments were compensated for by proportional changes in the sales of the other four car segments. For example, for 2016, the figures in Table II.B.3–2 indicate that luxury car sales in 2016 are 1,548,242 units. Luxury car sales are 1,048,341 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 decreased to 1,523,171 units. Thus, overall for 2016, luxury car sales had to increase by 25,071 units or 6 percent. The agencies accordingly increased 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.

The agencies used a slightly different approach to adjust for changing sales of the remaining four car segments. Starting with full-size cars, the agencies again determined the overall percentage change that needed to occur in future year full-size car sales after 1) adjusting for total sales per AEO 2010, 2) adjusting for manufacturer sales mix per CSM and 3) adjusting 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, the agencies assigned the entire change to mid-size vehicles. The agencies did so because the CSM data followed the trend of increasing volumes of smaller cars while reducing volumes of larger cars. If a consumer had previously purchased a full-size car, we thought it unlikely that their next purchase would decrease by two size categories, down 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 model years 2012–2016—the reference fleet—which matched the total sales projections of the AEO forecast and the manufacturer and segment splits of the CSM forecast. These sales splits can be found in Chapter 1 of the Joint TSD for this final rule.

As mentioned above, the agencies applied a slightly different process to truck sales, because the agencies 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, the

[51] **Note**: In the NPRM, Ford's 2008 sales per segment, and the total number of cars was different than shown here. The change in values is due to a correction of vehicle segments for some of Ford's vehicles.

agencies applied an iterative, but straightforward process for adjusting 2008 truck sales to match the AEO and CSM forecasts.

The first three steps were exactly the same as for cars. EPA and NHTSA broke down each manufacturer's truck sales into the truck segments as defined by CSM. The agencies then adjusted all manufacturers' truck segment sales by the same factor so that total truck sales in each model year matched AEO projections for truck sales by model year. The agencies 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, the agencies adjusted the sales of each truck segment by a common factor so that total sales for that segment matched the combination of the AEO and CSM forecasts. For example, projected sales of large pickups across all manufacturers were 1,286,184 units in 2016 after adjusting total sales to match AEO'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 AEO's total sales forecast indicated total large pickup sales of 1,379,036 units. Thus, we increased each manufacturer's sales of large pickups by 7 percent.[52] The agencies applied the same type of adjustment to all the other truck segments at the same time. The result was a set of sales projections which matched AEO's total truck sales projection and CSM's market segment forecast. However, after this step, sales 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 AEO'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 to the desired result. The agencies repeated these adjustments, matching manufacturer sales mix in one step and then market segment in the next 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 percent of our goal, which is well within the needs of this analysis.

The next step in developing the reference fleets 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—*i.e.,* the vehicles comprising the baseline fleet. 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 by interested parties. Two, because it is constructed beginning with actual sales data, this vehicle fleet is limited to vehicle models known to satisfy consumer demands in light of price, utility, performance, safety, and other vehicle attributes.

As noted above, the agencies gathered most of the information about the 2008 baseline 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 final rule. Thus, the agencies augmented this description with publicly available data which includes more complete technology descriptions from Ward's Automotive Group.[53] In a few instances when required vehicle information (such as vehicle footprint) was not available from these two sources, the agencies obtained this information from publicly accessible Internet sites such as *Motortrend.com* and *Edmunds.com.*[54]

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, the agencies placed each vehicle in the EPA certification database into one of the CSM market segments. The agencies then totaled the sales by each manufacturer for each market segment. If the combination of AEO 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 percent 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 percent of Toyota's compact car sales.

The projection of average footprint for both cars and trucks remained virtually constant over the years covered by the final rulemaking. This occurrence is strictly a result of the CSM projections. There are a number of trends that occur in the CSM projections that caused the average footprint to remain constant. First, as the number of subcompacts increases, so do the number of 2-wheel drive crossover vehicles (that are regulated as cars). Second, truck volumes have many segment changes during the rulemaking time frame. There is no specific footprint related trend in any segment that can be linked to the unchanging footprint, but there is a trend that non-pickups' volumes will move from truck segments that are ladder frame to those that are unibody-type vehicles. A table of the footprint projections is available in the TSD as well as further discussion on this topic.

4. How was the development of the baseline and reference fleets for this Final Rule different from NHTSA's historical approach?

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.

The proposal discusses many of the advantages and disadvantages of the market forecast approach used by the agencies, including the agencies' interest in examining product plans as a check on the reference fleet developed by the agencies for this rulemaking. One of the primary reasons for the request for data in 2009 was to obtain permission from the manufacturers to make public their product plan information for model years 2010 and 2011. There are a number of reasons that this could be advantageous in the development of a reference fleet. First,

[52] **Note**: In the NPRM this example showed 29 percent instead of 7 percent. The significant decrease was due to using the filtered 4th quarter CSM forecast. Commenters, such as GM, had commented that we had too many full-size trucks and vans, and this change addresses their comment.

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

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

some known changes to the fleet may not be captured by the approach of solely using publicly available information. 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 Mercury Sable, the Pontiac Grand Prix, the Pontiac G5 and the Saturn Vue. 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. However, although the agencies recognize that these specific vehicles will be discontinued, we continue to include them in the market forecast because they are useful as a surrogate for successor vehicles that may appear in the rulemaking time frame to replace the discontinued vehicles in that market segment.[55]

Second, the agencies' market forecast does not include some forthcoming vehicle models, such as the Chevrolet Volt, the Ford Fiesta and several publicly announced electric vehicles, including the announcements from Nissan regarding the Leaf. 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 defining specific vehicle models in the reference fleet 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. Chrysler Group LLC has announced plans to offer small- and medium-sized cars using Fiat powertrains. 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.

Some commenters, such as CBD and NESCAUM, suggested that the agencies' omission of known future vehicles and technologies in the reference fleet causes inaccuracies, which CBD further suggested could lead the agencies to set lower standards. On the other hand, CARB commented that "the likely impact of this omission is minor." Because the agencies' analysis examines the costs and benefits of progressively adding technology to manufacturers' fleets, the omission of future vehicles and technologies primarily affects how much additional technology (and, therefore, how much incremental cost and benefit) is available relative to the point at which the agencies' examination of potential new standards begins. Thus, in fact, the omission only reflects the reference fleet, rather than the agencies' conclusions regarding how stringent the standards should be. This is discussed further below. The agencies believe the above-mentioned comments by CBD, NESCAUM, and others are based on a misunderstanding of the agencies' approach to analyzing potential increases in regulatory stringency. The agencies also note that manufacturers do not always use technology solely to increase fuel economy, and that use of technology to increase vehicles' acceleration performance or utility would probably make that technology unavailable toward more stringent standards. Considering the incremental nature of the agencies' analysis, and the counterbalancing aspects of potentially omitted technology in the reference fleet, the agencies believe their determination of the stringency of new standards has not been impacted by any such omissions.

Moreover, EPA and NHTSA believe that not including such vehicles after MY 2008 does not significantly impact our estimates of the technology required to comply with the standards. If included, these vehicles could increase the extent to which manufacturers are, in the reference case, expected to over-comply with the MY 2011 CAFE standards, and could thereby make the new standards appear to cost less and yield less benefit relative to the reference case. However, in the agencies' judgment, production of the most advanced technology vehicles, such as the Chevy Volt or the Nissan Leaf (for example), will most likely be too limited during MY 2011 through MY 2016 to significantly impact manufacturers' compliance positions. While we are projecting the characteristics of the future fleet by extrapolating from the MY 2008 fleet, the primary difference between the future fleet and the 2008 fleet in the same vehicle segment is the use of additional CO_2-reducing and fuel-saving technologies. Both the NHTSA and EPA models add such technologies to evaluate means of complying with the standards, and the costs of doing so. Thus, our future projections of the vehicle fleet generally shift vehicle designs towards those more likely to be typical of newer vehicles. Compared to using product plans that show continued fuel economy increases planned based on expectations that CAFE standards will continue to increase, this approach helps to clarify the costs and benefits of the new standards, as the costs and benefits of all fuel economy improvements beyond those required by the MY 2011 CAFE standards are being assigned to the final rules. In some cases, the "actual" (vs. projected or "modeled") new vehicles being introduced into the market by manufacturers are done so in anticipation of this rulemaking. On the other hand, manufacturers may plan to continue using technologies to improve vehicle performance and/or utility, not just fuel economy. Our approach prevents some of these actual technological improvements and their associated cost and fuel economy improvements from being assumed in the reference fleet. Thus, the added technology will not be considered to be free (or having no benefits) for the purposes of this rule.

In this regard, the agencies further note that manufacturer announcements regarding forward models (or future vehicle models) need not be accepted automatically. Manufacturers tend to limit accurate production intent information in these releases for reasons such as: (a) Competitors will closely examine their information for data in their product planning decisions; (b) the press coverage of forward model announcements is not uniform, meaning highly anticipated models have more coverage and materials than models that may be less exciting to the public and consistency and uniformity cannot be ensured with the usage of press information; and (c) these market projections are subject to change (sometimes significant), and manufacturers may not want to give the appearance of being indecisive, or under/over-confident to their shareholders and the public with premature release of information.

NHTSA has evaluated the use of public manufacturer forward model press information to update the vehicle fleet inputs to the baseline and reference fleet. The challenges in this approach are evidenced by the continuous stream of manufacturer press releases throughout a defined rulemaking period. Manufacturers' press releases suffer from the same types of inaccuracies that many commenters believe can affect product plans.

[55] An example of this is in the GM Pontiac line, which is in the process of being phased out during the course of this rulemaking. GM has similar vehicles within their other brands (like Chevy) that will "presumably" pick up the loss in Pontiac share. We model this simply by leaving the Pontiac brand in.

Manufacturers can often be overly optimistic in their press releases, both on projected date of release of new models and on sales volumes.

More generally and more critically, as discussed in the proposal and as endorsed by many of the public comments, there are several advantages to the approach used by the agencies in this final rule. 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. 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 addition, by developing baseline and reference fleets 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. An additional advantage of the approach used for this rule is a consistent projection of the change in fuel economy and CO_2 emissions across the various vehicles from the application of new technology. With the approach used for this final rule, the baseline market data comes from actual vehicles (on the road today) which have actual fuel economy test data (in contrast to manufacturer estimates of future product fuel economy)—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.

5. How does manufacturer product plan data factor into the baseline used in this Final Rule?

In the spring and fall of 2009, many manufacturers submitted product plans in response to NHTSA's recent requests that they do so. 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 for vehicles 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 agencies' 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 manufacturer's data.

Also, 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 [56] 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.

Additionally, as discussed in the NPRM, in an effort to update the 2008 baseline to account for the expected changes in the fleet in the near-term model years 2009–2011 described above, NHTSA requested permission from the manufacturers to make this limited product plan information public. Unfortunately, virtually no manufacturers agreed to allow the use of their data after 2009 model year. A few manufacturers, such as GM and Ford, stated we could use their 2009 product plan data after the end of production (December 31), but this would not have afforded us sufficient time to do the analysis for the final rule. Since the agencies were unable to obtain consistent updates, the baseline and reference fleets were not updated beyond 2008 model year for the final rule. The 2008 baseline fleet and projections were instead updated using the latest AEO and CSM data as discussed earlier.

NHTSA and EPA recognize that the approach applied for the current rule gives transparency and openness of the vehicle market forecast high priority, and accommodates minor inaccuracies that may be introduced by not accounting for future product mix changes anticipated in manufacturers' confidential product plans. For any future fleet analysis that the agencies are required to perform, NHTSA and EPA plan to request that manufacturers submit product plans and allow some public release of information. In performing this analysis, the agencies plan to reexamine potential tradeoffs between transparency and technical reasonableness, and to explain resultant choices.

C. Development of Attribute-Based Curve Shapes

In the NPRM, NHTSA and EPA proposed to set 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.[57] 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

[56] 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.

[57] 49 U.S.C. 32902(a)(3)(A).

goal of coordinating and harmonizing CO_2 standards promulgated under the CAA and CAFE standards promulgated under EPCA, EPA also proposed to issue standards that are attribute-based and defined by mathematical functions. There was consensus in the public comments that EPA should develop attribute-based CO_2 standards.

Comments received in response to the agencies' decision to base standards on vehicle footprint were largely supportive. Several commenters (BMW, NADA, NESCAUM) expressed support for attribute-based (as opposed to flat or universal) standards generally, and agreed with EPA's decision to harmonize with NHTSA in this respect. Many commenters (Aluminum Association, BMW, ICCT, NESCAUM, NY DEC, Schade, Toyota) also supported the agencies' decision to continue setting CAFE standards, and begin setting GHG standards, on the basis of vehicle footprint, although one commenter (NJ DEP) opposed the use of footprint due to concern that it encourages manufacturers to upsize vehicles and undercut the gains of the standard. Of the commenters supporting the use of footprint, several focused on the benefits of harmonization—both between EPA and NHTSA, and between the U.S. and the rest of the world. BMW commented, for example, that many other countries use weight-based standards rather than footprint-based. While BMW did not object to NHTSA's and EPA's use of footprint-based standards, it emphasized the impact of this non-harmonization on manufacturers who sell vehicles globally, and asked the agencies to consider these effects. NADA supported the use of footprint, but cautioned that the agencies must be careful in setting the footprint curve for light trucks to ensure that manufacturers can continue to provide functionality like 4WD and towing/hauling capacity.

Some commenters requested that the agencies consider other or more attributes in addition to footprint, largely reiterating comments submitted to the MYs 2011–2015 CAFE NPRM. Cummins supported the agencies using a secondary attribute to account for towing and hauling capacity in large trucks, for example, while Ferrari asked the agencies to consider a multi-attribute approach incorporating curb weight, maximum engine power or torque, and/or engine displacement, as it had requested in the previous round of CAFE rulemaking. An individual, Mr. Kenneth Johnson, commented that weight-based standards would be preferable to footprint-based ones, because weight correlates better with fuel economy than footprint, because the use of footprint does not necessarily guarantee safety the way the agencies say it does, and because weight-based standards would be fairer to manufacturers.

In response, EPA and NHTSA continue to believe that the benefits of footprint-attribute-based standards outweigh any potential drawbacks raised by commenters, and that harmonization between the two agencies should be the overriding goal on this issue. As discussed by NHTSA in the MY 2011 CAFE final rule,[58] the agencies believe that the possibility of gaming is lowest with footprint-based standards, as opposed to weight-based or multi-attribute-based standards. Specifically, standards that incorporate weight, torque, power, towing capability, and/or off-road capability in addition to 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 average fuel economy and CO_2 levels projected by the agencies. The agencies recognize that based on economic and consumer demand factors that are external to this rule, the distribution of footprints in the future may be different (either smaller or larger) than what is projected in this rule. However, the agencies continue to believe that there will not be significant shifts in this distribution as a direct consequence of this rule. The agencies are therefore finalizing MYs 2012–2016 CAFE and GHG standards based on footprint.

The agencies also recognize that there could be benefits for a number of manufacturers if there was greater international harmonization of fuel economy and GHG standards, but this is largely a question of how stringent standards are and how they are enforced. It is entirely possible that footprint-based and weight-based systems can coexist internationally and not present an undue burden for manufacturers if they are carefully crafted. Different countries or regions may find different attributes appropriate for basing standards, depending on the particular challenges they face—from fuel prices, to family size and land use, to safety concerns, to fleet composition and consumer preference, to other environmental challenges besides climate change. The agencies anticipate working more closely with other countries and regions in the future to consider how to mitigate these issues in a way that least burdens manufacturers while respecting each country's need to meet its own particular challenges.

Under an attribute-based standard, every vehicle model has a performance target (fuel economy and CO_2 emissions for CAFE and CO_2 emissions standards, respectively), the level of which depends on the vehicle's attribute (for the proposal, footprint). The manufacturers' fleet average performance is determined by the production-weighted[59] average (for CAFE, harmonic average) of those targets. NHTSA and EPA are promulgating CAFE and CO_2 emissions standards defined by constrained linear functions and, equivalently, piecewise linear functions.[60] 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 was defined according to the following formula:[61]

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

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),

[58] *See* 74 FR 14359 (Mar. 30, 2009).

[59] Production for sale in the United States.

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

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

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.

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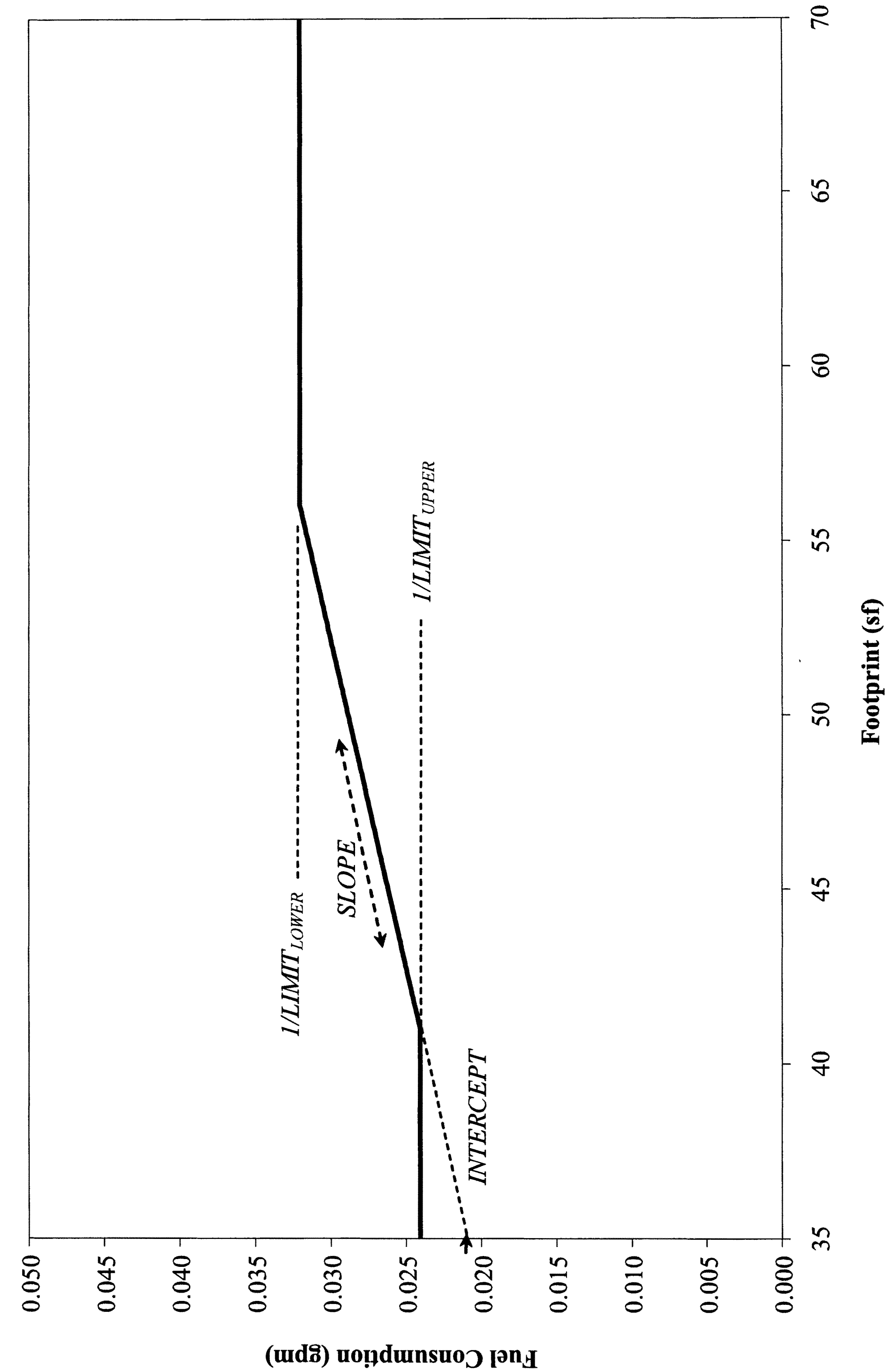

Figure II.C-1 The Shape of the Constrained Linear Form

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.

EPA proposed 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 and for each model year. Described mathematically, EPA's proposed piecewise linear function was 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 similar in form to the fuel economy equation above, 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)[62]
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–2.

[62] These a, b, d coefficients differ from the a, b, d coefficients in the constrained linear fuel economy equation primarily by a factor of 8887 (plus an additive factor for air conditioning).

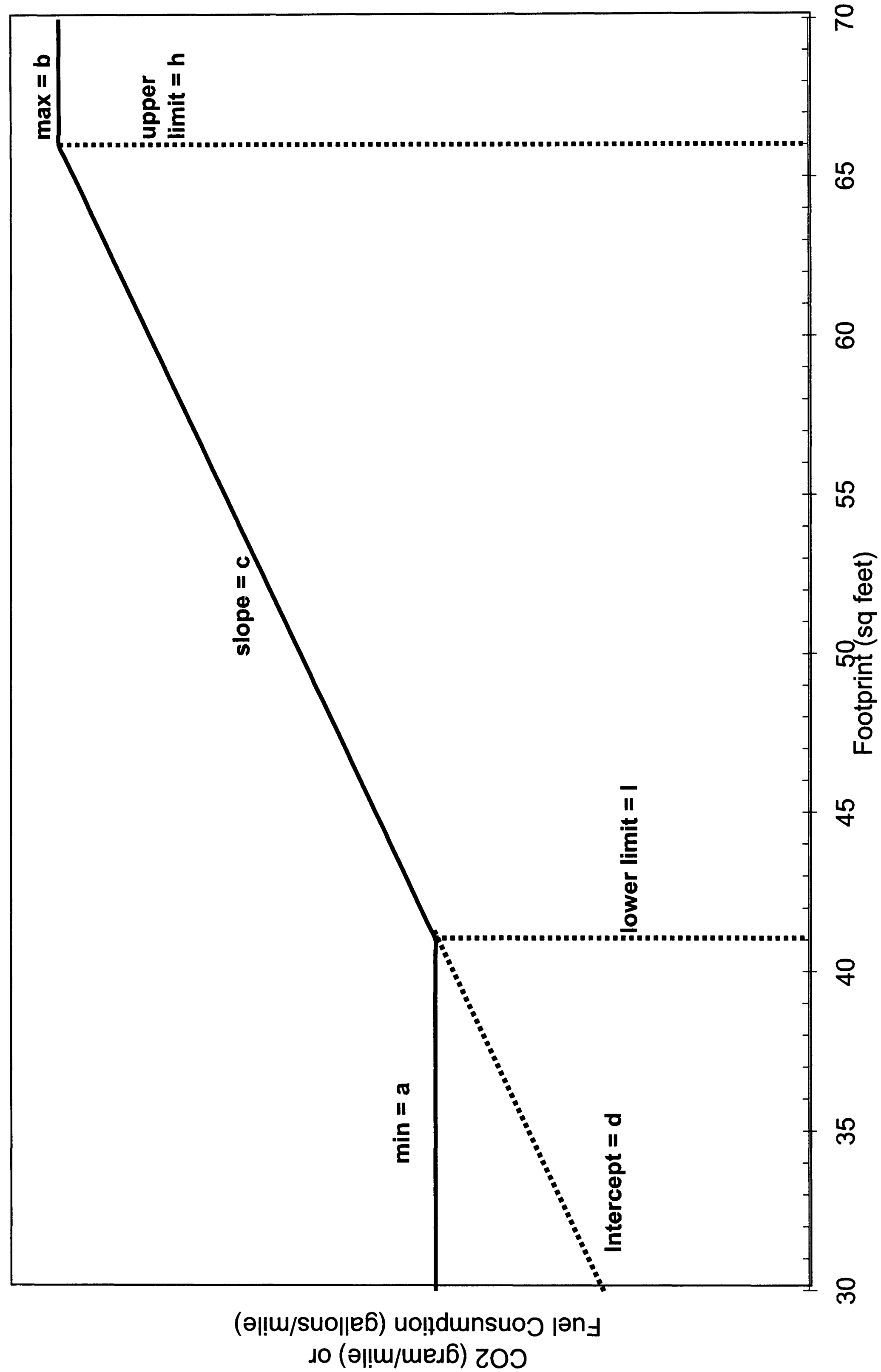

Figure II.C-2 The Shape of the Piecewise Linear Form

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As for the constrained linear form, the specific form and stringency of the piecewise linear function 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 the proposed rules, 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 involved defining the relevant vehicle characteristics in the form used by NHTSA's CAFE model (*e.g.,* fuel economy, footprint, vehicle class, technology) described in Section II.B of this preamble and in Chapter 1 of the Joint TSD. However, because the baseline fleet utilizes a wide range of available fuel saving technologies, NHTSA used the CAFE model to develop a fleet to which all of the technologies discussed in Chapter 3 of the Joint TSD [63] were applied, except dieselization and strong hybridization. This was accomplished 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 and EPA also continued to fit the sloped portion of the function to vehicle models between the footprint values at which the agencies 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 result in stringency levels that are technologically infeasible and/or economically impracticable for those manufacturers that may elect to focus on the smallest 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 and EPA selected footprints above and below which to apply constraints (*i.e.,* minimum and maximum values) on the function. The agencies believe that the linear form performs well in describing the observed relationship between footprint and fuel consumption or CO_2 emissions for vehicle models within the footprint ranges covering most vehicle models, but that the single (as opposed to piecewise) linear form does not perform well in describing this relationship for the smallest and largest vehicle models. For passenger cars, the agency noted that several manufacturers offer small, sporty coupes below 41 square feet, such as the BMW Z4 and Mini, Honda S2000, Mazda MX–5 Miata, Porsche Carrera and 911, and Volkswagen New Beetle. Because such vehicles represent a small portion (less than 10 percent) of the passenger car market, yet often have performance, utility, and/or structural characteristics that could make it technologically infeasible and/or economically impracticable for manufacturers focusing on such vehicles to achieve the very challenging average requirements that could apply in the absence of a constraint, EPA and NHTSA proposed to "cut off" the linear portion of the passenger car function at 41 square feet. The agencies recognize that for manufacturers who make small vehicles in this size range, this cut off creates some incentive to downsize (*i.e.,* further reduce the size, and/or increase the production of models currently smaller than 41 square feet) to make it easier to meet the target. The cut off may also create the incentive for manufacturers who do not currently offer such models to do so in the future. However, at the same time, the agencies believe that there is a limit to the market for cars smaller than 41 square feet—most consumers likely have some minimum expectation about interior volume, among other things. The agencies thus believe that the number of consumers who will want vehicles smaller than 41 square feet (regardless of how they are priced) is small, and that the incentive to downsize in response to this final rule, if present, will be minimal. For consistency, the agency proposed to "cut off" the light truck function at the same footprint, although no light trucks are currently offered below 41 square feet. The agencies 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 and EPA therefore also proposed to "cut off" the linear portion of the passenger car function at 56 square feet. Finally, the agencies 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. EPA and NHTSA therefore proposed to "cut off" the linear portion of the light truck function at 66 square feet.

Having developed a set of vehicle emissions and footprint data which represent the benefit of all non-diesel, non-hybrid technologies, we determined 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 limits) and the straight line of 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 parameters (*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.C–3 and II.C–4 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.

[63] 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.

For trucks, the corresponding MAD was 10 percent.

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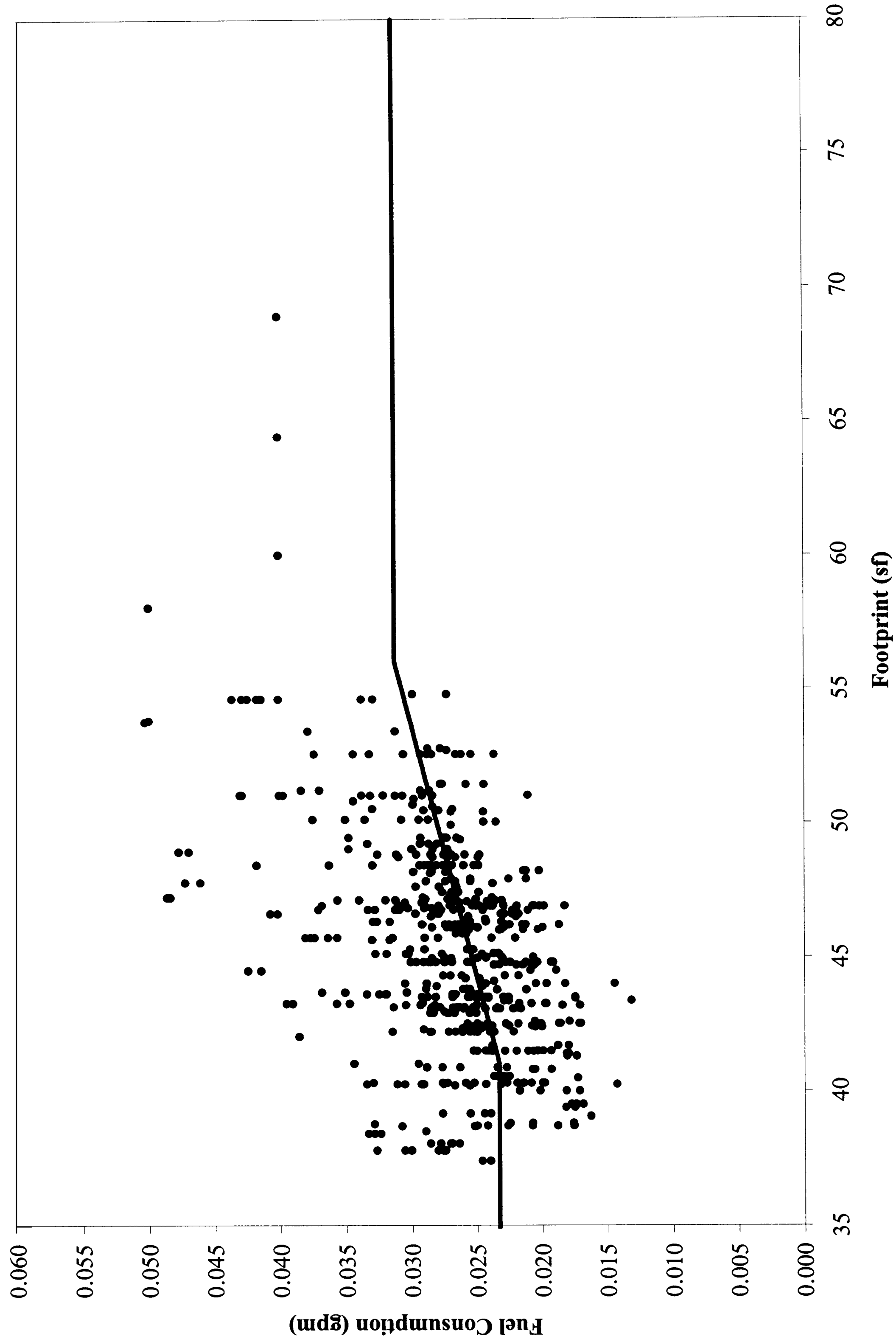

Figure II.C-3 "Maximum Technology" Passenger Fleet with Fitted Constrained Linear Function

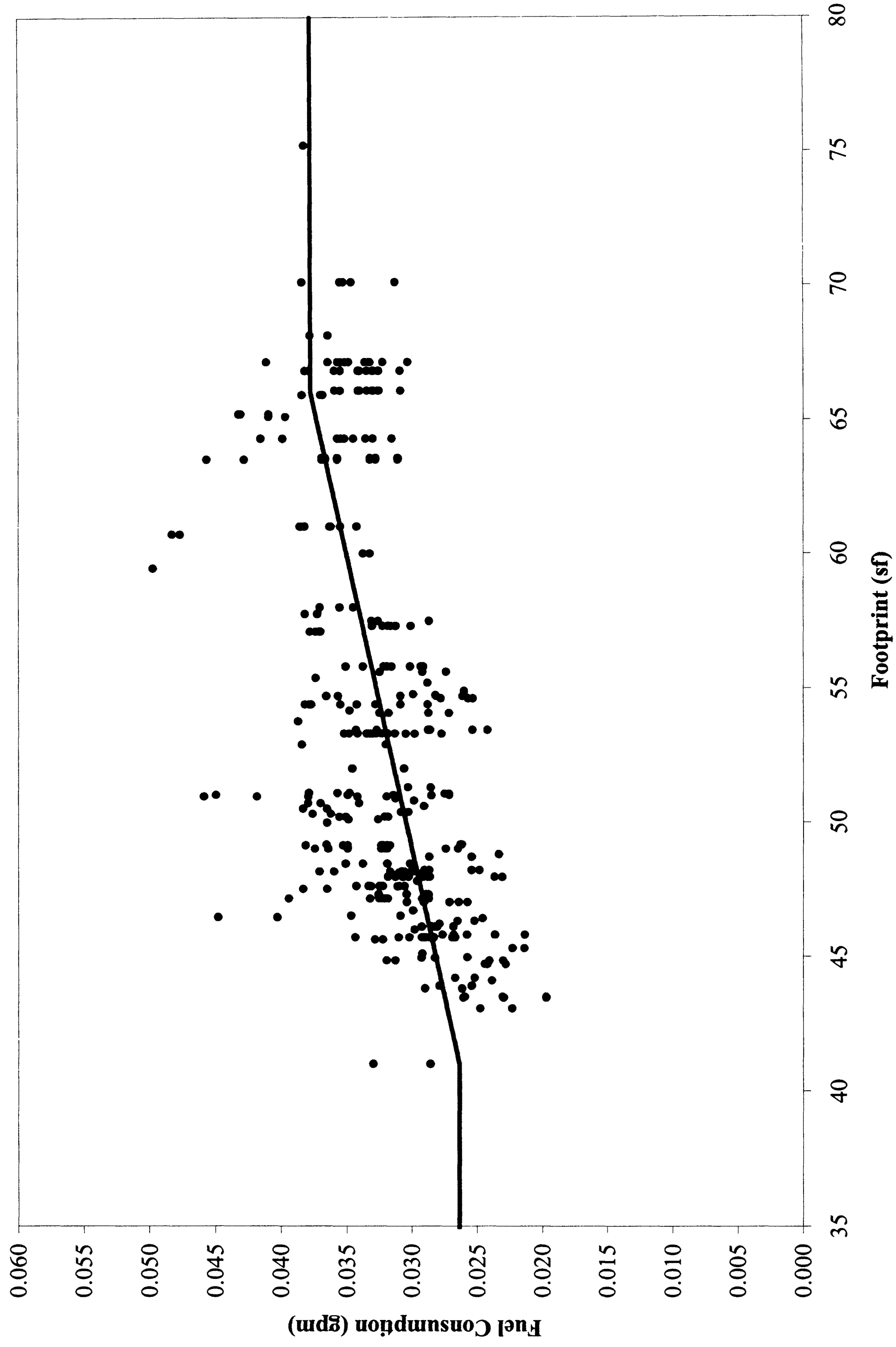

Figure II.C–4 "Maximum Technology" Light Truck with Fitted Constrained Linear Function

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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 same fleetwide fuel economy (and CO_2 emission levels) for cars and light trucks described in the NPRM.

A number of public comments generally supported the agencies' choice of attribute-based mathematical functions, as well as the methods applied to fit the function. Ferrari indicated support for the use of a constrained linear form rather than a constrained logistic form, support for the application of limits on the functions' values, support for a generally less steep passenger car curve compared to MY 2011, and support for the inclusion of all manufacturers in the analysis used to fit the curves. ICCT also supported the use of a constrained linear form. Toyota expressed general support for the methods and outcome, including a less-steep passenger car curve, and the application of limits on fuel economy targets applicable to the smallest vehicles. The UAW commented that the shapes and levels of the curves are reasonable.

Other commenters suggested that changes to the agencies' methods and results would yield better outcomes. GM suggested that steeper curves would provide a greater incentive for limited-line manufacturers to apply technology to smaller vehicles. GM argued that steeper and, in their view, fairer curves could be obtained by using sales-weighted least-squares regression rather than minimization of the unweighted mean absolute deviation. Conversely, students from UC Santa Barbara commented that the passenger car and light truck curves should be flatter and should converge over time in order to encourage the market to turn, as the agencies' analysis assumes it will, away from light trucks and toward passenger cars.

NADA commented that there should be no "cut-off" points (*i.e.,* lower limits or floors), because these *de facto* "backstops" might limit consumer choice, especially for light trucks—a possibility also suggested by the Alliance. The Alliance and several individual manufacturers also commented that the cut-off point for light trucks should be shifted to 72 square feet (from the proposed 66 square feet), arguing that the preponderance of high-volume light truck models with footprints greater than 66 square feet is such that a 72 square foot cut-off point makes it unduly challenging for manufacturers serving the large pickup market and thereby constitutes a *de facto* backstop. Also, with respect to the smallest light truck models, Honda commented that the cut-off point should be set at the point defining the smallest 10 percent of the fleet, both for consistency with the passenger car cut-off point, and to provide a greater incentive for manufacturers to downsize the smallest light truck models (which provide greater functionality than passenger cars).

Other commenters focused on whether the agencies should have separate curves for different fleets or whether they should have a single curve that applied to both passenger cars and light trucks. This issue is related, to some extent, to commenters who discussed whether car and truck definitions should change. CARB, Ford, and Toyota supported separate curves for cars and trucks, generally stating that different fleets have different functional characteristics and these characteristics are appropriately addressed by separate curves. Likewise, AIAM, Chrysler, and NADA supported leaving the current definitions of car and truck the same. CBD, ICCT, and NESCAUM supported a single curve, based on concerns about manufacturers gaming the system and reclassifying passenger cars as light trucks in order to obtain the often-less stringent light truck standard, which could lead to lower benefits than anticipated by the agencies.

In addition, the students from UC Santa Barbara reported being unable to reproduce the agencies' analysis to fit curves to the passenger car and light truck fleets, even when using the model, inputs, and external analysis files posted to NHTSA's Web site when the NPRM was issued.

Having considered public comments, NHTSA and EPA have re-examined the development of curves underlying the standards proposed in the NPRM, and are promulgating standards based on the same underlying curves. The agencies have made this decision considering that, while EISA mandates that CAFE standards be defined by a mathematical function in terms of one or more attributes related to fuel economy, neither EISA nor the CAA require that the mathematical function be limited to the observed or theoretical dependence of fuel economy on the selected attribute or attributes. As a means by which CAFE and GHG standards are specified, the mathematical function can and does properly play a normative role. Therefore, NHTSA and EPA have concluded that, as supported by comments, the mathematical function can reasonably be based on a blend of analytical and policy considerations, as discussed below and in the Joint Technical Support Document.

With respect to GM's recommendation that NHTSA and EPA use weighted least-squares analysis, the agencies find that the market forecast used for analysis supporting both the NPRM and the final rule exhibits the two key characteristics that previously led NHTSA to use minimization of the unweighted Mean Absolute Deviation (MAD) rather than weighted least-squares analysis. First, projected model-specific sales volumes in the agencies' market forecast cover an extremely wide range, such that, as discussed in NHTSA's rulemaking for MY 2011, while unweighted regression gives low-selling vehicle models and high-selling vehicle models equal emphasis, sales-weighted regression would give some vehicle models considerably more emphasis than other vehicle models.[64] The agencies' intention is to fit a curve that describes a technical relationship between fuel economy and footprint, given comparable levels of technology, and this supports weighting discrete vehicle models equally. On the other hand, sales weighted regression would allow the difference between other vehicle attributes to be reflected in the analysis, and also would reflect consumer demand.

Second, even after NHTSA's "maximum technology" analysis to increase technological parity of vehicle models before fitting curves, the agencies' market forecast contains many significant outliers. As discussed in NHTSA's rulemaking for MY 2011, MAD is a statistical procedure that has been demonstrated to produce more efficient parameter estimates than least-squares analysis in the presence of significant outliers.[65] In addition, the

[64] For example, the agencies' market forecast shows MY 2016 sales of 187,000 units for Toyota's 2WD Sienna, and shows 27 model configurations with MY 2016 sales of fewer than 100 units. Similarly, the agencies' market forecast shows MY 2016 sales of 268,000 for the Toyota Prius, and shows 29 model configurations with MY 2016 sales of fewer than 100 units. Sales-weighted analysis would give the Toyota Sienna and Prius more than a thousand times the consideration of many vehicle model configurations. Sales-weighted analysis would, therefore, cause a large number of vehicle model configurations to be virtually ignored. *See* discussion in NHTSA's final rule for MY 2011 passenger car and light truck CAFE standards, 74 FR 14368 (Mar. 30, 2009), and in NHTSA's NPRM for that rulemaking, 73 FR 24423–24429 (May 2, 2008).

[65] *Id.* In the case of a dataset not drawn from a sample with a Gaussian, or normal, distribution, there is often a need to employ robust estimation methods rather than rely on least-squares approach to curve fitting. The least-squares approach has as an underlying assumption that the data are drawn

agencies remain concerned that the steeper curves resulting from weighted least-squares analysis would increase the risk that energy savings and environmental benefits would be lower than projected, because the steeper curves would provide a greater incentive to increase sales of larger vehicles with lower fuel economy levels. Based on these technical considerations and these concerns regarding potential outcomes, the agencies have decided not to re-fit curves using weighted least-squares analysis, but note that they may reconsider using least-squares regression in future analysis.

NHTSA and EPA have considered GM's comment that steeper curves would provide a greater incentive for limited-line manufacturers to apply technology to smaller vehicles. While the agencies agree that a steeper curve would, absent any changes in fleet mix, tend to shift average compliance burdens away from GM and toward companies that make smaller vehicles, the agencies are concerned, as stated above, that steeper curves would increase the risk that induced increases in vehicle size could erode projected energy and environmental benefits.

NHTSA and EPA have also considered the comments by the students from UC Santa Barbara indicating that the passenger car and light truck curves should be flatter and should converge over time. The agencies conclude that flatter curves would reduce the incentives intended in shifting from "flat" CAFE standards to attribute-based CAFE and GHG standards—those being the incentive to respond to attribute-based standards in ways that minimize compromises in vehicle safety, and the incentive for more manufacturers (than primarily those selling a wider range of vehicles) across the range of the attribute to have to increase the application of fuel-saving technologies. With regard to whether the agencies should set separate curves or a single one, NHTSA also notes that EPCA requires NHTSA to establish standards separately for passenger cars and light trucks, and thus concludes that the standards for each fleet should be based on the characteristics of vehicles in each fleet. In other words, the passenger car curve should be based on the characteristics of passenger cars, and the light truck curve should be based on the characteristics of light trucks—thus to the extent that those characteristics are different, an artificially-forced convergence would not accurately reflect those differences. However, such convergence could be appropriate depending on future trends in the light vehicle market, specifically further reduction in the differences between passenger car and light truck characteristics. While that trend was more apparent when car-like 2WD SUVs were classified as light trucks, it seems likely to diminish for the model year vehicles subject to these rules as the truck fleet will be more purely "truck-like" than has been the case in recent years.

NHTSA and EPA have also considered comments on the maxima and minima that the agencies have applied to "cut off" the linear function underlying the proposed curves for passenger cars and light trucks. Contrary to NADA's suggestion that there should be no such cut-off points, the agencies conclude that curves lacking maximum fuel economy targets (*i.e.,* minimum CO_2 targets) would result in average fuel economy and GHG requirements that would not be technologically feasible or economically practicable for manufacturers concentrating on those market segments. In addition, minimum fuel economy targets (*i.e.,* maximum CO_2 targets) are important to mitigate the risk to energy and environmental benefits of potential market shifts toward large vehicles. The agencies also disagree with comments by the Alliance and several individual manufacturers that the cut-off point for light trucks should be shifted to 72 square feet (from the proposed 66 square feet) to ease compliance burdens facing manufacturers serving the large pickup market. Such a shift would increase the risk that energy and environmental benefits of the standards would be compromised by induced increases in the sales of large pickups, in situations where the increased compliance burden is feasible and appropriate. Also, the agencies' market forecast suggests that most of the light trucks models with footprints larger than 66 square feet have curb weights near or above 5,000 pounds. This suggests, in turn, that in terms of highway safety, there is little or no need to discourage downsizing of light trucks with footprints larger than 66 square feet. Based on these energy, environmental, technological feasibility, economic practicability, and safety considerations, the agencies conclude that the light truck curve should be cut off at 66 square feet, as proposed, rather than at 72 square feet. The agencies also disagree with Honda's suggestion that the cut-off point for the smallest trucks be shifted to a larger footprint value, because doing so could potentially increase the incentive to reclassify vehicles in that size range as light trucks, and could thereby increase the possibility that energy and environmental benefits of the rule would be less than projected.

Finally, considering comments by the UC Santa Barbara students regarding difficulties reproducing NHTSA's analysis, NHTSA reexamined its analysis, and discovered some erroneous entries in model inputs underlying the analysis used to develop the curves proposed in the NPRM. These errors are discussed in NHTSA's final Regulatory Impact Analysis (FRIA) and have since been corrected. They include the following: Incorrect valvetrain phasing and lift inputs for many BMW engines, incorrect indexing for some Daimler models, incorrectly enabled valvetrain technologies for rotary engines and Atkinson cycle engines, omitted baseline applications of cylinder deactivation in some Honda and GM engines, incorrect valve phasing codes for some 4-cylinder Chrysler engines, omitted baseline applications of advanced transmissions in some VW models, incorrectly enabled advanced electrification technologies for several hybrid vehicle models, and incorrect DCT effectiveness estimates for subcompact passenger cars. These errors, while not significant enough to impact the overall analysis of stringency, did affect the fitted slope for the passenger car curve and would have prevented precise replication of NHTSA's NPRM analysis by outside parties.

After correcting these errors and repeating the curve development analysis presented in the NPRM, NHTSA obtained the curves shown below in Figures II.C–5 and II.C–6 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.

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from a normal distribution, and hence fits a curve using a sum-of-squares method to minimize errors. This approach will, in a sample drawn from a non-normal distribution, give excessive weight to outliers by making their presence felt in proportion to the square of their distance from the fitted curve, and, hence, distort the resulting fit. With outliers in the sample, the typical solution is to use a robust method such as a minimum absolute deviation, rather than a squared term, to estimate the fit (*see, e.g.,* "AI Access: Your Access to Data Modeling," at *http://www.aiaccess.net/English/Glossaries/GlosMod/e_gm_O_Pa.htm#Outlier*). The effect on the estimation is to let the presence of each observation be felt more uniformly, resulting in a curve more representative of the data (*see, e.g.,* Peter Kennedy, *A Guide to Econometrics,* 3rd edition, 1992, MIT Press, Cambridge, MA).

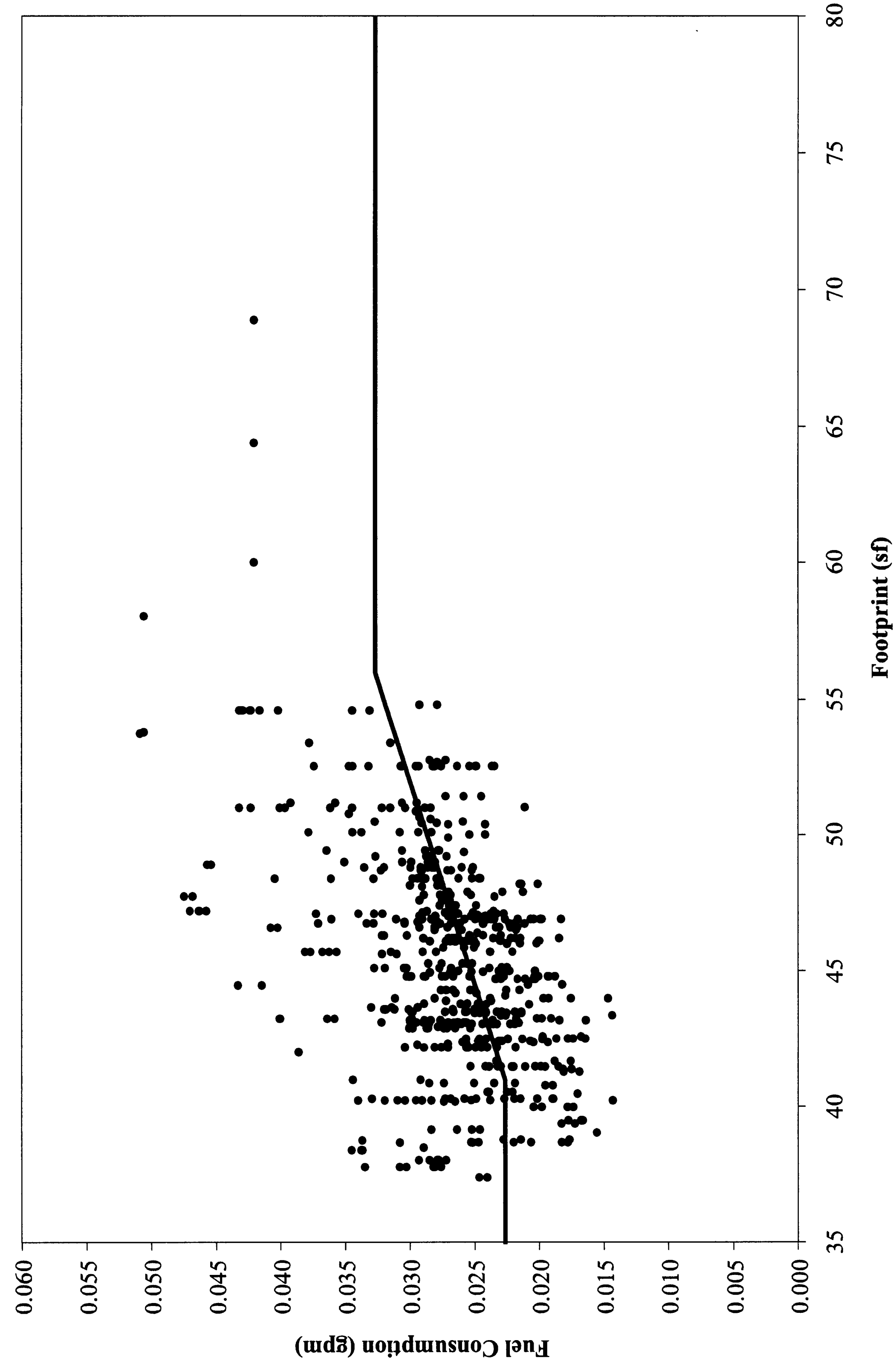

Figure II.C-5 Revised "Maximum Technology" Passenger Fleet with Fitted Constrained Linear Function

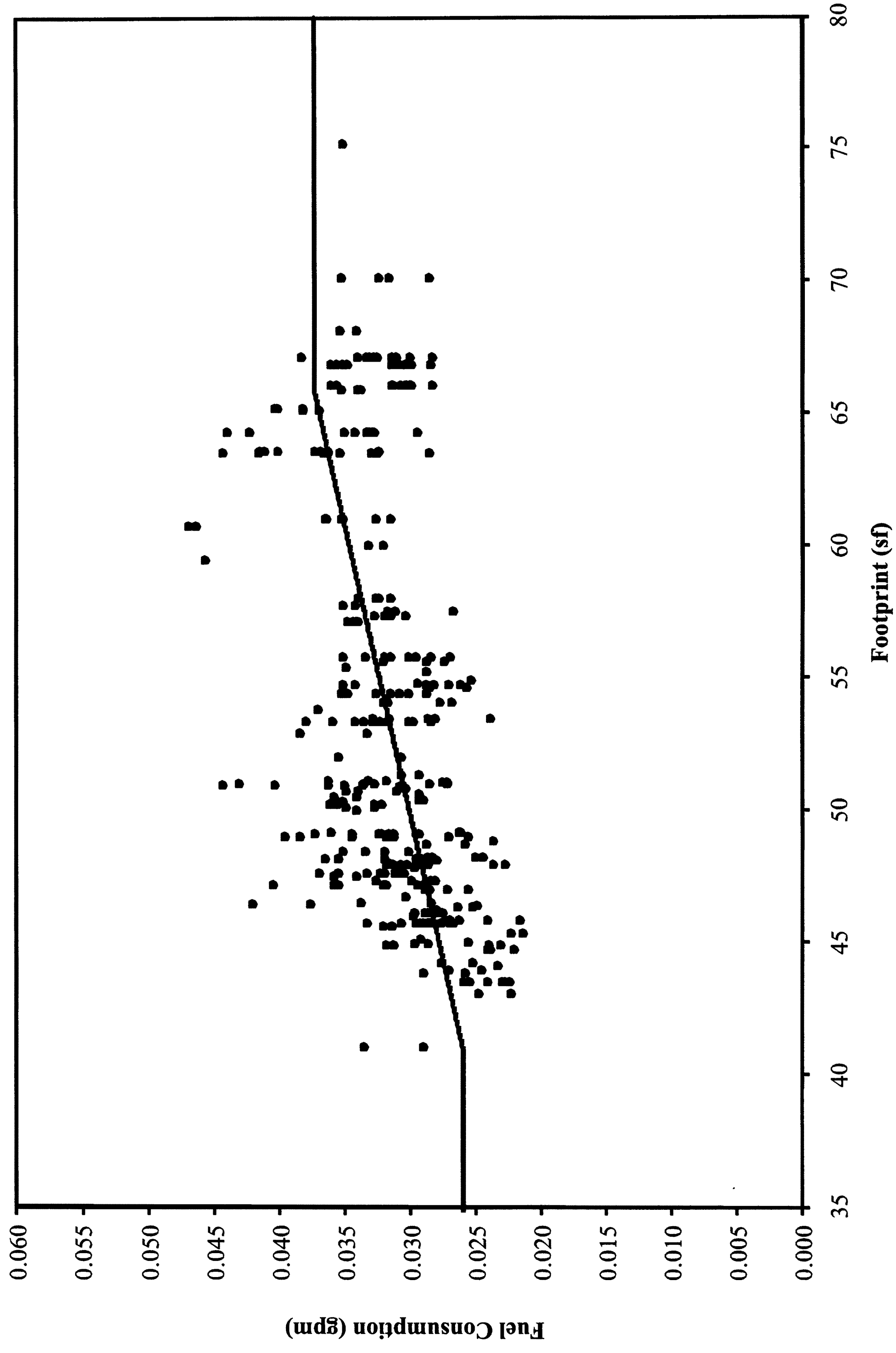

Figure II.C-6 Revised "Maximum Technology" Light Truck with Fitted Constrained Linear Function

This refitted passenger car curve is similar to that presented in the NPRM, and the refitted light truck curve is nearly identical to the corresponding curve in the NPRM. However, the slope of the refitted passenger car curve is about 27 percent steeper (on a gpm per sf basis) than the curve presented in the NPRM. For passenger cars and light trucks, respectively, Figures II.C–7 and II.C–8 show the results of adjustment—discussed in the next section—of the above curves to yield the average required fuel economy levels corresponding to the final standards.

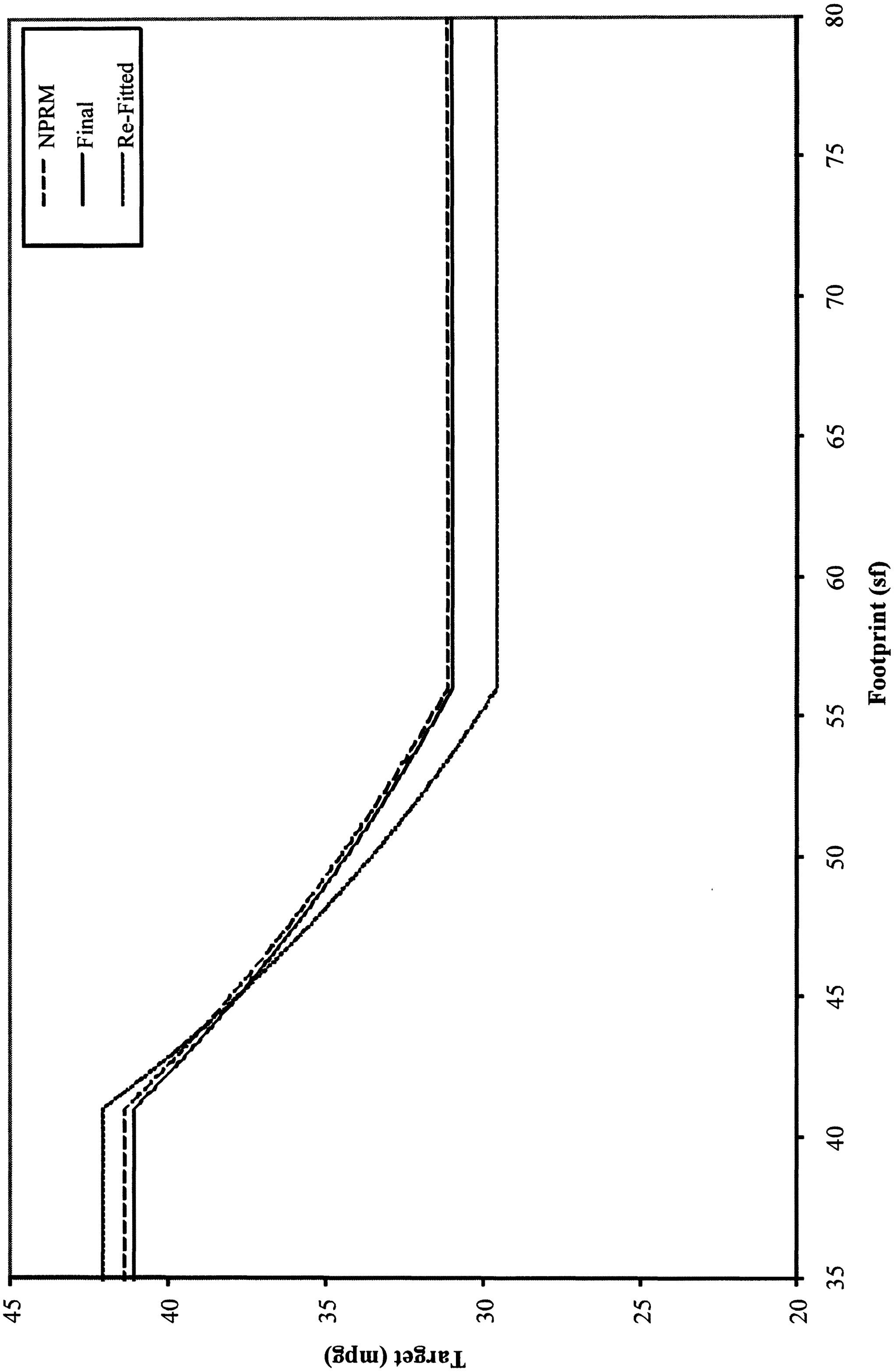

Figure II.C-7 MY 2016 Passenger Car Targets: NPRM, Final Rule, and if Using Re-Fitted Curve

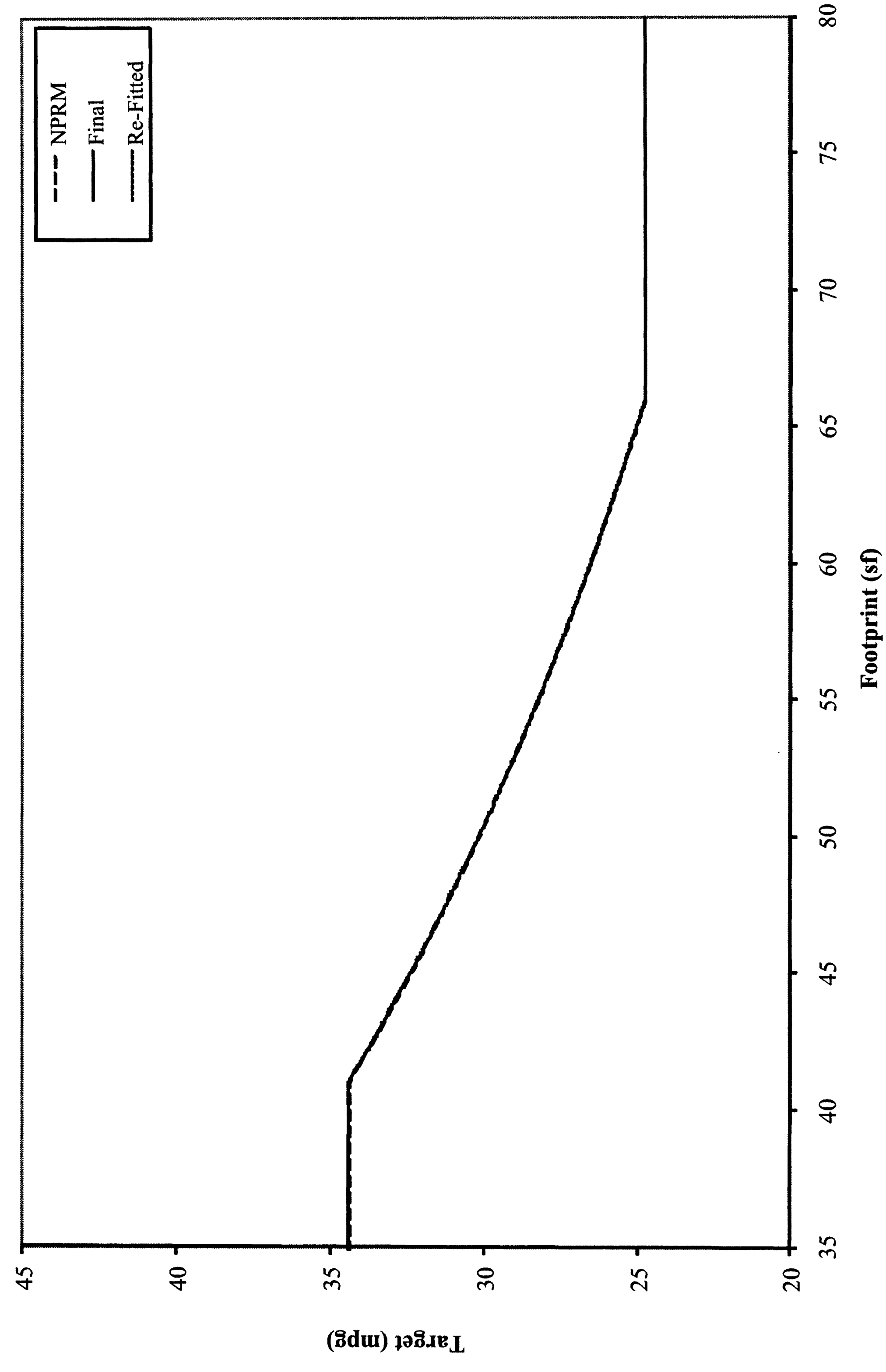

Figure II.C-8 MY 2016 Light Truck Targets: NPRM, Final Rule, and if Using Re-Fitted Curve

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While the resultant light truck curves are visually indistinguishable from one another, the refitted curve for passenger cars would increase stringency for the smallest cars, decrease stringency for the largest cars, and provide a greater incentive to increase vehicle size throughout the range of footprints within which NHTSA and EPA project most passenger car models will be sold through MY 2016. The agencies are concerned that these changes would make it unduly difficult for manufacturers to introduce new small passenger cars in the United States, and unduly risk losses in energy and environmental benefits by increasing incentives for the passenger car market to shift toward larger vehicles.

Also, the agencies note that the refitted passenger car curve produces only a slightly closer fit to the corrected fleet than would the curve estimated in the NPRM; with respect to the corrected fleet (between the "cut off" footprint values, and after the "maximum technology" analysis discussed above), the mean absolute deviation for the refitted curve is 13.887 percent, and that of a refitted curve held to the original slope is 13.933 percent. In other words, the data support the original slope very nearly as well as they support the refitted slope.

Considering NHTSA's and EPA's concerns regarding the change in incentives that would result from a refitted curve for passenger cars, and considering that the data support the original curves about as well as they would support refitted curves, the agencies are finalizing CAFE and GHG standards based on the curves presented in the NPRM.

Finally, regarding some commenters' inability to reproduce the agencies' NPRM analysis, NHTSA believes that its correction of the errors discussed above and its release (on NHTSA's Web site) of the updated Volpe model and all accompanying inputs and external analysis files should enable outside parties to independently reproduce the agencies' analysis. If outside parties continue to experience difficulty in doing so, we encourage them to contact NHTSA, and the agency will do its best to provide assistance.

Thus, in summary, the agencies' approach to developing the attribute-based mathematical functions for MY 2012–2016 CAFE and CO_2 standards represents the agencies' best technical judgment and consideration of potential outcomes at this time, and we are confident that the conclusions have resulted in appropriate and reasonable standards. The agencies recognize, however, that aspects of these decisions may merit updating or revision in future analysis to support CAFE and CO_2 standards or for other purposes. Consistent with best rulemaking practices, the agencies will take a fresh look at all assumptions and approaches to curve fitting, appropriate attributes, and mathematical functions in the context of future rulemakings.

The agencies also recognized in the NPRM the possibility that lower fuel prices could lead to lower fleetwide fuel economy (and higher CO_2 emissions) than projected in this rule. One way of addressing that concern is through the use of a universal standard—that is, an average standard set at a (single) absolute level. This is often described as a "backstop standard." The agencies explained that under the CAFE program, EISA requires such a minimum average fuel economy standard for domestic passenger cars, but is silent with regard to similar backstops for imported passenger cars and light trucks, while under the CAA, a backstop could be adopted under section 202(a) assuming it could be justified under the relevant statutory criteria. NHTSA and EPA also noted that the flattened portions of the curves at the largest footprints directionally address the issue of a backstop (*i.e.,* the mpg "floor" or gpm "ceiling" applied to the curves provides a universal and absolute value for that range of footprints). The agencies sought 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.

The agencies received a number of comments regarding the need for a backstop beyond NHTSA's alternative minimum standard. Comments were divided fairly evenly between support for and opposition to additional backstop standards. The following organizations supported the need for EPA and NHTSA to have explicit backstop standards: American Council for an Energy Efficient Economy (ACEEE), American Lung Association, California Air Resources Board (CARB), Environment America, Environment Defense Fund, Massachusetts Department of Environmental Protection, Natural Resources Defense Council (NRDC), Northeast States for Coordinated Air Use Management (NESCAUM), Public Citizen and Safe Climate Campaign, Sierra Club, State of Washington Department of Ecology, Union of Concerned Scientists, and a number of private citizens. Commenters in favor of additional backstop standards for all fleets for both NHTSA and EPA [66] generally stated that the emissions reductions and fuel savings expected to be achieved by MY 2016 depended on assumptions about fleet mix that might not come to pass, and that various kinds of backstop standards or "ratchet mechanisms" [67] were necessary to ensure that those reductions were achieved in fact. In addition, some commenters [68] stated that manufacturers might build larger vehicles or more trucks during MYs 2012–2016 than the agencies project, for example, because (1) any amount of slope in target curves encourages manufacturers to upsize, and (2) lower targets for light trucks than for passenger cars encourage manufacturers to find ways to reclassify vehicles as light trucks, such as by dropping 2WD versions of SUVs and offering only 4WD versions, perhaps spurred by NHTSA's reclassification of 2WD SUVs as passenger cars. Both of these mechanisms will be addressed further below. Some commenters also discussed EPA authority under the CAA to set backstops,[69] agreeing with EPA's analysis that section 202(a) allows such standards since EPA has wide discretion under that section to craft standards.

The following organizations opposed a backstop: Alliance of Automobile Manufacturers (AAM), Association of International Automobile Manufacturers (AIAM), Ford Motor Company, National Automobile Dealers Association (NADA), Toyota Motor Company, and the United Auto Workers Union. Commenters stating that additional backstops would not be necessary disagreed that upsizing was likely,[70] and emphasized the anti-backsliding characteristics of the target curves. Others argued that universal absolute standards as backstops could restrict consumer choice of vehicles. Commenters making legal arguments under EPCA/EISA[71] stated that Congress' silence regarding backstops for imported passenger cars and light trucks should be construed as a lack of authority for NHTSA to create further backstops. Commenters making legal arguments under the CAA[72] focused on the lack of clear authority under the CAA to create multiple GHG emissions standards for the same fleets of vehicles based on the same statutory criteria, and opposed EPA taking steps that would reduce harmonization with NHTSA in standard setting. Furthermore, AIAM indicated that EISA's requirement that the combined (car and truck) fuel economy level reach at least 35 mpg by

[66] ACEEE, American Lung Association, CARB, Christopher Lish, Environment America, EDF, MA DEP, NRDC, NESCAUM, Public Citizen, Sierra Club *et al.,* SCAQMD, UCS, WA DE.

[67] Commenters generally defined a "ratchet mechanism" as an automatic re-calculation of stringency to ensure cumulative goals are reached by 2016, even if emissions reductions and fuel savings fall short in the earlier years covered by the rulemaking.

[68] CBD, MA DEP, NJ DEP, Public Citizen, Sierra Club *et al.,* UCS.

[69] CARB, Public Citizen, Sierra Club *et al.*

[70] For example, the Alliance and Toyota said that upsizing would not be likely because (1) it would not necessarily make compliance with applicable standards easier, since larger vehicles tend to be heavier and heavier vehicles tend to achieve worse fuel economy/emissions levels; (2) it may require expensive platform changes; (3) target curves become increasingly more stringent from year to year, which reduces the benefits of upsizing; and (4) the mpg floor and gpm ceiling for the largest vehicles (the point at which the curve is "cut off") discourages manufacturers from continuing to upsize beyond a point because doing so makes it increasingly difficult to meet the flat standard at that part of the curve.

[71] AIAM, Alliance, Ford, NADA, Toyota.

[72] Alliance, Ford, NADA, UAW.

2020 itself constitutes a backstop.[73] One individual [74] commented that while additional backstop standards might be necessary given optimism of fleet mix assumptions, both agencies' authorities would probably need to be revised by Congress to clarify that backstop standards (whether for individual fleets or for the national fleet as a whole) were permissible.

In response, EPA and NHTSA remain confident that their projections of the future fleet mix are reliable, and that future changes in the fleet mix of footprints and sales are not likely to lead to more than modest changes in projected emissions reductions or fuel savings.[75] Both agencies thus remain confident in these fleet projections and the resulting emissions reductions and fuel savings from the standards. As explained in Section II.B above, the agencies' projections of the future fleet are based on the most transparent information currently available to the agencies. In addition, there are only a relatively few model years at issue. Moreover, market trends today are consistent with the agencies' estimates, showing shifts from light trucks to passenger cars and increased emphasis on fuel economy from all vehicles.

Finally, the shapes of the curves, including the "flattening" at the largest footprint values, tend to avoid or minimize regulatory incentives for manufacturers to upsize their fleet to change their compliance burden. Given the way the curves are fit to the data points (which represent vehicle models' fuel economy mapped against their footprint), the agencies believe that there is little real benefit to be gained by a manufacturer upsizing their vehicles. As discussed above, the agencies' analysis indicates that, for passenger car models with footprints falling between the two flattened portions of the corresponding curve, the actual slope of fuel economy with respect to footprint, if fit to that data by itself, is about 27 percent steeper than the curve the agencies are promulgating today. This difference suggests that manufacturers would, if anything, have more to gain by reducing vehicle footprint than by increasing vehicle footprint. For light trucks, the agencies' analysis indicates that, for models with footprints falling between the two flatted portions of the corresponding curve, the slope of fuel economy with respect to footprint is nearly identical to the curve the agencies are promulgating today. This suggests that, within this range, manufacturers would typically have little incentive to either incrementally increase or reduce vehicle footprint. The agencies recognize that based on economic and consumer demand factors that are external to this rule, the distribution of footprints in the future may be different (either smaller or larger) than what is projected in this rule. However, the agencies continue to believe that there will not be significant shifts in this distribution as a direct consequence of this rule.

At the same time, adding another backstop standard would have virtually no effect if the standard was weak, but a more stringent backstop could compromise the objectives served by attribute-based standards—that they distribute compliance burdens more equally among manufacturers, and at the same time encourage manufacturers to apply fuel-saving technologies rather than simply downsizing their vehicles, as they did in past decades under flat standards. This is why Congress mandated attribute-based CAFE standards in EISA. This compromise in objectives could occur for any manufacturer whose fleet average was above the backstop, irrespective of why they were above the backstop and irrespective of whether the industry as a whole was achieving the emissions and fuel economy benefits projected for the final standards, the problem the backstop is supposed to address. For example, the projected industry wide level of 250 gm/mile for MY 2016 is based on a mix of manufacturer levels, ranging from approximately 205 to 315 gram/mile [76] but resulting in an industry wide basis in a fleet average of 250 gm/mile. Unless the backstop was at a very weak level, above the high end of this range, then some percentage of manufacturers would be above the backstop even if the performance of the entire industry remains fully consistent with the emissions and fuel economy levels projected for the final standards. For these manufacturers and any other manufacturers who were above the backstop, the objectives of an attribute based standard would be compromised and unnecessary costs would be imposed. This could directionally impose increased costs for some manufacturers. It would be difficult if not impossible to establish the level of a backstop standard such that costs are likely to be imposed on manufacturers only when there is a failure to achieve the projected reductions across the industry as a whole. An example of this kind of industry wide situation could be when there is a significant shift to larger vehicles across the industry as a whole, or if there is a general market shift from cars to trucks. The problem the agencies are concerned about in those circumstances is not with respect to any single manufacturer, but rather is based on concerns over shifts across the fleet as a whole, as compared to shifts in one manufacturer's fleet that may be more than offset by shifts the other way in another manufacturer's fleet. However, in this respect, a traditional backstop acts as a manufacturer specific standard.

The concept of a ratchet mechanism recognizes this problem, and would impose the new more stringent standard only when the problem arises across the industry as a whole. While the new more stringent standards would enter into force automatically, any such standards would still need to provide adequate lead time for the manufacturers. Given the limited number of model years covered by this rulemaking and the short lead-time already before the 2012 model year, a ratchet mechanism in this rulemaking that would automatically tighten the standards at some point after model year 2012 is finished and apply the new more stringent standards for model

[73] NHTSA and EPA agree with AIAM that the EISA 35 mpg requirement in MY 2020 has a backstop-like function, in that it requires a certain level of achieved fleetwide fuel economy by a certain date, although it is not literally a backstop standard. Considering that NHTSA's MY 2011 CAFE standards increased projected average fuel economy requirements (relative to the MY 2010 standards) at a significantly faster rate than would be required to achieve the 35-in-2020 requirement, and considering that the standards being finalized today would increase projected average combined fuel economy requirements to 34.1 mpg in MY 2016, four years before MY 2020, the agencies believe that the U.S. vehicle market would have to shift in highly unexpected ways in order to put the 35-in-2020 requirement at risk, even despite the fact that due to the attribute-based standards, average fuel economy requirements will vary depending on the mix of vehicles produced for sale in the U.S. in each model year. The agencies further emphasize that both NHTSA and EPA plan to conduct and document retrospective analyses to evaluate how the market's evolution during the rulemaking timeframe compares with the agencies' forecasts employed for this rulemaking. Additionally, we emphasize that both agencies have the authority, given sufficient lead time, to revise their standards upwards if necessary to avoid missing the 35-in-2020 requirement.

[74] Schade.

[75] For reference, NHTSA's March 2009 final rule establishing MY 2011 CAFE standards was based on a forecast that passenger cars would represent 57.6 percent of the MY 2011 fleet, and that MY 2011 passenger cars and light trucks would average 45.6 square feet (sf) and 55.1 sf, respectively, such that average required CAFE levels would be 30.2 mpg, 24.1 mpg, and 27.3 mpg, respectively, for passenger cars, light trucks, and the overall light-duty fleet. Based on the agencies' current market forecast, even as soon as MY 2011, passenger cars will comprise a *larger* share (59.2 percent) of the light vehicle market; passenger cars and light trucks will, on average, be smaller by 0.5 sf and 1.3 sf, respectively; and average required CAFE levels will be higher by 0.2 mpg, 0.3 mpg, and 0.3 mpg, respectively, for passenger cars, light trucks, and the overall light-duty fleet.

[76] Based on estimated standards presented in Tables III.B.1–1 and III.B.1–2.

years 2016 or earlier, would fail to provide adequate lead time for any new, more stringent standards

Additionally, we do not believe that the risk of vehicle upsizing or changing vehicle offerings to "game" the passenger car and light truck definitions is as great as commenters imply for the model years in question.[77] The changes that commenters suggest manufacturers might make are neither so simple nor so likely to be accepted by consumers. For example, 4WD versions of vehicles tend to be more expensive and, other things being equal, have inherently lower fuel economy than their 2WD equivalent models. Therefore, although there is a market for 4WD vehicles, and some consumers might shift from 2WD vehicles to 4WD vehicles if 4WD becomes available at little or no extra cost, many consumers still may not desire to purchase 4WD vehicles because of concerns about cost premium and additional maintenance requirements; conversely, many manufacturers often require the 2WD option to satisfy demand for base vehicle models. Additionally, increasing the footprint of vehicles requires platform changes, which usually requires a product redesign phase (the agencies estimate that this occurs on average once every 5 years for most models). Alternatively, turning many 2WD SUVs into 2WD light trucks would require manufacturers to squeeze a third row of seats in or significantly increase their GVWR, which also requires a significant change in the vehicle.[78] The agencies are confident that the anticipated increases in average fuel economy and reductions in average CO_2 emission rates can be achieved without backstops under EISA or the CAA. As noted above, the agencies plan to conduct retrospective analysis to monitor progress. Both agencies have the authority to revise standards if warranted, as long as sufficient lead time is provided.

The agencies acknowledge that the MY 2016 fleet emissions and fuel economy goals of 250 g/mi and 34.1 mpg for EPA and NHTSA respectively are estimates and not standards (the MY 2012–2016 curves are the standards). Changes in fuel prices, consumer preferences, and/or vehicle survival and mileage accumulation rates could result in either smaller or larger oil and GHG savings. As explained above and elsewhere in the rule, the agencies believe that the possibility of not meeting (or, alternatively, exceeding) fuel economy and emissions goals exists, but is not likely. Given this, and given the potential complexities in designing an appropriate backstop, the agencies believe the balance here points to not adopting additional backstops at this time for the MYs 2012–2016 standards other than NHTSA's finalizing of the ones required by EPCA/EISA for domestic passenger cars. Nevertheless, the agencies recognize there are many factors that are inherently uncertain which can affect projections in the future, including fuel price and other factors which are unrelated to the standards contained in this final rule. Such factors can affect consumer preferences and are difficult to predict. At this time and based on the available information, the agencies have not included a backstop for model years 2012–2016. However, if circumstances change in the future in unanticipated ways, the agencies may revisit the issue of a backstop in the context of a future rulemaking either for model years 2012–2016 or as needed for standards for model years beyond 2016. This issue will be discussed further in Sections III and IV.

D. Relative Car-Truck Stringency

The agencies proposed fleetwide standards with the projected levels of stringency of 34.1 mpg or 250 g/mi in MY 2016 (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 for those model years, the agencies were 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.[79] 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 for the proposal, the agencies explored a number of possible alternatives, and for the reasons described in the proposal used the Volpe model in order to estimate stringencies at which net benefits would be maximized. The agencies have followed the same approach in calculating the relative car-truck stringency for the final standards promulgated today. Further details of the development of this approach can be found in Section IV of this preamble as well as in NHTSA's RIA and EIS. 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 remained 31 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.B.1–1. 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 final rule.

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[77] We note that NHTSA's recent clarification of the light truck definitions has significantly reduced the potential for gaming, and resulted in the reclassification of over a million vehicles from the light truck to the passenger car fleet.

[78] Increasing the GVWR of a light truck (assuming this was the only goal) can be accomplished in a number of ways, and must include consideration of: (1) Redesign of wheel axles; (2) improving the vehicle suspension; (3) changes in tire specification (which will likely affect ride quality); (4) vehicle dynamics development (especially with vehicles equipped with electronic stability control); and (5) brake redesign. Depending on the vehicle, some of these changes may be easier or more difficult than others.

[79] 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.

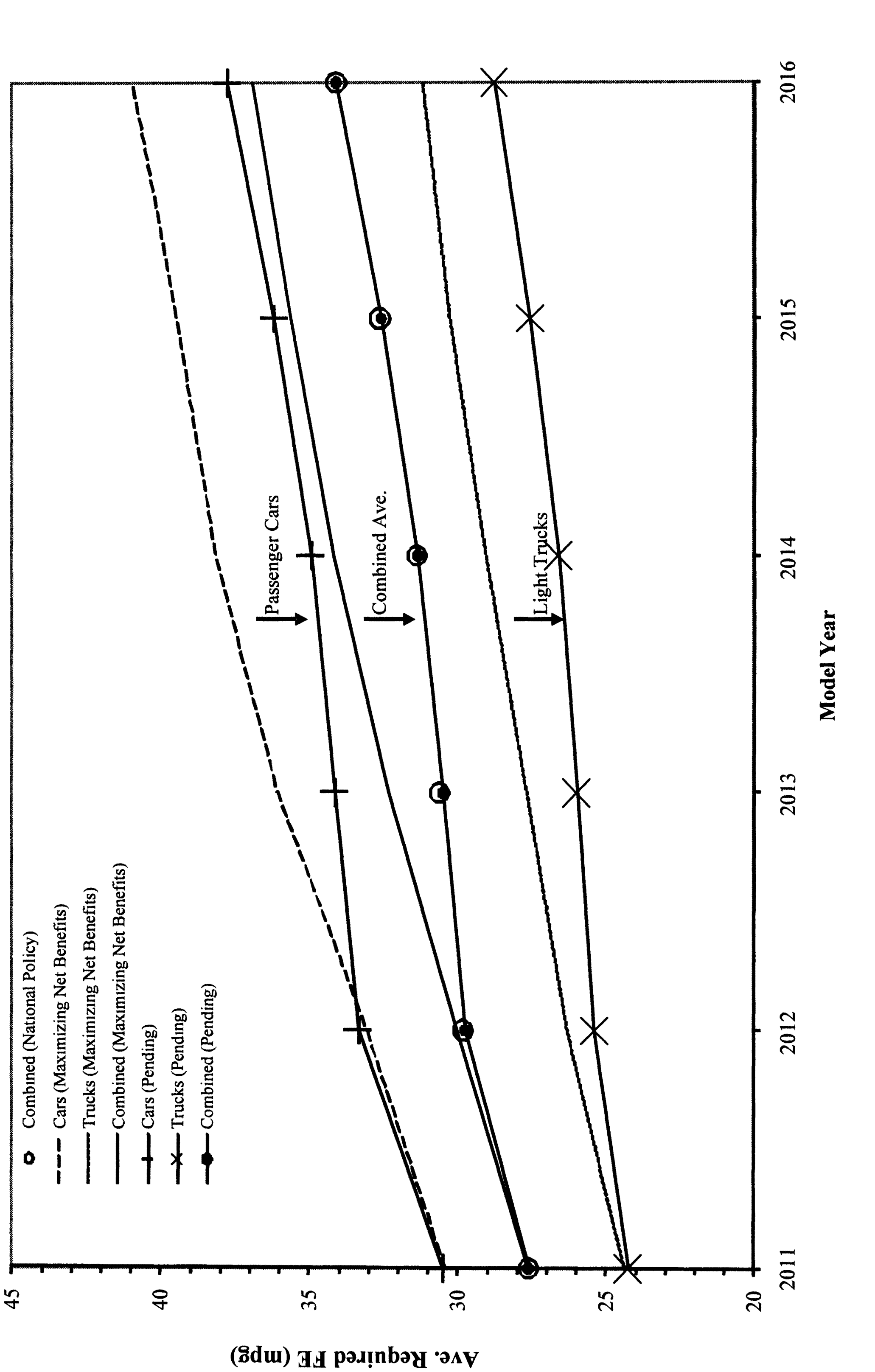

Figure II.D-1 Shifting the Standards from the Maximizing Net Benefit Levels to the Levels Consistent with the Combined Fuel Economy Standards in this Rule

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The final car and truck standards for EPA (Table I.B.1–4 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.

[80] We assume slightly higher A/C penetration in 2012 than was assumed in the proposal only to

Continued

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

	Average technology penetration (%)	Average credit for cars	Average credit for trucks	Average credit for combined fleet
2012	[80] 28	3.4	3.8	3.5
2013	40	4.8	5.4	5.0
2014	60	7.2	8.1	7.5
2015	80	9.6	10.8	10.0
2016	85	10.2	11.5	10.6

The agencies sought comment on the use of this methodology for apportioning the fleet stringencies to relative car and truck standards for 2012–2016. General Motors commented that, compared to the passenger car standard, the light truck standard is too stringent because "the most fuel efficient cars and small trucks already meet the 2016 MY requirements" but "the most fuel efficient large trucks must increase fuel economy by 20 percent to meet the 2016 MY requirements." GM recommended that the agencies relax stringency specifically for large pickups, such as the Silverado.

The agencies disagree with the premise of the comment that the standard is too stringent under the applicable statutory provisions because some existing large trucks are not already meeting a later model year standard. Our analysis shows that the standards are not too stringent for manufacturers selling these vehicles. The agencies' analyses demonstrate a means by which manufacturers could apply cost-effective technologies in order to achieve the standards, and we have provided adequate lead time for the technology to be applied. More important, the agencies' analysis demonstrate that the fleetwide emission standards for MY 2016 are technically feasible, for example by implementing technologies such as engine downsizing, turbocharging, direct injection, improving accessories and tire rolling resistance, etc.

GM did not comment on the use of the methodology applied by the agencies to develop the gap between the passenger car and light truck standards—only on the outcome of the methodology. For the reasons discussed below, the agencies maintain that the methodology applied above provides an appropriate basis to determine the gap between the passenger car and light truck standards, and disagree with GM's arguments that the outcome is unfair.

First, GM's argument incorrectly suggests that every individual vehicle model must achieve its fuel economy and emissions targets. CAFE standards and new GHG emissions standards apply to fleetwide average performance, not model-specific performance, even though average required levels are based on average model-specific targets, and the agencies' analysis demonstrates that GM and other manufacturers of large trucks can cost-effectively comply with the new standards.

Second, GM implies that every manufacturer must be challenged equally with respect to fuel economy and emissions. Although NHTSA and EPA maintain that attribute-based CAFE and GHG emissions standards can more evenly balance compliance challenges, attribute-based standards are not intended to and cannot make these challenges equal, and while the agencies are mindful of the potential impacts of the standards on the relative competitiveness of different vehicle manufacturers, there is nothing in EPCA or the CAA [81] requiring that these challenges be equal.

We have also already addressed and rejected GM's suggestion of shifting the "cut off" point for light trucks from 66 square feet to 72 square feet, thereby "dropping the floor" of the target function for light trucks. As discussed in the preceding section, this is so as not to forego the rules' energy and environmental benefits, and because there is little or no safety basis to discourage downsizing of the largest light trucks.

Finally, NHTSA and EPA disagree with GM's claim that the outcome of the agencies' approach is unfairly burdensome for light trucks as compared to passenger cars. Based on the agencies' market forecast, NHTSA's analysis indicates that incremental technology outlays could, on average, be comparable for passenger cars and light trucks under the final CAFE standards, and further indicates that the ratio of total benefits to total costs could be greater under the final light truck standards than under the final passenger car standards.

E. Joint Vehicle Technology Assumptions

Vehicle technology assumptions, *i.e.,* assumptions about technologies' cost, effectiveness, and the rate at which they can be incorporated into new vehicles, are often controversial as they have a significant impact on the levels of the standards. The agencies must, therefore, take great care in developing and justifying these estimates. In developing technology inputs for the analysis of the MY 2012–2016 standards, the agencies reviewed the technology assumptions that NHTSA used in setting the MY 2011 standards, the comments that NHTSA received in response to its May 2008 Notice of Proposed Rulemaking (NPRM), and the comments received in response to the NPRM for this rule. 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

correct for rounding that occurred in the curve setting process.

[81] As NHTSA explained in the NPRM, 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." *CEI–I,* 793 F.2d 1322, 1352 (D.C. Cir. 1986). 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. Similarly, EPA is afforded great discretion under section 202(a) of the CAA to balance issues of technical feasibility, cost, adequacy of lead time, and safety, and certainly is not required to do so in a manner that imposes regulatory obligations uniformly on each manufacturer. *See NRDC* v. *EPA,* 655 F. 2d 318, 322, 328 (D.C. Cir. 1981) (wide discretion afforded by the statutory factors, and EPA predictions of technical feasibility afforded considerable discretion subject to constraints of reasonableness EPA predictions of technical feasibility afforded considerable discretion subject to constraints of reasonableness); and cf. *International Harvester Co.* v. *Ruckelshaus,* 479 F. 2d 615, 640 (D.C. Cir. 1973) ("as long as feasible technology permits the demand for new passenger automobiles to be generally met, the basic requirements of the Act would be satisfied, even though this might occasion fewer models and a more limited choice of engine types").

estimates identified in EPA's July 2008 Advance Notice of Proposed Rulemaking. The review of these documents was supplemented with updated information from more current literature, new product plans from manufacturers, and from EPA certification testing.

As a general matter, EPA and NHTSA believe that the best way to derive technology cost estimates is to conduct real-world tear down studies. Most of the commenters on this issue agreed. The advantages not only lie in the rigor of the approach, but also in its transparency. 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 and the processes required to integrate them. As such, tear down studies require a significant amount of time and are very costly. EPA has been conducting tear down studies to assess the costs of vehicle technologies under a contract with FEV. Further details for this methodology is described below and in the TSD.

Due to the complexity and time incurred in a tear down study, only a few technologies evaluated in this rulemaking have been costed in this manner thus far. The agencies prioritized the technologies to be costed first based on how prevalent the agencies believed they might be likely to be during the rulemaking time frame, and based on their anticipated cost-effectiveness. The agencies believe that the focus on these important technologies (listed below) is sufficient for the analysis in this rule, but EPA is continuing to analyze more technologies beyond this rule as part of studies both already underway and in the future. For most of 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 in the Technical Support Document.

Similarly, the agencies followed a BOM approach for developing the technology 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 has been conducting a study for NHTSA to update Chapter 3 of their 2002 NAS Report, which presents technology effectiveness estimates for light-duty vehicles. The update takes a fresh look at that list of technologies and their associated cost and effectiveness values. The updated NAS report was expected to be available on September 30, 2009, but has not been completed and released to the public. The results from this study thus are unavailable for this rulemaking. The agencies look forward to considering the results from this study as part of the next round of rulemaking for CAFE/GHG standards.

1. What technologies did 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 lead time available for this rule is not sufficient to move most of these 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 FRIA, and Chapter 1 of EPA's final RIA. Technologies to reduce CO_2 and HFC emissions from air conditioning systems are discussed in Section III of this preamble and in EPA's final RIA.

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 final rule have been revised from the NHTSA MY 2011 CAFE final rule. Additionally, the diesel technology option has been made available to small cars in the Volpe and OMEGA models. Though this is not expected to make a significant difference in the modeling results, the agencies agreed with the commenters that supported such a revision.

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 to enable the engine to operate in a more efficient operating range over a broader range of vehicle 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 and an infinite number of transmission ratios that enable the engine to operate in a more efficient operating range over a broader range of vehicle operating conditions.

• *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, thereby 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 the final standards.

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. The latter is covered explicitly within the A/C credit program.

• *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 discussed later in this preamble and 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 higher 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 than other hybrids. 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.

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

As mentioned above, EPA and NHTSA believe that the best way to derive technology cost estimates is to conduct real-world tear down studies. To date, the costs of the following five technologies have been evaluated with respect to their baseline (or replaced) technologies. For these technologies noted below, the agencies relied on the tear down data available and scaling methodologies used in EPA's ongoing study with FEV. Only the cost estimate for the first technology on the list below was used in the NPRM. The others were completed subsequent to the publication of the NPRM.

1. Stoichiometric gasoline direct injection and turbo charging with engine downsizing (T–DS) for a large DOHC 4 cylinder engine to a small DOHC (dual overhead cam) 4 cylinder engine.

2. Stoichiometric gasoline direct injection and turbo charging with engine downsizing for a SOHC single overhead cam) 3 valve/cylinder V8 engine to a SOHC V6 engine.

3. Stoichiometric gasoline direct injection and turbo charging with engine downsizing for a DOHC V6 engine to a DOHC 4 cylinder engine.

4. 6-speed automatic transmission replacing a 5-speed automatic transmission.

5. 6-speed wet dual clutch transmission (DCT) replacing a 6-speed automatic transmission.

This costing methodology has been published and gone through a peer review.[82] Using this tear down costing methodology, FEV has developed costs for each of the above technologies. In addition, FEV and EPA extrapolated the engine downsizing costs for the following scenarios that were outside of the noted study cases:[83]

1. Downsizing a SOHC 2 valve/cylinder V8 engine to a DOHC V6.

2. Downsizing a DOHC V8 to a DOHC V6.

3. Downsizing a SOHC V6 engine to a DOHC 4 cylinder engine.

4. Downsizing a DOHC 4 cylinder engine to a DOHC 3 cylinder engine.

The agencies relied on the findings of FEV in part for estimating the cost of these technologies in this rulemaking. However, for some of the technologies, NHTSA and EPA modified FEV's estimated costs. FEV made the assumption that these technologies would be mature when produced in large volumes (450,000 units or more). The agencies believe that there is some uncertainty regarding each manufacturer's near-term ability to employ the technology at the volumes assumed in the FEV analysis. There is also the potential for near term (earlier than 2016) supplier-level Engineering, Design and Testing (ED&T) costs to be in excess of those considered in the FEV analysis as existing equipment and facilities are converted to production of new technologies. The agencies have therefore decided to average the FEV results with the NPRM values in an effort to account for these near-term factors. This methodology was done for the following technologies:

1. Converting a port-fuel injected (PFI) DOHC I4 to a turbocharged-downsized-stoichiometric GDI DOHC I3.

2. Converting a PFI DOHC V6 engine to a T–DS-stoichiometric GDI DOHC I4.

3. Converting a PFI SOHC V6 engine to a T–DS-stoichiometric GDI DOHC I4.

4. Converting a PFI DOHC V8 engine to a T–DS-stoichiometric GDI DOHC V6.

5. Converting a PFI SOHC 3V V8 engine to a T–DS-stoichiometric GDI DOHC V6.

6. Converting a PFI SOHC 2V V8 engine to a T–DS-stoichiometric GDI DOHC V6.

7. Replacing a 4-speed automatic transmission with a 6-speed automatic transmission.

8. Replacing a 5-speed automatic transmission with a 6-speed automatic transmission.

9. Replacing a 6-speed automatic transmission with a 6-speed wet dual clutch transmission.

For the I4 to Turbo GDI I4 study applied in the NPRM, the agencies requested from FEV an adjusted cost estimate which accounted for these uncertainties as an adjustment to the base technology burden rate.[84] These new costs are used in the final rules. These details are also further described in the memo to the docket.[85] 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

[82] EPA–420–R–09–020; EPA docket number EPA–HQ–OAR–2009–0472–11282 and 11285.

[83] "Binning of FEV Costs to GDI, Turbo-charging, and Engine Downsizing," memorandum to Docket EPA–HQ–OAR–2009–0472, from Michael Olechiw, U.S. EPA, dated March 25, 2010.

[84] Burden costs include the following fixed and variable costs: Rented and leased equipment; manufacturing equipment depreciation; plant office equipment depreciation; utilities expense; insurance (fire and general); municipal taxes; plant floor space (equipment and plant offices); maintenance of manufacturing equipment—non-labor; maintenance of manufacturing building—general, internal and external, parts, and labor; operating supplies; perishable and supplier-owned tooling; all other plant wages (excluding direct, indirect and MRO labor); returnable dunnage maintenance; and intra-company shipping costs (*see* EPA–HQ–OAR–2009–0472–0149).

[85] "Binning of FEV Costs to GDI, Turbo-charging, and Engine Downsizing," memorandum to Docket EPA–HQ–OAR–2009–0472, from Michael Olechiw, U.S. EPA, dated March 25, 2010.

suppliers served largely as a check on publicly-available data.

For the other technologies, considering all sources of information (including public comments) and using the BOM approach, the agencies worked together intensively to determine component costs for each of the technologies and build up the costs accordingly. Where estimates differ between sources, we have used our engineering judgment to arrive at what we believe to be the best available cost estimate, and explained the basis for that exercise of judgment in the TSD. Building on NHTSA's estimates developed for the MY 2011 CAFE final rule and EPA's Advance Notice of Proposed Rulemaking, which relied on the EPA 2008 Staff Technical Report,[86] the agencies took a fresh look at technology cost and effectiveness values for purposes of the joint rulemaking 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 in NHTSA's MY 2011 final rule based on recommendation from Ricardo, Inc., as described above. EPA used a similar approach in the EPA 2008 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 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,[87] [88] [89] [90] [91] [92] [93] revised several component costs of several major technologies: turbocharging with engine downsizing (as described above), 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 final RIA.

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,[94] and indirect costs were accounted for using the ICM (indirect cost multiplier) approach explained in Chapter 3 of the Joint TSD, rather than using the traditional Retail Price Equivalent (RPE) multiplier approach. A report explaining how EPA developed the ICM approach can be found in the docket for this rule. The comments addressing the ICM approach were generally positive and encouraging. However, one commenter suggested that we had mischaracterized the complexity of a few of our technologies, which would result in higher or lower markups than presented in the NPRM. That commenter also suggested that we had used the ICMs as a means of placing a higher level of manufacturer learning on the cost estimates. The latter comment is not true and the methodology behind the ICM approach is explained in detail in the reports that are available in the docket for this rule.[95] The former is open to debate given the subjective nature of the engineering analysis behind it, but upon further thought both agencies believe that the complexities used in the NPRM were appropriate and have, therefore, carried those forward into the final rule. We discuss this in greater detail in the Response to Comments document.

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. The agencies also carefully examined the pertinent public comments. 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

[86] 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.

[87] 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—update).

[88] 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—update).

[89] "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.

[90] 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.

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

[92] Vehicle fuel economy certification data.

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

[94] 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.

[95] Rogozhin, Alex, Michael Gallaher, and Walter McManus, "Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers," EPA 420–R–09–003, Docket EPA Docket EPA–HQ–OAR–2009–0472–0142, February 2009, *http://epa.gov/otaq/ld-hwy/420r09003.pdf; A. Rogozhin et al., International Journal of Production Economics 124 (2010) 360–368, Volume 124, Issue 2, April 2010.*

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 first into the NPRM, and now into these final rules. When NHTSA and EPA's estimates for effectiveness diverged slightly due to differences in how the agencies apply technologies to vehicles in their respective models, we report the ranges for the effectiveness values used in each model. There were only a few comments on the technology effectiveness estimates used in the NPRM. Most of the technologies that were mentioned in the comments were the more advanced technologies that are not assumed to have large penetrations in the market within the timeframe of this rule, notably hybrid technologies. Even if the effectiveness figures for hybrid vehicles were adjusted, it would have made little difference in the NHTSA and EPA analysis of the impacts and costs of the rule. The response to comments document has more specific responses to these comments.

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 enormous 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 the final standards, 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.

Chapter 3 of the 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 final rule take into account only those associated with the initial build of the vehicle. Although comments were received to the NPRM that suggested there could be additional maintenance required with some new technologies (*e.g.,* turbocharging, hybrids, etc.), and that additional maintenance costs could occur as a result, the agencies do not believe that the amount of additional cost will be significant in the timeframe of this rulemaking, based on the relatively low application rates for these technologies. The agencies will undertake a more detailed review of these potential costs in preparation for the next round of CAFE/GHG standards.

F. Joint Economic Assumptions

The agencies' final analysis of alternative CAFE and GHG standards for the model years covered by this final rulemaking rely on a range of forecast information, economic estimates, and input parameters. This section briefly describes the agencies' choices of specific parameter values. These 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 final rule, NHTSA and EPA reconsidered previous comments that NHTSA had received, reviewed newly available literature, and reviewed comments received in response to the proposed rule. For this final rule, we made three major changes to the economic assumptions. First, we revised the technology costs to reflect more recently available data. Second, we updated fuel price and transportation demand assumptions to reflect the Annual Energy Outlook (AEO) 2010 Early Release. Third, we have updated our estimates of the social cost of carbon (SCC) based on a recent interagency process. The key economic assumptions are summarized below, and are discussed in greater detail in Section III (EPA) and Section IV (NHTSA), as well as in Chapter 4 of the Joint TSD, Chapter VIII of NHTSA's RIA and Chapter 8 of EPA's RIA.

• *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. This accounts for both the direct and indirect costs associated with implementing new technologies in response to this final rule. The technology cost estimates for a select group of technologies have changed since the NPRM. These changes, as summarized in Section II.E and in Chapter 3 of the Joint TSD, were made in response to updated cost estimates available to the agencies shortly after publication of the NPRM, not in response to comments. In general, commenters were supportive of the cost estimates used in the NPRM and the transparency of the methodology used to generate them.

• *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. This issue is discussed in EPA's RIA, Section 8.1.2 and NHTSA's RIA Section VIII.H. The agencies requested 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. Commenters did not provide recommendations for how to evaluate the quality of different models or identify a model appropriate for the agencies' purposes. Some commenters expressed various concerns about the use of existing consumer vehicle choice models. While EPA and NHTSA are not using a consumer vehicle choice model to analyze the effects of this rule, we continue to investigate these models.

- *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 final 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).[96] NHTSA previously used this estimate in its MY 2011 final rule, and the agencies confirmed it based on independent analysis for use in this FRM. No substantive comments were received on this input.
- *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. For the proposed rule, the agencies had relied on the then most recent fuel price projections from the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2009 (Revised Updated). However, for this final rule, the agencies have updated the analyses based on AEO 2010 (December 2009 Early 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.[97] AEO 2010 includes slightly lower petroleum prices compared to AEO 2009.

The forecasts of fuel prices reported in EIA's AEO 2010 Early Release Reference Case extends through 2035, compared to the AEO 2009 which only went through 2030. As in the proposal, fuel prices beyond the time frame of AEO's forecast were estimated using an average growth rate.

While EIA revised AEO 2010, the vehicle MPG standards are similar to those that were published in AEO 2009. No substantive comments were received on the use of AEO as a source of fuel prices.[98]

- *Consumer valuation of fuel economy and payback period*—In estimating the impacts on vehicle sales, the agencies assume that potential buyers value the resulting fuel savings improvements that would result from alternative CAFE and GHG standards 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. One commenter argued that higher-fuel-economy vehicles should have higher resale prices than vehicles with lower fuel economy, but did not provide supporting data. This revision, if made, would increase the net benefits of the rule. Another commenter supported the use of a five-year payback period for this analysis. In the absence of data to support changes, EPA and NHTSA have kept the same assumptions. In the analysis of net benefits, EPA and NHTSA assume that vehicle buyers benefit from the full fuel savings over the vehicle's lifetime, discounted for present value calculations at 3 and 7 percent.
- *Vehicle sales assumptions*—The first step in estimating lifetime fuel consumption by vehicles produced during a model year is to calculate the number of vehicles expected to be produced and sold.[99] The agencies relied on the AEO 2010 Early Release 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. No substantive comments were received on vehicle survival assumptions.
- *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),[100] adjusted to account for the effect on vehicle use of subsequent increases in fuel prices. Due to the lower fuel prices projected in AEO 2010, the average vehicle is estimated to be used slightly more (~3 percent) over its lifetime than assumed in the proposal. 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 2010 Early Release Reference Case. The growth rate in average annual car and light truck use produced by this calculation is

[96] 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.

[97] Energy Information Administration, Annual Energy Outlook 2010, Early Release Reference Case (December 2009), Table 12. Available at *http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html* (last accessed February 02, 2010).

[98] Kahan, A. and Pickrell, D. Memo to Docket EPA–HQ–OAR–2009–0472 and Docket NHTSA–2009–0059. "Energy Information Administration's Annual Energy Outlook 2009 and 2010." March 24, 2010.

[99] 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 Feb. 15, 2010).

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

approximately 1.1 percent per year.[101] 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.[102] While commenters requested further detail on the assumptions regarding total vehicle use, no specific issues were raised.

• *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 more stringent 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. We received comments supporting our proposed value of 10 percent, although we also received comments recommending higher and lower values. However, we did not receive any new data or comments that justify revising the 10 percent value for the rebound effect at this time.

• *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. These benefits are measured by the net "consumer surplus" resulting from increased vehicle use, over and above the fuel expenses associated with this additional travel. 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.[103] *Please see* the Chapter 4 of the 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.[104]

• *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 expected costs from 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.[105] 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. Since the agencies are taking a global perspective with respect to the estimate of the social cost of carbon for this rulemaking, the agencies do not include the value of any reduction in monopsony payments as a benefit from lower fuel consumption, because those payments from a global perspective represent a transfer of income from consumers of petroleum products to oil suppliers rather than a savings in real economic resources. Similarly, the agencies do not include any savings in budgetary outlays to support U.S. military activities among the benefits of higher fuel economy and the resulting fuel savings. 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 $0.169 (2007$). 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.[106]

[101] 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.

[102] 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.

[103] 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 Feb. 15, 2010); update *available at http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2-11-03.pdf* (last accessed Feb. 15, 2010).

[104] 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 Feb. 15, 2010).

[105] 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.

[106] 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 percent imported crude petroleum and 10 percent

Continued

The energy security analysis conducted for this rule estimates that the world price of oil will fall modestly in response to lower U.S. demand for refined fuel. One potential result of this decline in the world price of oil would be an increase in the consumption of petroleum products outside the U.S., which would in turn lead to a modest increase in emissions of greenhouse gases, criteria air pollutants, and airborne toxics from their refining and use. While additional information would be needed to analyze this "leakage effect" in detail, NHTSA provides a sample estimate of its potential magnitude in its Final EIS.[107] This analysis indicates that the leakage effect is likely to offset only a modest fraction of the reductions in emissions projected to result from the rule.

EPA and NHTSA received comments about the treatment of the monopsony effect, macroeconomic disruption effect, and the military costs associated with the energy security benefits of this rule. The agencies did not receive any comments that justify changing the energy security analysis. As a result, the agencies continue to only use the macroeconomic disruption component of the energy security analysis under a global context when estimating the total energy security benefits associated with this rule. Further, the Agencies did not receive any information that they could use to quantity that component of military costs directly related to energy security, and thus did not modify that part of its analysis. A more complete discussion of the energy security analysis can be found in Chapter 4 of the Joint TSD, and Sections III and IV of this preamble.

• 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.

○ *Economic value of reductions in criteria air pollutants*—For the purpose of the joint technical analysis, 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 rule includes a description of these values. Separately, EPA also conducted air quality modeling to estimate the change in ambient concentrations of criteria pollutants and used this as a basis for estimating the human health benefits and their economic value. Section III.H.7 presents these benefits estimates.

○ *Reductions in GHG emissions*—Emissions of carbon dioxide and other 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 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 2010).[108] 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 received extensive comments about how to improve the characterization of the SCC and have since developed new estimates through an interagency modeling exercise. The comments addressed various issues, such as discount rate selection, treatment of uncertainty, and emissions and socioeconomic trajectories, and justified the revision of SCC for the final rule. The modeling exercise involved running three integrated assessment models using inputs agreed upon by the interagency group for climate sensitivity, socioeconomic and emissions trajectories, and discount rates. A more complete discussion of SCC can be found in the Technical Support Document, *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (hereafter, "SCC TSD"); revised SCC estimates corresponding to assumed values of the discount rate are shown in Table II.F–1.[109]

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 percent = 0.50 gallons + 0.45 gallons = 0.95 gallons.

[107] NHTSA Final Environmental Impact Statement: Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2012–2016, February 2010, page 3–14.

[108] 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.

[109] Interagency Working Group on Social Cost of Carbon, U.S. Government, with participation by Council of Economic Advisers, Council on Environmental Quality, Department of Agriculture, Department of Commerce, Department of Energy, Department of Transportation, Environmental Protection Agency, National Economic Council, Office of Energy and Climate Change, Office of Management and Budget, Office of Science and Technology Policy, and Department of Treasury, "*Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,*" February 2010, available in docket EPA–HQ–OAR–2009–0472.

TABLE II.F–1—SOCIAL COST OF CO_2, 2010

[In 2007 dollars]

Discount Rate	5%	3%	2.5%	3%
Source of Estimate	Mean of Estimates Values			95th percentile estimate.
2010 Estimate	$5	$21	$35	$65.

• *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 final standards, the agencies have employed discount rates of both 3 percent and 7 percent. We received some comments on the discount rates used in the proposal, most of which were directed at the discount rates used to value future fuel savings and the rates used to value of the social cost of carbon. In general, commenters were supporting one of the discount rates over the other, although some suggested that our rates were too high or too low. We have revised the discounting used when calculating the net present value of social cost of carbon as explained in Sections III.H. and VI but have not revised our discounting procedures for other costs or benefits.

For the reader's reference, Table II.F–2 below summarizes the values used to calculate the impacts of each final 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 recognize that each of these values has some degree of uncertainty, which the agencies further discuss in the Joint TSD. 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) inclusion of 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 RIA.

TABLE II.F–2—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.
Average tank volume refilled during refueling stop	55%.
Annual growth in average vehicle use	1.15%.
Fuel Prices (2012–50 average, $/gallon):	
Retail gasoline price	$3.66.
Pre-tax gasoline price	$3.29.
Economic Benefits From Reducing Oil Imports ($/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)	$1,300.
Nitrogen oxides (NO_X)—vehicle use	$5,100.
Nitrogen oxides (NO_X)—fuel production and distribution	$ 5,300.
Particulate matter ($PM_{2.5}$)—vehicle use	$ 240,000.
Particulate matter ($PM_{2.5}$)—fuel production and distribution	$ 290,000.
Sulfur dioxide (SO_2)	$ 31,000.
Carbon dioxide (CO_2) emissions in 2010	$5. $21. $35. $65.
Annual Increase in CO_2 Damage Cost	variable, depending on estimate.
External Costs From Additional Automobile Use ($/vehicle-mile)	
Congestion	$ 0.054.
Accidents	$ 0.023.
Noise	$ 0.001.

TABLE II.F–2—ECONOMIC VALUES FOR BENEFITS COMPUTATIONS—Continued

[2007$]

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 Rates Applied to Future Benefits	3%, 7%.

G. What are the estimated safety effects of the final MYs 2012–2016 CAFE and GHG standards?

The primary goals of the final CAFE and GHG standards are to reduce fuel consumption and GHG emissions, but in addition to these intended effects, the agencies must consider the potential of the standards to affect vehicle safety,[110] which the agencies have assessed in evaluating the appropriate levels at which to set the final standards. Safety trade-offs associated with fuel economy increases have occurred in the past, and the agencies must be mindful of the possibility of future ones. These past safety trade-offs occurred because manufacturers chose, at the time, to build smaller and lighter vehicles—partly in response to CAFE standards—rather than adding more expensive fuel-saving technologies (and maintaining vehicle size and safety), and the smaller and lighter vehicles did not fare as well in crashes as larger and heavier vehicles. Historically, as shown in FARS data analyzed by NHTSA, 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 per crash is higher for small/light vehicle crashes.

Changes in relative safety are related to shifts in the distribution of vehicles on the road. A policy that induces a widening in the size distribution of vehicles on the road, could result in negative impacts on safety, The primary mechanism in this rulemaking for mitigating the potential negative effects on safety is the application of footprint-based standards, which create a disincentive for manufacturers to produce smaller-footprint vehicles. This is because as footprint decreases, the corresponding fuel economy/GHG emission target becomes more stringent.[111] The shape of the footprint curves themselves have also been designed to be approximately "footprint neutral" within the sloped portion of the functions—that is, to neither encourage manufacturers to increase the footprint of their fleets, nor to decrease it. Upsizing also is discouraged through a "cut-off" at larger footprints. For both cars and light trucks there is a "cut-off" that affects vehicles smaller than 41 square feet. The agencies recognize that for manufacturers who make small vehicles in this size range, this cut off creates some incentive to downsize (*i.e.* further reduce the size and/or increase the production of models currently smaller than 41 square feet) to make it easier to meet the target. The cut off may also create some incentive for manufacturers who do not currently offer such models to do so in the future. However, at the same time, the agencies believe that there is a limit to the market for cars smaller than 41 square feet—most consumers likely have some minimum expectation about interior volume, among other things. In addition, vehicles in this market segment are the lowest price point for the light-duty automotive market, with a number of models in the $10,000 to $15,000 range. In order to justify selling more vehicles in this market in order to generate fuel economy or CO_2 credits (that is, for this final rule to be the incentive for selling more vehicles in this small car segment), a manufacturer would need to add additional technology to the lowest price segment vehicles, which could be challenging. Therefore, due to these two reasons (a likely limit in the market place for the smallest sized cars and the potential consumer acceptance difficulty in adding the necessary technologies in order to generate fuel economy and CO_2 credits), the agencies believe that the incentive for manufacturers to increase the sale of vehicles smaller than 41 square feet due to this rulemaking, if present, is small. For further discussion on these aspects of the standards, *please see* Section II.C above and Chapter 2 of the Joint TSD.

Manufacturers have stated, however, that they will reduce vehicle weight as one of the cost-effective means of increasing fuel economy and reducing CO_2 emissions, and the agencies have incorporated this expectation into our modeling analysis supporting today's final standards. NHTSA's previous analyses examining the relationship between vehicle mass and fatalities found fatality increases as vehicle weight and size were reduced, but these previous analyses did not differentiate between weight reductions and size (*i.e.,* weight and footprint) reductions.

The question of the effect of changes in vehicle mass 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, as discussed by a number of commenters to the NPRM. This contentiousness arises, at least in part, from the difficulty of isolating vehicle mass from other confounding factors (*e.g.,* driver behavior, or vehicle factors such as engine size and wheelbase). In addition, several vehicle factors have been closely related historically, such as vehicle mass, wheelbase, and track width. The issue has been reviewed and analyzed in the literature for more than two decades. For the reader's reference, much more information about safety in the CAFE context is available in Chapter IX of NHTSA's FRIA. Chapter 7.6 of EPA's final RIA also contained

[110] In this rulemaking document, vehicle safety is defined as *societal* fatality rates which include fatalities to occupants of all the vehicles involved in the collisions, plus any pedestrians.

[111] We note, however, that 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, or to other portions of the vehicle outside the wheels. The crush space provided by those portions of a vehicle can make important contributions to managing crash energy. At least one manufacturer has confidentially indicated plans to reduce overhang as a way of reducing mass on some vehicles during the rulemaking time frame. Additionally, simply because footprint-based standards create no incentive to downsize vehicles, does not mean that manufacturers may not choose to do so if doing so makes it easier to meet the overall standard (as, for example, if the smaller vehicles are so much lighter that they exceed their targets by much greater amounts).

additional discussion on mass and safety.

Over the past several years, as also discussed by a number of commenters to the NPRM, contention has arisen with regard to the applicability of analysis of historical crash data to future safety effects due to mass reduction. The agencies recognize that there are a host of factors that may make future mass reduction different than what is reflected in the historical data. For one, the footprint-based standards have been carefully developed by the agencies so that they do not encourage vehicle footprint reductions as a way of meeting the standards, but so that they do encourage application of fuel-saving technologies, including mass reduction. This in turn encourages manufacturers to find ways to separate mass reduction from footprint reduction, which will very likely result in a future relationship between mass and fatalities that is safer than the historical relationship. However, as manufacturers pursue these methods of mass reduction, the fleet moves further away from the historical trends, which the agencies recognize.

NHTSA's NPRM analysis of the safety effects of the proposed CAFE standards was based on NHTSA's 2003 report concerning mass and size reduction in MYs 1991–1999 vehicles, and evaluated a "worst-case scenario" in which the safety effects of the combined reductions of both mass and size for those vehicles were determined for the future passenger car and light truck fleets.[112] In the NPRM analysis, mass and size could not be separated from one another, resulting in what NHTSA recognized was a larger safety disbenefit than was likely under the MYs 2012–2016 footprint-based CAFE standards. NHTSA emphasized, however, that actual fatalities would likely be less than these "worst-case" estimates, and possibly significantly less, based on the various factors discussed in the NPRM that could reduce the estimates, such as careful mass reduction through material substitution, etc.

For the final rule, as discussed in the NPRM and in recognition of the importance of conducting analysis that better reflects, within the limits of our current knowledge, the potential safety effects of future mass reduction in response to the final CAFE and GHG standards that is highly unlikely to involve concurrent reductions in footprint, NHTSA has revised its analysis in consultation with EPA. Perhaps the most important change has been that NHTSA agreed with commenters that it was both possible and appropriate to separate the effect of mass reductions from the effect of footprint reductions. NHTSA thus performed a new statistical analysis, hereafter referred to as the 2010 Kahane analysis, of the MYs 1991–99 vehicle database from its 2003 report (now including rather than excluding 2-door cars in the passenger car fleet), assessing relationships between fatality risk, mass, and footprint for both passenger cars and LTVs (light trucks and vans).[113] As part of its results, the new report presents an "upper-estimate scenario," a "lower-estimate scenario," as well as an "actual regression result scenario" representing potential safety effects of future mass reductions without corresponding vehicle size reductions, that assume, by virtue of being a cross-sectional analysis of historical data, that historical relationships between vehicle mass and fatalities are maintained. The "upper-estimate scenario" and "lower-estimate scenario" are based on NHTSA's judgment as a vehicle safety agency, and are not meant to convey any more or less likelihood in the results, but more to convey a sense of bounding for potential safety effects of reducing mass while holding footprint constant. The upper-estimate scenario reflects potential safety effects given the report's finding that, using the one-step regression method of the 2003 Kahane report, the regression coefficients show that mass and footprint each accounted for about half the fatality increase associated with downsizing in a cross-sectional analysis of MYs 1991–1999 cars. A similar effect was found for lighter LTVs. Applying the same regression method to heavier LTVs, however, the coefficients indicated a significant societal fatality reduction when mass, but not footprint, is reduced in the heavier LTVs.[114] Fatalities are reduced primarily because mass reduction in the heavier LTVs will reduce risk to occupants of the other cars and lighter LTVs involved in collisions with these heavier LTVs.[115] Thus, even in the "upper-estimate scenario," the potential fatality increases associated with mass reduction in the passenger cars would be to a large extent offset by the benefits of mass reduction in the heavier LTVs.

The lower-estimate scenario, in turn, reflects NHTSA's estimate of potential safety effects if future mass reduction is accomplished entirely by material substitution, smart design,[116] and component integration, among other things, that can reduce mass without perceptibly changing a vehicle's shape, functionality, or safety performance, maintaining structural strength without compromising other aspects of safety. If future mass reduction follows this path, it could limit the added risk close to only the effects of mass *per se* (the ability to transfer momentum to other vehicles or objects in a collision), resulting in estimated effects in passenger cars that are substantially smaller than in the upper-estimate scenario based directly on the regression results. The lower-estimate scenario also covers both passenger cars and LTVs.

Overall, based on the new analyses, NHTSA estimated that fatality effects could be markedly less than those estimated in the "worst-case scenario" presented in the NPRM. The agencies believe that the overall effect of mass reduction in cars and LTVs may be close to zero, and may possibly be beneficial in terms of the fleet as a whole if mass reduction is carefully applied in the future (as with careful material substitution and other methods of mass reduction that can reduce mass without perceptibly changing a car's shape, functionality, or safety performance,

[112] The analysis excluded 2-door cars.

[113] "Relationships Between Fatality Risk, Mass, and Footprint in Model Year 1991–1999 and Other Passenger Cars and LTVs," Charles J. Kahane, NCSA, NHTSA, March 2010. The text of the report may be found in Chapter IX of NHTSA's FRIA, where it constitutes a section of that chapter. We note that this report has not yet been externally peer-reviewed, and therefore may be changed or refined after it has been subjected to peer review. The results of the report have not been included in the tables summarizing the costs and benefits of this rulemaking and did not affect the stringency of the standards. NHTSA has begun the process for obtaining peer review in accordance with OMB guidance. The agency will ensure that concerns raised during the peer review process are addressed before relying on the report for future rulemakings. The results of the peer review and any subsequent revisions to the report will be made available in a public docket and on NHTSA's Web site as they are completed.

[114] Conversely, the coefficients indicate a significant increase if footprint is reduced.

[115] We note that there may be some (currently non-quantifiable) welfare losses for purchasers of these heavier LTVs, the mass of which is reduced in response to these final standards. This is due to the fact that in certain crashes, as discussed below and in greater detail in Chapter IX of the NHTSA FRIA, more mass will always be helpful (although certainly in other crashes, the amount of mass reduction modeled by the agency will not be enough to have any significant effect on driver/occupant safety). However, we believe the effects of this will likely be minor. Consumer welfare impacts of the final rule are discussed in more detail in Chapter VIII of the NHTSA FRIA.

[116] Manufacturers may reduce mass through smart design using computer aided engineering (CAE) tools that can be used to better optimize load paths within structures by reducing stresses and bending moments applied to structures. This allows better optimization of the sectional thicknesses of structural components to reduce mass while maintaining or improving the function of the component. Smart designs also integrate separate parts in a manner that reduces mass by combining functions or the reduced use of separate fasteners. In addition, some "body on frame" vehicles are redesigned with a lighter "unibody" construction.

and maintain its structural strength without making it excessively rigid). This is especially important if the mass reduction in the heavier LTVs is greater (in absolute terms) than in passenger cars, as discussed further below and in the 2010 Kahane report.

The following sections will address how the agencies addressed potential safety effects in the NPRM for the proposed standards, how commenters responded, and the work that NHTSA has done since the NPRM to revise its estimates of potential safety effects for the final rule. The final section discusses some of the agencies' plans for the future with respect to potential analysis and studies to further enhance our understanding of this important and complex issue.

1. What did the agencies say in the NPRM with regard to potential safety effects?

In the NPRM preceding these final standards, NHTSA's safety assessment derived from the agency's belief that some of these vehicle factors, namely vehicle mass and footprint, could not be accurately separated. NHTSA relied on the 2003 study by Dr. Charles Kahane, 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.[117] The study compares the fatality rates of LTVs and cars to quantify differences between vehicle types, given drivers of the same age/gender, etc. In that 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, safety features, and size of the occupant compartment, that were naturally or historically confounded with mass in MYs 1991–1999 vehicles. The rationale was that adding length, width, or strength to a vehicle historically also made it heavier.

NHTSA utilized the relationships between mass and safety from Kahane (2003), expressed as percentage increases in fatalities per 100-pound mass reduction, and examined the mass effects assumed in the NPRM modeling analysis. While previous CAFE rulemakings had limited mass reduction as a "technology option" to vehicles over 5,000 pounds GVWR, both NHTSA's and EPA's modeling analyses in the NPRM included mass reduction of up to 5–10 percent of baseline curb weight, depending on vehicle subclass, in response to recently-submitted manufacturer product plans as well as public statements indicating that these levels were possible and likely. 5–10 percent represented a maximum bound; EPA's modeling, for example, included average vehicle weight reductions of 4 percent between MYs 2011 and 2016, although the average per-vehicle mass reduction was greater in absolute terms for light trucks than for passenger cars. NHTSA's assumptions for mass reduction were also limited by lead time such that mass reductions of 1.5 percent were included for redesigns occurring prior to MY 2014, and mass reductions of 5–10 percent were only "achievable" in redesigns occurring in MY 2014 or later. NHTSA further assumed that mass 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).

Based on these assumptions of how manufacturers might comply with the standards, NHTSA examined the effects of the identifiable safety trends over the lifetime of the vehicles produced in each model year. The effects were estimated on a year-by-year basis, assuming that certain known safety trends would result in a reduction in the target population of fatalities from which the mass effects are derived.[118] Using this method, NHTSA found a 12.6 percent reduction in fatality levels between 2007 and 2020. The estimates derived from applying Kahane's 2003 percentages to a baseline of 2007 fatalities were then multiplied by 0.874 to account for changes that the agency believed would take place in passenger car and light truck safety between the 2007 baseline on-road fleet used for that particular analysis and year 2020.[119]

NHTSA and EPA both emphasized that the safety effect estimates in the NPRM needed to be understood in the context of the 2003 Kahane report, which is 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 those analyses were used to predict the safety-related fatalities that could occur in the unlikely event that weight reduction for MYs 2012–2016 is accomplished entirely by reducing mass *and* reducing footprint. Any estimates derived from those analyses represented a "worst-case" estimate of safety effects, for several reasons.

First, manufacturers are far less likely to reduce mass by "downsizing" (making vehicles smaller overall) under the current attribute-based standards, because the standards are based on vehicle footprint. The selection of footprint as the attribute in setting CAFE and GHG standards helps to reduce the incentive to alter a vehicle's physical dimensions. This is because as footprint decreases, the corresponding fuel economy/GHG emission target becomes more stringent.[120] The shape of the footprint curves themselves have also been designed to be approximately "footprint neutral" within the sloped portion of the functions—that is, to neither encourage manufacturers to increase the footprint of their fleets, nor to decrease it. For further discussion on these aspects of the standards, *please see* Section II.C above and Chapter 2 of the Joint TSD. However, as discussed in Sections III.H.1 and IV.G.6 below, the agencies acknowledge some uncertainty regarding how consumer purchases will change in response to the vehicles

[117] Kahane, Charles J., PhD, "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 March 10, 2010).

[118] NHTSA explained that there are several identifiable safety trends that are already in place or expected to occur in the foreseeable future and that were 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. Additionally, the agency stated that it anticipates 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 mass reductions. Thus, while the percentage increases in Kahane (2003) was applied, the reduced base resulted in smaller absolute increases than those that were predicted in the 2003 report.

[119] 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)

[120] We note, however, that 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, or to other portions of the vehicle outside the wheels. The crush space provided by those portions of a vehicle can make important contributions to managing crash energy. NHTSA noted in the NPRM that at least one manufacturer has confidentially indicated plans to reduce overhang as a way of reducing mass on some vehicles during the rulemaking time frame. Additionally, simply because footprint-based standards create no incentive to downsize vehicles, does not mean that manufacturers may not choose to do so if doing so makes it easier to meet the overall standard (as, for example, if the smaller vehicles are so much lighter that they exceed their targets by much greater amounts).

designed to meet the MYs 2012–2016 standards. This could potentially affect the mix of vehicles sold in the future, including the mass and footprint distribution.

As a result, the agencies found it likely that a significant portion of the mass reduction in the MY 2012–2016 vehicles would be accomplished by strategies, such as material substitution, smart design, reduced powertrain requirements,[121] and mass compounding, that have a lesser safety effect than the prevalent 1980s strategy of simply making the vehicles smaller. The agencies noted that to the extent that future mass reductions could be achieved by these methods—without any accompanying reduction in the size or structural strength of the vehicle—then the fatality increases associated with the mass reductions anticipated by the model as a result of the proposed standards could be significantly smaller than those in the worst-case scenario.

However, even though the agencies recognized that these methods of mass reduction could be technologically feasible in the rulemaking time frame, and included them as such in our modeling analyses, the agencies diverged as to how potential safety effects accompanying such methods of mass reduction could be evaluated, particularly in relation to the worst-case scenario presented by NHTSA. NHTSA stated that it could not predict how much smaller those increases would be for any given mixture of mass reduction methods, since the data on the safety effects of mass reduction alone (without size reduction) was not available due to the low numbers of vehicles in the current on-road fleet that have utilized these technologies extensively. Further, to the extent that mass reductions were accomplished through use of light, high-strength materials, NHTSA emphasized that there would be significant additional costs that would need to be determined and accounted for than were reflected in the agency's proposal.

Additionally, NHTSA emphasized that while it thought material substitution and other methods of mass reduction could considerably lessen the potential safety effects compared to the historical trend, NHTSA also stated that it did not believe the effects in passenger cars would be smaller than zero. EPA disagreed with this, and stated in the NPRM that the safety effects could very well be smaller than zero. Even though footprint-based standards discourage downsizing as a way of "balancing out" sales of larger/heavier vehicles, they do not discourage manufacturers from reducing crush space in overhang areas or from reducing structural support as a way of taking out mass.[122] Moreover, NHTSA's analysis had also found that lighter cars have a higher involvement rate in fatal crashes, even after controlling for the driver's age, gender, urbanization, and region of the country. Being unable to explain this clear trend in the crash data, NHTSA stated that it must assume that mass reduction is likely to be associated with higher fatal-crash rates, no matter how the weight reduction is achieved.

NHTSA also noted in the NPRM that several studies by Dynamic Research, Inc. (DRI) had been repeatedly cited to the agency in support of the proposition that reducing vehicle mass while maintaining track width and wheelbase would lead to significant safety benefits. In its 2005 studies, one of which was published and peer-reviewed through the Society of Automotive Engineers as a technical paper, DRI attempted to assess the independent effects of vehicle weight and size (in terms of wheelbase and track width) on safety, and presented results indicating that reducing vehicle weight tends to reduce fatalities, but that reducing vehicle wheelbase and track width tends to increase fatalities. DRI's analysis was based on FARS data for MYs 1985–1998 passenger cars and 1985–1997 light trucks, similar to the MYs 1991–1999 car and truck data used in the 2003 Kahane report. However, DRI included 2-door passenger cars, while the 2003 Kahane report excluded those vehicles out of concern that their inclusion could bias the results of the regression analysis, because a significant proportion of MYs 1991–1999 2-door cars were sports and "muscle" cars, which have particularly high fatal crash rates for their relatively short wheelbases compared to the rest of the fleet. While in the NPRM NHTSA rejected the results of the DRI studies based in part on this concern, the agencies note that upon further consideration, NHTSA has agreed for this final rule that the inclusion of 2-door cars in regression analysis of historical data is appropriate, and indeed has no overly-biasing effects.

The 2005 DRI studies also differed from the 2003 Kahane report in terms of their estimates of the effect of vehicle weight on rollover fatalities. The 2003 Kahane report analyzed a single variable, curb weight, as a surrogate for both vehicle size and weight, and found that curb weight reductions would increase rollover fatalities. The DRI study, in contrast, attempted to analyze curb weight, wheelbase, and track width separately, and found that curb weight reduction would *decrease* rollover fatalities, while wheelbase reduction and track width reduction would increase them. DRI suggested that heavier vehicles may have higher rollover fatalities for two reasons: first, because taller vehicles tend to be heavier, so the correlation between vehicle height and weight and vehicle center-of-gravity height may make heavier vehicles more rollover-prone; and second, because heavier vehicles may have been less rollover-crashworthy due to FMVSS No. 216's constant (as opposed to proportional) requirements for MYs 1995–1999 vehicles weighing more than 3,333 lbs unloaded.

Overall, DRI's 2005 studies found a reduction in fatalities for cars (580 in the first study, and 836 in the second study) and for trucks (219 in the first study, 682 in the second study) for a 100 pound reduction in curb weight without accompanying wheelbase or track width reductions. In the NPRM, NHTSA disagreed with the results of the DRI studies, out of concern that DRI's inclusion of 2-door cars in its analysis biased the results, and because NHTSA was unable to reproduce DRI's results despite repeated attempts. NHTSA stated that it agreed intuitively with DRI's conclusion that vehicle mass reductions without accompanying size reductions (as through substitution of a heavier material for a lighter one) would be less harmful than downsizing, but without supporting real-world data and unable to verify DRI's results, NHTSA stated that it could not conclude that mass reductions would result in safety benefits. EPA, in contrast, believed that DRI's results contained some merit, in particular because the study separated the effects of mass and size and EPA stated that applying them using the curb weight reductions in EPA's modeling analysis would show an overall reduction of fatalities for the proposed standards.

On balance, both agencies recognized that mass reduction could be an important tool for achieving higher levels of fuel economy and reducing CO_2 emissions, and emphasized that NHTSA's fatality estimates represented a worst-case scenario for the potential effects of the proposed standards, and

[121] Reduced powertrain requirements do not include a reduction in performance. When vehicle mass is reduced, engine torque and transmission gearing can be altered so that acceleration performance is held constant instead of improving. A detailed discussion is included in Chapter 3 of the Technical Support Document.

[122] However, we recognize that FMVSS and NCAP ratings may limit the manufacturer's ability to reduce crush space or structural support.

that actual fatalities will be less than these estimates, possibly significantly less, based on the various factors discussed in the NPRM that could reduce the estimates. The agencies sought comment on the safety analysis and discussions presented in the NPRM.

2. What public comments did the agencies receive on the safety analysis and discussions in the NPRM?

Several dozen commenters addressed the safety issue. Claims and arguments made by commenters in response to the safety effects analysis and discussion in the NPRM tended to follow several general themes, as follows:

- NHTSA's safety effects estimates are inaccurate because they do not account for:
  - While NHTSA's study only considers vehicles from MYs 1991–1999, more recently-built vehicles are safer than those, and future vehicles will be safer still;
  - Lighter vehicles are safer than heavier cars in terms of crash-avoidance, because they handle and brake better;
  - Fatalities are linked more to other factors than mass;
  - The structure of the standards reduces/contributes to potential safety effects from mass reduction;
  - NHTSA could mitigate additional safety effects from mass reduction, if there are any, by simply regulating safety more;
  - Casualty risks range widely for vehicles of the same weight or footprint, which skews regression analysis and makes computer simulation a better predictor of the safety effects of mass reduction;
- DRI's analysis shows that lighter vehicles will save lives, and NHTSA reaches the opposite conclusion without disproving DRI's analysis;
  - Possible reasons that NHTSA and DRI have reached different conclusions:
    - NHTSA's study should distinguish between reductions in size and reductions in weight like DRI's;
    - NHTSA's study should include two-door cars;
    - NHTSA's study should have used different assumptions;
    - NHTSA's study should include confidence intervals;
- NHTSA should include a "best-case" estimate in its study;
- NHTSA should not include a "worst-case" estimate in its study;

The agencies recognize that the issue of the potential safety effects of mass reduction, which was one of the many factors considered in the balancing that led to the agencies' conclusion as to appropriate stringency levels for the MYs 2012–2016 standards, is of great interest to the public and could possibly be a more significant factor in regulators' and manufacturers' decisions with regard to future standards beyond MY 2016. The agencies are committed to analyzing this issue thoroughly and holistically going forward, based on the best available science, in order to further their closely related missions of safety, energy conservation, and environmental protection. We respond to the issues and claims raised by commenters in turn below.

NHTSA's estimates are inaccurate because NHTSA's study only considers vehicles from MYs 1991–1999, but more recently-built vehicles are safer than those, and future vehicles will be safer still

A number of commenters (CAS, Adcock, NACAA, NJ DEP, NY DEC, UCS, and Wenzel) argued that the 2003 Kahane report, on which the "worst-case scenario" in the NPRM was based, is outdated because it considers the relationship between vehicle weight and safety in MYs 1991–1999 passenger cars. These commenters generally stated that data from MYs 1991–1999 vehicles provide an inaccurate basis for assessing the relationship between vehicle weight and safety in current or future vehicles, because the fleets of vehicles now and in the future are increasingly different from that 1990s fleet (more crossovers, fewer trucks, lighter trucks, etc.), with different vehicle shapes and characteristics, different materials, and more safety features. Several of these commenters argued that NHTSA should conduct an updated analysis for the final rule using more recent data—Wenzel, for example, stated that an updated regression analysis that accounted for the recent introduction of crossover SUVs would likely find reduced casualty risk, similar to DRI's previous finding using fatality data. CEI, in contrast, argued that the "safety trade-off" would not be eliminated by new technologies and attribute-based standards, because additional weight inherently makes a vehicle safer to its own occupants, citing the 2003 Kahane report, while AISI argued that Desapriya had found that passenger car drivers and occupants are two times more likely to be injured than drivers and occupants in larger pickup trucks and SUVs.

Several commenters (Adcock, CARB, Daimler, NESCAUM, NRDC, Public Citizen, UCS, Wenzel) suggested that NHTSA's analysis was based on overly pessimistic assumptions about how manufacturers would choose to reduce mass in their vehicles, because manufacturers have a strong incentive in the market to build vehicles safely. Many of these commenters stated that several manufacturers have already committed publicly to fairly ambitious mass reduction goals in the mid-term, but several stated further that NHTSA should not assume that manufacturers will reduce the same amount of mass in all vehicles, because it is likely that they will concentrate mass reduction in the heaviest vehicles, which will improve compatibility and decrease aggressivity in the heaviest vehicles. Daimler emphasized that all vehicles will have to comply with the Federal Motor Vehicle Safety Standards, and will likely be designed to test well in NHTSA's NCAP tests.

Other commenters (Aluminum Association, CARB, CAS, ICCT, MEMA, NRDC, U.S. Steel) also emphasized the need for NHTSA to account for the safety benefits to be expected in the future from use of advanced materials for lightweighting purposes and other engineering advances. The Aluminum Association stated that advanced vehicle design and construction techniques using aluminum can improve energy management and minimize adverse safety effects of their use,[123] but that NHTSA's safety analysis could not account for those benefits if it were based on MYs 1991–1999 vehicles. CAS, ICCT, and U.S. Steel discussed similar benefits for more recent and future vehicles built with high strength steel (HSS), although U.S. Steel cautioned that given the stringency of the proposed standards, manufacturers would likely be encouraged to build smaller and lighter vehicles in order to achieve compliance, which fare worse in head-on collisions than larger, heavier vehicles. AISI, in contrast to U.S. Steel, stated that in its research with the Auto/Steel Partnership and in programs supported by DOE, it had found that the use of new Advanced HSS steel grades could enable mass of critical crash structures, such as front rails and bumper systems, to be reduced by 25 percent without degrading performance in standard NHTSA frontal or IIHS offset

[123] The Aluminum Association (NHTSA–2009–0059–0067.3) stated that its research on vehicle safety compatibility between an SUV and a mid-sized car, done jointly with DRI, shows that reducing the weight of a heavier SUV by 20% (a realistic value for an aluminum-intensive vehicle) could reduce the combined injury rate for both vehicles by 28% in moderately severe crashes. The commenter stated that it would keep NHTSA apprised of its results as its research progressed. Based on the information presented, NHTSA believes that this research appears to agree with NHTSA's latest analysis, which finds that a reduction in weight for the heaviest vehicles may improve overall fleet safety.

instrumented crash tests compared to their "heavier counterparts."

Agencies' response: NHTSA, in consultation with EPA and DOE, plans to begin updating the MYs 1991–1999 database on which NHTSA's safety analyses in the NPRM and final rule are based in the next several months in order to analyze the differences in safety effects against vehicles built in more recent model years. As this task will take at least a year to complete, beginning it immediately after the NPRM would not have enabled the agency to complete it and then conduct a new analysis during the period between the NPRM and the final rule.

For purposes of this final rule, however, we believe that using the same MYs 1991–1999 database as that used in the 2003 Kahane study provides a reasonable basis for attempting to estimate safety effects due to reductions in mass. While commenters often stated that updating the database would help to reveal the effect of recently-introduced lightweight vehicles with extensive material substitution, there have in fact not yet been a significant number of vehicles with substantial mass reduction/material substitution to analyze, and they must also show up in the crash databases for NHTSA to be able to add them to its analysis. Based on NHTSA's research, specifically, on three statistical analyses over a 12-year period (1991–2003) covering a range of 22 model years (1978–1999), NHTSA believes that the relationships between mass, size, and safety has only changed slowly over time, although we recognize that they may change somewhat more rapidly in the future.[124] As the on-road fleet gains increasing numbers of vehicles with increasing amounts of different methods of mass reduction applied to them, we may begin to discern changes in the crash databases due to the presence of these vehicles, but any such changes are likely to be slow and evolutionary, particularly in the context of MYs 2000–2009 vehicles. The agencies do expect that further analysis of historical data files will continue to provide a robust and practicable basis for estimating the potential safety effects that might occur with future reductions in vehicle mass. However, we recognize that estimates derived from analysis of historical data, like estimates from any other type of analysis (including simulation-based analysis, which cannot feasibly cover all relevant scenarios), will be uncertain in terms of predicting actual future outcomes with respect to a vehicle fleet, driving population, and operating environment that does not yet exist.

The agencies also recognize that more recent vehicles have more safety features than 1990s vehicles, which are likely to make them safer overall. To account for this, NHTSA did adjust the results of both its NPRM and final rule analysis to include known safety improvements, like ESC and increases in seat belt use, that have occurred since MYs 1991–1999.[125] However, simply because newer vehicles have more safety countermeasures, does not mean that the weight/safety relationship necessarily changes. More likely, it would change the target population (the number of fatalities) to which one would apply the weight/safety relationship. Thus, we still believe that some mass reduction techniques for both passenger cars and light trucks can make them less safe, in certain crashes as discussed in NHTSA's FRIA, than if mass had not been reduced.[126]

As for NHTSA's assumptions about mass reduction, in its analysis, NHTSA generally assumed that lighter vehicles could be reduced in weight by 5 percent while heavier light trucks could be reduced in weight by 10 percent. NHTSA recognizes that manufacturers might choose a different mass reduction scheme than this, and that its quantification of the estimated effect on safety would be different if they did. We emphasize that our estimates are based on the assumptions we have employed and are intended to help the agency consider the potential effect of the final standards on vehicle safety. Thus, based on the 2010 Kahane analysis, reductions in weight for the heavier light trucks would have positive overall safety effects,[127] while mass reductions for passenger cars and smaller light trucks would have negative overall safety effects.

NHTSA's estimates are inaccurate because they do not account for the fact that lighter vehicles are safer than heavier cars in terms of crash-avoidance, because they handle and brake better

ICCT stated that lighter vehicles are better able to avoid crashes because they "handle and brake slightly better," arguing that size-based standards encourage lighter-weight car-based SUVs with "significantly better handling and crash protection" than 1996–1999 mid-size SUVs, which will reduce both fatalities and fuel consumption. ICCT stated that NHTSA did not include these safety benefits in its analysis. DRI also stated that its 2005 report found that crash avoidance improves with reduction in curb weight and/or with increases in wheelbase and track, because "Crash avoidance can depend, amongst other factors, on the vehicle directional control and rollover characteristics." DRI argued that, therefore, "These results indicate that vehicle weight reduction tends to decrease fatalities, but vehicle wheelbase and track reduction tends to increase fatalities."

Agencies' response: In fact, NHTSA's regression analysis of crash fatalities per million registration years measures the effects of crash avoidance, if there are any, as well as crashworthiness. Given that the historical empirical data for passenger cars show a trend of higher crash rates for lighter cars, it is unclear whether lighter cars have, in the net, superior crash avoidance, although the agencies recognize that they may have advantages in certain individual situations. EPA presents a discussion of improved accident avoidance as vehicle mass is reduced in Chapter 7.6 of its final RIA. The important point to emphasize is that it depends on the situation—it would oversimplify drastically to point to one situation in which extra mass helps or hurts and then extrapolate effects for crash avoidance across the board based on only that.

For example, the relationship of vehicle mass to rollover and directional stability is more complex than commenters imply. For rollover, it is true that if heavy pickups were always more top-heavy than lighter pickups of the same footprint, their higher center of gravity could make them more rollover-prone, yet some mass can be placed so as to lower a vehicle's center of gravity and make it less rollover-prone. For mass reduction to be beneficial in rollover crashes, then, it must take

[124] NHTSA notes the CAS' comments regarding changes in the vehicle fleets since the introduction of CAFE standards in the late 1970s, but believes they apply more to the differences between late 1970s through 1980s vehicles and 2010s vehicles than to the differences between 1990s and 2010s vehicles. NHTSA believes that the CAS comments regarding the phase-out of 1970s vehicles and their replacement with safer, better fuel-economy-achieving 1980s vehicles paint with rather too large a brush to be relevant to the main discussion of whether the 2003 Kahane report database can reasonably be used to estimate safety effects of mass reduction for the MYs 2012–2016 fleet.

[125] See NHTSA FRIA Chapter IX.

[126] If one has a vehicle (vehicle A), and both reduces the vehicle's mass and adds new safety equipment to it, thus creating a variant (vehicle A_1), the variant might conceivably have a level of overall safety for its occupants equal to that of the original vehicle (vehicle A). However, vehicle A_1 might not be as safe as second variant (vehicle A_2) of vehicle A, one that is produced by adding to vehicle A the same new safety equipment added to the first variant, but this time without any mass reduction.

[127] This is due to the beneficial effect on the occupants of vehicles struck by the downweighted larger vehicles.

center of gravity height into account along with other factors such as passenger compartment design and structure, suspension, the presence of various safety equipment, and so forth.

Similarly, for directional stability, it is true that having more mass increases the "understeer gradient" of cars—*i.e.,* it reinforces their tendency to proceed in a straight line and slows their response to steering input, which would be harmful where prompt steering response is essential, such as in a double-lane-change maneuver to avoid an obstacle. Yet more mass and a higher understeer gradient could help when it is better to remain on a straight path, such as on a straight road with icy patches where wheel slip might impair directional stability. Thus, while less vehicle mass can sometimes improve crash avoidance capability, there can also be situations when more vehicle mass can help in other kinds of crash avoidance.

Further, NHTSA's research suggests that additional vehicle mass may be even more helpful, as discussed in Chapter IX of NHTSA's FRIA, when the average driver's response to a vehicle's maneuverability is taken into account. Lighter cars have historically (1976–2009) had higher collision-involvement rates than heavier cars—even in multi-vehicle crashes where directional and rollover stability is not particularly an issue.[128] Based on our analyses using nationally-collected FARS and GES data, drivers of lighter cars are more likely to be the culpable party in a 2-vehicle collision, even after controlling for footprint, the driver's age, gender, urbanization, and region of the country.

Thus, based on this data, it appears that lighter cars may not be driven as well as heavier cars, although it is unknown why this is so. If poor drivers intrinsically chose light cars (self-selection), it might be evidenced by an increase in antisocial driving behavior (such as DWI, drug involvement, speeding, or driving without a license) as car weight decreases, after controlling for driver age and gender—in addition to the increases in merely culpable driver behavior (such as failure to yield the right of way). But analyses in NHTSA's 2003 report did not show an increase in antisocial driver behavior in the lighter cars paralleling their increase in culpable involvements.

NHTSA also hypothesizes that certain aspects of lightness and/or smallness in a car may give a driver a perception of greater maneuverability that ultimately results in driving with less of a "safety margin," *e.g.,* encouraging them to weave in traffic. That may appear paradoxical at first glance, as maneuverability is, in the abstract, a safety plus. Yet the situation is not unlike powerful engines that could theoretically enable a driver to escape some hazards, but in reality have long been associated with high crash and fatality rates.[129]

NHTSA's estimates are inaccurate because fatalities are linked more to other factors than mass

Tom Wenzel stated that the safety record of recent model year crossover SUVs indicates that weight reduction in this class of vehicles (small to mid-size SUVs) resulted in a reduction in fatality risk. Wenzel argued that NHTSA should acknowledge that other vehicle attributes may be as important, if not more important, than vehicle weight or footprint in terms of occupant safety, such as unibody construction as compared to ladder-frame, lower bumpers, and less rigid frontal structures, all of which make crossover SUVs more compatible with cars than truck-based SUVs.

Marc Ross commented that fatalities are linked more strongly to intrusion than to mass, and stated that research by safety experts in Japan and Europe suggests the main cause of serious injuries and deaths is intrusion due to the failure of load-bearing elements to properly protect occupants in a severe crash. Ross argued that the results from this project have "overturned the original views about compatibility," which thought that mass and the mass ratio were the dominant factors. Since footprint-based standards will encourage the reduction of vehicle weight through materials substitution while maintaining size, Ross stated, they will help to reduce intrusion and consequently fatalities, as the lower weight reduces crash forces while maintaining size preserves crush space. Ross argued that this factor was not considered by NHTSA in its discussion of safety. ICCT agreed with Ross' comments on this issue.

In previous comments on NHTSA rulemakings and in several studies, Wenzel and Ross have argued generally that vehicle design and "quality" is a much more important determinant of vehicle safety than mass. In comments on the NPRM, CARB, NRDC, Sierra Club, and UCS echoed this theme.

ICCT commented as well that fatality rates in the EU are much lower than rates in the U.S., even though the vehicles in the EU fleet tend to be smaller and lighter than those in the U.S. fleet. Thus, ICCT argued, "This strongly supports the idea that vehicle and highway design are far more important factors than size or weight in vehicle safety." ICCT added that "It also suggests that the rise in SUVs in the U.S. has not helped reduce fatalities." CAS also commented that Germany's vehicle fleet is both smaller and lighter than the American fleet, and has lower fatality rates.

Agencies' response: NHTSA and EPA agree that there are many features that affect safety. While crossover SUVs have lower fatality rates than truck-based SUVs, there are no analyses that attribute the improved safety to mass alone, and not to other factors such as the lower center of gravity or the unibody construction of these vehicles. While a number of improvements in safety can be made, they do not negate the potential that another 100 lbs. could make a passenger car or crossover vehicle safer for its occupants, because of the effects of mass per se as discussed in NHTSA's FRIA, albeit similar mass reductions could make heavier LTVs safer to other vehicles without necessarily harming their own drivers and occupants. Moreover, in the 2004 response to docket comments, NHTSA explained that the significant relationship between mass and fatality risk persisted even after controlling for vehicle price or nameplate, suggesting that vehicle "quality" as cited by Wenzel and Ross is not necessarily more important than vehicle mass.

As for reductions in intrusions due to material substitution, the agencies agree generally that the use of new and innovative materials may have the potential to reduce crash fatalities, but such vehicles have not been introduced in large numbers into the vehicle fleet. The agencies will continue to monitor the situation, but ultimately the effects of different methods of mass reduction on overall safety in the real world (not just in simulations) will need to be analyzed when vehicles with these types of mass reduction are on the road in sufficient quantities to provide statistically significant results. For example, a vehicle that is designed to be

[128] See, *e.g.,* NHTSA (2000). *Traffic Safety Facts 1999.* Report No. DOT HS 809 100. Washington, DC: National Highway Traffic Safety Administration, p. 71; Najm, W.G., Sen, B., Smith, J.D., and Campbell, B.N. (2003). *Analysis of Light Vehicle Crashes and Pre-Crash Scenarios Based on the 2000 General Estimates System,* Report No. DOT HS 809 573. Washington, DC: National Highway Traffic Safety Administration, p. 48.

[129] Robertson, L.S. (1991), "How to Save Fuel and Reduce Injuries in Automobiles," *The Journal of Trauma,* Vol. 31, pp. 107–109; Kahane, C.J. (1994). Correlation of NCAP Performance with Fatality Risk in Actual Head-On Collisions, NHTSA Technical Report No. DOT HS 808 061. Washington, DC: National Highway Traffic Safety Administration, *http://www-nrd.nhtsa.dot.gov/Pubs/808061.PDF,* pp. 4–7.

much stiffer to reduce intrusion is likely to have a more severe crash pulse and thus impose greater forces on the occupants during a crash, and might not necessarily be good for elderly and child occupant safety in certain types of crashes. Such trade-offs make it difficult to estimate overall results accurately without real world data. The agencies will continue to evaluate and analyze such real world data as it becomes available, and will keep the public informed as to our progress.

ICCT's comment illustrates the fact that different vehicle fleets in different countries can face different challenges. NHTSA does not believe that the fact that the EU vehicle fleet is generally lighter than the U.S. fleet is the exclusive reason, or even the primary factor, for the EU's lower fatality rates. The data ICCT cites do not account for significant differences between the U.S. and EU such as in belt usage, drunk driving, rural/urban roads, driving culture, etc.

The structure of the standards reduces/contributes to potential safety risks from mass reduction

Since switching in 2006 to setting attribute-based light truck CAFE standards, NHTSA has emphasized that one of the benefits of a footprint-based standard is that it discourages manufacturers from building smaller, less safe vehicles to achieve CAFE compliance by "balancing out" their larger vehicles, and thus avoids a negative safety consequence of increasing CAFE stringency.[130] Some commenters on the NPRM (Daimler, IIHS, NADA, NRDC, Sierra Club *et al.*) agreed that footprint-based standards would protect against downsizing and help to mitigate safety risks, while others stated that there would still be safety risks even with footprint-based standards—CEI, for example, argued that mass reduction inherently creates safety risks, while IIHS and Porsche expressed concern about footprint-based standards encouraging manufacturers to manipulate wheelbase, which could reduce crush space and worsen vehicle handling. U.S. Steel and AISI both commented that the "aggressive schedule" for the proposed increases in stringency could encourage manufacturers to build smaller, lighter vehicles in order to comply.

Some commenters also focused on the shape and stringency of the target curves and their potential effect on vehicle safety. IIHS agreed with the agencies' tentative decision to cut off the target curves at the small-footprint end. Regarding the safety effect of the curves requiring less stringent targets for larger vehicles, while IIHS stated that increasing footprint is good for safety, CAS, Wenzel, and the UCSB students stated that decreasing footprint may be better for safety in terms of risk to occupants of other vehicles. Daimler, Wenzel, and the University of PA Environmental Law Project commented generally that more similar passenger car and light truck targets at identical footprints (as Wenzel put it, a single target curve) would improve fleet compatibility and thus, safety, by encouraging manufacturers to build more passenger cars instead of light trucks.

Agencies' response: The agencies continue to believe that footprint-based standards help to mitigate potential safety risks from downsizing if the target curves maintain sufficient slope, because, based on NHTSA's analysis, larger-footprint vehicles are safer than smaller-footprint vehicles.[131] The structure of the footprint-based curves will also discourage the upsizing of vehicles. Nevertheless, we recognize that footprint-based standards are not a panacea—NHTSA's analysis continues to show that there was a historical relationship between lower vehicle mass and increased safety risk in passenger cars even if footprint is maintained, and there are ways that manufacturers may increase footprint that either improve or reduce vehicle safety, as indicated by IIHS and Porsche.

With regard to whether the agencies should set separate curves or a single one, NHTSA also notes in Section II.C that EPCA requires NHTSA to establish standards separately for passenger cars and light trucks, and thus concludes that the standards for each fleet should be based on the characteristics of vehicles in each fleet. In other words, the passenger car curve should be based on the characteristics of passenger cars, and the light truck curve should be based on the characteristics of light trucks—thus to the extent that those characteristics are different, an artificially-forced convergence would not accurately reflect those differences. However, such convergence could be appropriate depending on future trends in the light vehicle market, specifically further reduction in the differences between passenger car and light truck characteristics. While that trend was more apparent when car-like 2WD SUVs were classified as light trucks, it seems likely to diminish for the model year vehicles subject to these rules as the truck fleet will be more purely "truck-like" than has been the case in recent years.

NHTSA's estimates are inaccurate because NHTSA could mitigate additional safety risks from mass reduction, if there are any, by simply regulating safety more

Since NHTSA began considering the potential safety risks from mass reduction in response to increased CAFE standards, some commenters have suggested that NHTSA could mitigate those safety risks, if any, by simply regulating more.[132] In response to the safety analysis presented in the NPRM, several commenters stated that NHTSA should develop additional safety regulations to require vehicles to be designed more safely, whether to improve compatibility (Adcock, NY DEC, Public Citizen, UCS), to require seat belt use (CAS, UCS), to improve rollover and roof crush resistance (UCS), or to improve crashworthiness generally by strengthening NCAP and the star rating system (Adcock). Wenzel commented further that "Improvements in safety regulations will have a greater effect on occupant safety than FE standards that are structured to maintain, but may actually increase, vehicle size."

Agencies' response: NHTSA appreciates the commenters' suggestions and notes that the agency is continually striving to improve motor vehicle safety consistent with its mission. As noted above, improving safety in other areas affects the target population that the mass/footprint relationship could affect, but it does not necessarily change the relationship.

The 2010 Kahane analysis discussed in this final rule evaluates the relative safety risk when vehicles are made lighter than they might otherwise be absent the final MYs 2012–2016 standards. It does consider the effect of known safety regulations as they are projected to affect the target population.

Casualty risks range widely for vehicles of the same weight or footprint, which skews regression analysis and makes computer simulation a better predictor of the safety effects of mass reduction

[130] We note that commenters were divided on whether they believed there was a clear correlation between vehicle size/weight and safety (CEI, Congress of Racial Equality, Heritage Foundation, IIHS, Spurgeon, University of PA Environmental Law Project) or whether they believed that the correlation was less clear, for example, because they believed that vehicle design was more important than vehicle mass (CARB, Public Citizen).

[131] *See* Chapter IX of NHTSA's FRIA.

[132] *See, e.g.,* MY 2011 CAFE final rule, 74 FR 14403–05 (Mar. 30, 2009).

Wenzel commented that he had found, in his most recent work, after accounting for drivers and crash location, that there is a wide range in casualty risk for vehicles with the same weight or footprint. Wenzel stated that for drivers, casualty risk does generally decrease as weight or footprint increases, especially for passenger cars, but the degree of variation in the data for vehicles (particularly light trucks) at a given weight or footprint makes it difficult to say that a decrease in weight or footprint will necessarily result in increased casualty risk. In terms of risk imposed on the drivers of other vehicles, Wenzel stated that risk increases as light truck weight or footprint increases.

Wenzel further stated that because a regression analysis can only consider the average trend in the relationship between vehicle weight/size and risk, it must "ignore" vehicles that do not follow that trend. Wenzel therefore recommended that the agency employ computer crash simulations for analyzing the effect of vehicle weight reduction on safety, because they can "pinpoint the effect of specific vehicle designs on safety," and can model future vehicles which do not yet exist and are not bound to analyzing historical data. Wenzel cited, as an example, a DRI simulation study commissioned by the Aluminum Association (Kebschull 2004), which used a computer model to simulate the effect of changing SUV mass or footprint (without changing other attributes of the vehicle) on crash outcomes, and showed a 15 percent net decrease in injuries, while increasing wheelbase by 4.5 inches while maintaining weight showed a 26 percent net decrease in serious injuries.

Agencies' response: The agencies have reviewed Mr. Wenzel's draft report for DOE to which he referred in his comments, but based on NHTSA's work do not find such a wide range of safety risk for vehicles with the same weight, although we agree there is a range of risk for a given footprint. Wenzel found that for drivers, casualty risk does generally decrease as weight or footprint increases, especially for passenger cars, and that in terms of risk imposed on the drivers of other vehicles, risk increases as light truck weight or footprint increases, but concluded that the variation in the data precluded the possibility of drawing any conclusions. In the 2010 Kahane study presented in the FRIA, NHTSA undertook a similar analysis in which it correlated weight to fatality risk for vehicles of essentially the same footprint.[133] The "decile analysis," provided as a check on the trend/direction of NHTSA's regression analysis, shows that societal fatality risk generally increases and rarely decreases for lighter relative to heavier cars of the same footprint. Thus, while Mr. Wenzel was reluctant to draw a conclusion, NHTSA believes that both our research and Mr. Wenzel's appear to point to the same conclusion. We agree that there is a wide range in casualty risk among cars of the same footprint, but we find that that casualty risk is correlated with weight. The correlation shows that heavier cars have lower overall societal fatality rates than lighter cars of very similar footprint.

The agencies agree that simulation can be beneficial in certain circumstances. NHTSA cautions, however, that it is difficult for a simulation analysis to capture the full range of variations in crash situations in the way that a statistical regression analysis does. Vehicle crash dynamics are complex, and small changes in initial crash conditions (such as impact angle or closing speed) can have large effects on injury outcome. This condition is a consequence of variations in the deformation mode of individual components (*e.g.,* buckling, bending, crushing, material failure, etc.) and how those variations affect the creation and destruction of load paths between the impacting object and the occupant compartment during the crash event. It is therefore difficult to predict and assess structural interactions using computational methods when one does not have a detailed, as-built geometric and material model. Even when a complete model is available, prudent engineering assessments require extensive physical testing to verify crash behavior and safety. Despite all this, the agencies recognize that detailed crash simulations can be useful in estimating the relative structural effects of design changes over a limited range of crash conditions, and will continue to evaluate the appropriate use of this tool in the future.

Simplified crash simulations can also be valuable tools, but only when employed as part of a comprehensive analytical program. They are especially valuable in evaluating the relative effect and associated confidence intervals of feasible design alternatives. For example, the method employed by Nusholtz *et al.*[134] could be used by a vehicle designer to estimate the benefit of incremental changes in mass or wheelbase as well as the tradeoffs that might be made between them once that designer has settled on a preliminary design. A key difference between the research by Nusholtz and the research by Kebschull that Mr. Wenzel cited[135] is in their suggested applications. The former is useful in evaluating proposed alternatives early in the design process—Nusholtz specifically warns that the model provides only "general insights into the overall risk * * * and cannot be used to obtain specific response characteristics." Mr. Wenzel implies the latter can "isolate the effect of specific design changes, such as weight reduction" and thus quantify the fleet-wide effect of substantial vehicle redesigns. Yet while Kebschull reports injury reductions to three significant digits, there is no validation that vehicle structures of the proposed weight and stiffness are even feasible with current technology. Thus, while the agencies agree that computer simulations can be useful tools, we also recognize the value of statistical regression analysis for determining fleet-wide effects, because it inherently incorporates real-world factors in historical safety assessments.

DRI's analysis shows that lighter vehicles will save lives, and NHTSA reaches the opposite conclusion without disproving DRI's analysis

The difference between NHTSA's results and DRI's results for the relationship between vehicle mass and vehicle safety has been at the crux of this issue for several years. While NHTSA offered some theories in the NPRM as to why DRI might have found a safety benefit for mass reduction, NHTSA's work since then has enabled it to identify what we believe is the most likely reason for DRI's findings.

[133] Subsections 2.4 and 3.3 of new report.

[134] Nusholtz, G.S., G. Rabbiolo, and Y. Shi, "Estimation of the Effects of Vehicle Size and Mass on Crash-Injury Outcome Through Parameterized Probability Manifolds," Society of Automotive Engineers (2003), Document No. 2003–01–0905. *Available at http://www.sae.org/technical/papers/2003–01–0905* (last accessed Feb. 15, 2010).

[135] Mr. Wenzel cites the report by Kebschull et al. [2004, DRI–TR–04–04–02] as an example of what he regards as the effective use of computer crash simulation. NHTSA does not concur that this analysis represents a viable analytical method for evaluating the fleet-wide tradeoffs between vehicle mass and societal safety. The simulation method employed was not a full finite element representation of each major structural component in the vehicles in question. Instead, an Articulated Total Body (ATB) representation was constructed for each of two representative vehicles. In the ATB model, large structural subsystems were represented by a single ellipsoid. Consolidated load-deflection properties of these subsystems and the joints that tie them together were "calibrated" for an ATB vehicle model by requiring that it reproduce the acceleration pulse of a physical NHTSA crash test. NHTSA notes that vehicle simulation models that are calibrated to a single crash test configuration (*e.g.,* a longitudinal NCAP test into a rigid wall) are often ill-equipped to analyze alternative crash scenarios (*e.g.,* vehicle-to-vehicle crashes at arbitrary angles and lateral offsets).

The potential near multicollinearity of the variables of curb weight, track width, and wheelbase creates some degree of concern that any regression models with those variables could inaccurately calibrate their effects. However, based on its own experience with statistical analysis, NHTSA believes that the specific two-step regression model used by DRI increases this concern, because it weakens relationships between curb weight and dependent variables by splitting the effect of curb weight across the two regression steps.

The comments below are in response to NHTSA's theories in the NPRM about the source of the differences between NHTSA's and DRI's results. The majority of them are answered more fully in the 2010 Kahane report included in NHTSA's FRIA, but we respond to them in this document as well for purposes of completeness.

NHTSA and DRI may have reached different conclusions because NHTSA's study does not distinguish between reductions in size and reductions in weight like DRI's

Several commenters (CARB, CBD, EDF, ICCT, NRDC, and UCS) stated that DRI had been able to separate the effect of size and weight in its analysis, and in so doing proved that there was a safety benefit to reducing weight without reducing size. The commenters suggested that if NHTSA properly distinguished between reductions in size and reductions in weight, it would find the same result as DRI.

Agencies' response: In the 2010 Kahane analysis presented in the FRIA, NHTSA did attempt to separate the effects of vehicle size and weight by performing regression analyses with footprint (or alternatively track width and wheelbase) and curb weight as separate independent variables. For passenger cars, NHTSA found that the regressions attribute the fatality increase due to downsizing about equally to mass and footprint—that is, the effect of reducing mass alone is about half the effect of reducing mass *and* reducing footprint. Unlike DRI's results, NHTSA's regressions for passenger cars and for lighter LTVs did not find a safety benefit to reducing weight without reducing size; while NHTSA did find a safety benefit for reducing weight in the heaviest LTVs, the magnitude of the benefit as compared to DRI's was significantly smaller. NHTSA believes that these differences in results may be an artifact of DRI's two-step regression model, as explained above.

NHTSA and DRI may have reached different conclusions because NHTSA's study does not include two-door cars like DRI's

One of NHTSA's primary theories in the NPRM as to why NHTSA and DRI's results differed related to DRI's inclusion in its analysis of 2-door cars. NHTSA had excluded those vehicles from its analysis on the grounds that 2-door cars had a disproportionate crash rate (perhaps due to their inclusion of muscle and sports cars) which appeared likely to skew the regression. Several commenters argued that NHTSA should have included 2-door cars in its analysis. DRI and James Adcock stated that 2-door cars should not be excluded because they represent a significant portion of the light-duty fleet, while CARB and ICCT stated that because DRI found safety benefits whether 2-door cars were included or not, NHTSA should include 2-door cars in its analysis. Wenzel also commented that NHTSA should include 2-door cars in subsequent analyses, stating that while his analysis of MY 2000–2004 crash data from 5 states indicates that, in general, 4-door cars tend to have lower fatality risk than 2-door cars, the risk is even lower when he accounts for driver age/gender and crash location. Wenzel suggested that the increased fatality risk in the 2-door car population seemed primarily attributable to the sports cars, and that that was not sufficient grounds to exclude all 2-door cars from NHTSA's analysis.

Agencies' response: The agencies agree that 2-door cars can be included in the analysis, and NHTSA retracts previous statements that DRI's inclusion of them was incorrect. In its 2010 analysis, NHTSA finds that it makes little difference to the results whether 2-door cars are included, partially included, or excluded from the analysis. Thus, analyses of 2-door and 4-door cars combined, as well as other combinations, have been included in the analysis. That said, no combination of 2-door and 4-door cars resulted in NHTSA's finding a safety benefit for passenger cars due to mass reduction.

NHTSA and DRI may have reached different conclusions due to different assumptions

DRI commented that the differences found between its study and NHTSA's may be due to the different assumptions about the linearity of the curb weight effect and control variable for driver age, vehicle age, road conditions, and other factors. NHTSA's analysis was based on a two-piece linear model for curb weight with two different weight groups (less than 2,950 lbs., and greater than or equal to 2.950 lbs). The DRI analysis assumed a linear model for curb weight with a single weight group. Additionally, DRI stated that NHTSA's use of eight control variables (rather than three control variables like DRI used) for driver age introduces additional degrees of freedom into the regressions, which it suggested may be correlated with the curb weight, wheelbase, and track width, and/or other control variables. DRI suggested that this may also affect the results and cause or contribute to the differences in outcomes between NHTSA and DRI.

Agencies' response: NHTSA's FRIA documents that NHTSA analyzed its database using both a single parameter for weight (a linear model) and two parameters for weight (a two-piece linear model). In both cases, the logistic regression responded identically, allocating the same way between weight, wheelbase, track width, or footprint.[136] Thus, NHTSA does not believe that the differences between its results and DRI's results are due to whether the studies used a single weight group or two weight groups.

The FRIA also documents that NHTSA examined NHTSA's use of eight control variables for driver age (ages 14–30, 30–50, 50–70, 70+ for males and females separately, versus DRI's use of three control variables for age (FEMALE = 1 for females, 0 for males, YOUNGDRV = 35–AGE for drivers under 35, 0 for all others, OLDMAN = AGE–50 for males over 50, 0 for all others; OLDWOMAN = AGE–45 for females over 45, 0 for all others) to see if that affected the results. NHTSA ran its analysis using the eight control variables and again using three control variables for age, and obtained similar results each time.[137] Thus, NHTSA does not believe that the differences between its results and DRI's results are due to the number of control variables used for driver age.

NHTSA's and DRI's conclusions may be similar if confidence intervals are taken into account

DRI commented that NHTSA has not reported confidence intervals, while DRI has reported them in its studies. Thus, DRI argued, it is not possible to determine whether the confidence intervals overlap and whether the differences between NHTSA's and DRI's analyses are statistically significant.

Agencies' response: NHTSA has included confidence intervals for the main results of the 2010 Kahane analysis, as shown in Chapter IX of NHTSA's FRIA. For passenger cars, the NHTSA results are a statistically

[136] Subsections 2.2 and 2.3 of new report.

[137] *Id.*

significant increase in fatalities with a 100 pound reduction while maintaining track width and wheelbase (or footprint); the DRI results are a statistically significant decrease in fatalities with a 100 pound reduction while maintaining track width and wheelbase. The DRI results are thus outside the confidence bounds of the NHTSA results and do not overlap.

NHTSA should include a "best-case" estimate in its study

Several commenters (Center for Auto Safety, NRDC, Public Citizen, Sierra Club *et al.,* and Wenzel) urged NHTSA to include a "best-case" estimate in the final rule, showing scenarios in which lives were saved rather than lost. Public Citizen stated that there would be safety benefits to reducing the weight of the heaviest vehicles while leaving the weight of the lighter vehicles unchanged, and that increasing the number of smaller vehicles would provide safety benefits to pedestrians, bicyclists, and motorcyclists. Sierra Club *et al.* stated that new materials, smart design, and lighter, more advanced engines can all improve fuel economy while maintaining or increasing vehicle safety. Both Center for Auto Safety and Sierra Club argued that the agency should have presented a "best-case" scenario to balance out the "worst-case" scenario presented in the NPRM, especially if NHTSA itself believed that the worst-case scenario was not inevitable. NRDC requested that NHTSA present both a "best-case" and a "most likely" scenario. Wenzel simply stated that NHTSA did not present a "best-case" scenario, despite DRI's finding in 2005 that fatalities would be reduced if track width was held constant.

Agencies' response: NHTSA has included an "upper estimate" and a "lower estimate" in the new 2010 Kahane analysis. The lower estimate assumes that mass reduction will be accomplished entirely by material substitution or other techniques that do not perceptibly change a vehicle's shape, structural strength, or ride quality. The lower estimate examines specific crash modes and is meant to reflect the increase in fatalities for the specific crash modes in which a reduction in mass *per se* in the case vehicle would result in a reduction in safety: namely, collisions with larger vehicles not covered by the regulations (*e.g.,* trucks with a GVWR over 10,000 lbs), collisions with partially-movable objects (*e.g.,* some trees, poles, parked cars, etc.), and collisions of cars or light LTVs with heavier LTVs—as well as the specific crash modes where a reduction in mass *per se* in the case vehicle would benefit safety: namely, collisions of heavy LTVs with cars or lighter LTVs. NHTSA believes that this is the effect of mass *per se, i.e.,* the effects of reduced mass will generally persist in these crashes regardless of how the mass is reduced. The lower estimate attempts to quantify that scenario, although any such estimate is hypothetical and subject to considerable uncertainty. NHTSA believes that a "most likely" scenario cannot be determined with any certainty, and would depend entirely upon agency assumptions about how manufacturers intend to reduce mass in their vehicles. While we can speculate upon the potential effects of different methods of mass reduction, we cannot predict with certainty what manufacturers will ultimately do.

NHTSA should not include a "worst-case" estimate in its study

NRDC, Public Citizen and Sierra Club *et al.* commented that NHTSA should remove the "worst-case scenario" estimate from the rulemaking, generally because it was based on an analysis that evaluated historical vehicles, and future vehicles would be sufficiently different to render the "worst-case scenario" inapplicable.

Agencies' response: NHTSA stated in the NPRM that the "worst-case scenario" addressed the effect of a kind of downsizing (*i.e.,* mass reduction accompanied by footprint reduction) that was not likely to be a consequence of attribute-based CAFE standards, and that the agency would refine its analysis of such a scenario for the final rule. NHTSA has not used the "worst-case scenario" in the final rule. Instead, we present three scenarios: the first is an estimate based directly on the regression coefficients of weight reduction *while maintaining footprint* in the statistical analyses of historical data. As discussed above, presenting this scenario is possible because NHTSA attempted to separate the effects of weight and footprint reduction in the new analysis. However, even the new analysis of LTVs produced some coefficients that NHTSA did not consider entirely plausible. NHTSA also presents an "upper estimate" in which those coefficients for the LTVs were adjusted based on additional analyses and expert opinion as a safety agency and a "lower estimate," which estimates the effect if mass reduction is accomplished entirely by safety-conscious technologies such as material substitution.

3. How has NHTSA refined its analysis for purposes of estimating the potential safety effects of this Final Rule?

During the past months, NHTSA has extensively reviewed the literature on vehicle mass, size, and fatality risk. NHTSA now agrees with DRI and other commenters that it is essential to analyze the effect of mass independently from the effects of size parameters such as wheelbase, track width, or footprint—and that the NPRM's "worst-case" scenario based on downsizing (in which weight, wheelbase, and track width could all be changed) is not useful for that purpose. The agency should instead provide estimates that better reflect the more likely effect of the regulation—estimating the effect of mass reduction that maintains footprint.

Yet it is more difficult to analyze multiple, independent parameters than a single parameter (*e.g.,* curb weight), because there is a potential concern that the near multicollinearity of the parameters—the strong, natural and historical correlation of mass and size—can lead to inaccurate statistical estimates of their effects.[138] NHTSA has performed new statistical analyses of its historical database of passenger cars, light trucks, and vans (LTVs) from its 2003 report (now including also 2-door cars), assessing relationships between fatality risk, mass, and footprint. They are described in Subsections 2.2 (cars) and 3.2 (LTVs) of the 2010 Kahane report presented in Chapter IX of the FRIA. While the potential concerns associated with near multicollinearity are inherent in regression analyses with multiple size/mass parameters, NHTSA believes that the analysis approach in the 2010 Kahane report, namely a single-step regression analysis, generally reduces those concerns[139] and models the trends in the historical data. The results differ substantially from DRI's, based on a two-step regression analysis. Subsections 2.3 and 2.4 of the 2010

[138] Greene, W. H. (1993). *Econometric Analysis,* Second Edition. New York: Macmillan Publishing Company, pp. 266–268; Allison, P.D. (1999), *Logistic Regression Using the SAS System.* Cary, NC: SAS Institute Inc., pp. 48–51. The report shows variance inflation factor (VIF) scores in the 5–7 range for curb weight, wheelbase, and track width (or, alternatively, curb weight and footprint) in NHTSA's database, exceeding the 2.5 level where near multicollinearity begins to become a concern in logistic regression analyses.

[139] NHTSA believes that, given the near multicollinearity of the independent variables, the two-step regression augments the possibility of estimating inaccurate coefficients for curb weight, because it weakens relationships between curb weight and dependent variables by splitting the effect of curb weight across the two regression steps as discussed further in Subsection 2.3 of NHTSA's report.

Kahane report attempt to account for the differences primarily by applying selected techniques from DRI's analyses to NHTSA's database.

The statistical analyses—logistic regressions—of trends in MYs 1991–1999 vehicles generate one set of estimates of the possible effects of reducing mass by 100 pounds while maintaining footprint. While these effects might conceivably carry over to future mass reductions, there are two reasons that future safety effects of mass reduction could differ from projections from historical data:

- The statistical analyses are "cross-sectional" analyses that estimate the increase in fatality rates for vehicles weighing n-100 pounds relative to vehicles weighing n pounds, across the spectrum of vehicles on the road, from the lightest to the heaviest. They do not directly compare the fatality rates for a specific make and model before and after a 100-pound reduction from that model. Instead, they use the differences across makes and models as a surrogate for the effects of actual reductions within a specific model; those cross-sectional differences could include trends that are statistically, but not causally related to mass.
- The manner in which mass changed across MY 1991–1999 vehicles might not be consistent with future mass reductions, due to the availability of newer materials and design methods.

Therefore, Subsections 2.5 and 3.4 of the 2010 Kahane report supplement those estimates with one or more scenarios in which some of the logistic regression coefficients are replaced by numbers based on additional analyses and NHTSA's judgment of the likely effect of mass *per se* (the ability to transfer momentum to other vehicles or objects in a collision) and of what trends in the historical data could be avoided by current mass-reduction technologies such as materials substitution. The various scenarios may be viewed as a plausible range of point estimates for the effects of mass reduction while maintaining footprint, but they should not be construed as upper and lower bounds. Furthermore, being point estimates, they are themselves subject to uncertainties, such as, for example, the sampling errors associated with statistical analyses.

The principal findings and conclusions of the 2010 Kahane report are as follows:

Passenger cars: This database with the one-step regression method of the 2003 Kahane report estimates an increase of 700–800 fatalities when curb weight is reduced by 100 pounds *and* footprint is reduced by 0.65 square feet (the historic average footprint reduction per 100-pound mass reduction in cars). The regression attributes the fatality increase *about equally to curb weight and to footprint.* The results are approximately the same whether 2-door cars are fully included or partially included in the analysis or whether only 4-door cars are included (as in the 2003 report). Regressions by curb weight, track width and wheelbase produce findings quite similar to the regressions by curb weight and footprint, but the results with the single "size" variable, footprint, rather than the two variables, track width and wheelbase vary even less with the inclusion or exclusion of 2-door cars.

In Subsection 2.3 of the new report, a two-step regression method that resembles (without exactly replicating) the approach by DRI, *when applied to the same (NHTSA's) crash and registration data,* estimates a large *benefit* when mass is reduced, offset by even larger fatality increases when track width and wheelbase (or footprint) are reduced. NHTSA believes that the benefit estimated by this method is inaccurate, due to the potential concerns with the near multicollinearity of the parameters (curb weight, track width, and wheelbase) [140] even though the analysis is theoretically unbiased.[141] Almost any analysis incorporating those parameters has a possibility of inaccurate coefficients due to near multicollinearity; however, based on our own experience with other regression analyses of crash data, NHTSA believes a DRI-type two-step method augments the possibility of estimating inaccurate coefficients for curb weight, because it weakens relationships between curb weight and dependent variables by splitting the effect of curb weight across the two regression steps.

In Subsection 2.4 of the new report, as a check on the results from the regression methods, NHTSA also performed what we refer to as "decile" analyses: Simpler, tabular data analysis that compares fatality rates of cars of different mass but similar footprint. Decile analysis is not a precise tool because it does not control for confounding factors such as driver age/gender or the specific type of car, but it may be helpful in identifying the general directional trend in the data when footprint is held constant and curb weight varies. The decile analyses show that fatality risk in MY 1991–1999 cars generally increased and rarely decreased for lighter relative to heavier cars *of the same footprint.* They suggest that the historical, cross-sectional trend was generally in the lighter ↔ more fatalities direction and not in the opposite direction, as might be suggested by the regression coefficients from the method that resembles DRI's approach.

The regression coefficients from NHTSA's one-step method suggest that mass and footprint each accounted for about half the fatality increase associated with downsizing in a cross-sectional analysis of 1991–1999 cars. They estimate the historical difference in *societal* fatality rates (*i.e.,* including fatalities to occupants of all the vehicles involved in the collisions, plus any pedestrians) of cars of different curb weights but the same footprint. They may be considered an "upper-estimate scenario" of the effect of future mass reduction—if it were accomplished in a manner that resembled the historical cross-sectional trend—*i.e.,* without any particular regard for safety (other than not to reduce footprint).

However, NHTSA believes that future vehicle design is likely to take advantage of safety-conscious technologies such as materials substitution that can reduce mass without perceptibly changing a car's shape or ride and maintain its structural strength. This could avoid much of the risk associated with lighter and smaller vehicles in the historical analyses, especially the historical trend toward higher crash-involvement rates for lighter and smaller vehicles.[142] It could thereby shrink the added risk close to just the effects of mass *per se* (the ability to transfer momentum to other vehicles or objects in a collision). Subsection 2.5 of the 2010 Kahane report attempts to quantify a "lower-estimate scenario" for the potential effect of mass reduction achieved by safety-conscious technologies; the estimated effects are substantially smaller than in the upper-

[140] As evidenced by VIF scores in the 5–7 range, exceeding the 2.5 level where near multicollinearity begins to become a concern in logistic regression analyses.

[141] Subsection 2.3 of the 2010 Kahane report attempts to explain why the two-step method, when applied to NHTSA's 2003 database, produces results a lot like DRI's, but it does not claim that DRI obtained its results from its own database for exactly those reasons. NHTSA did not analyze DRI's database. The two-step method is "theoretically unbiased" in the sense that it seeks to estimate the same parameters as the one-step analysis.

[142] This is discussed in greater depth in Subsections 2.1 and 2.5 of the 2010 Kahane report. The historic trend toward higher crash-involvement rates for lighter and smaller vehicles is documented in IIHS Advisory No. 5, July 1988, *http://www.iihs.org/research/advisories/iihs_advisory_5.pdf*; IIHS News Release, February 24, 1998, *http://www.iihs.org/news/1998/iihs_news_022498.pdf*; Auto Insurance Loss Facts, September 2009, *http://www.iihs.org/research/hldi/fact_sheets/CollisionLoss_0909.pdf.*

estimate scenario based directly on the regression results.

We note, again, that the preceding paragraph is conditional. Nothing in the CAFE standard requires manufacturers to use material substitution or, more generally, take a safety-conscious approach to mass reduction.[143] Federal Motor Vehicle Safety Standards include performance tests that verify historical improvements in structural strength and crashworthiness, but few FMVSS provide test information that sheds light about how a vehicle rides or otherwise helps explain the trend toward higher crash-involvement rates for lighter and smaller vehicles. It is possible that using material substitution and other current mass reduction methods could avoid the historical trend in this area, but that remains to be studied as manufacturers introduce more of these vehicles into the on-road fleet in coming years. A detailed discussion of methods currently used for reducing the mass of passenger cars and light trucks is included in Chapter 3 of the Technical Support Document.

LTVs: The principal difference between LTVs and passenger cars is that mass reduction in the heavier LTVs is estimated to have significant societal benefits, in that it reduces the fatality risk for the occupants of cars and light LTVs that collide with the heavier LTVs. By contrast, footprint (size) reduction in LTVs has a harmful effect (for the LTVs' own occupants), as in cars. The regression method of the 2003 Kahane report applied to the database of that report estimates a societal increase of 231 fatalities when curb weight is reduced by 100 pounds *and* footprint is reduced by 0.975 square feet (the historic average footprint reduction per 100-pound mass reduction in LTVs). But the regressions attribute an overall *reduction* of 266 fatalities to the 100-pound mass reduction and an increase of 497 fatalities to the .975-square-foot footprint reduction. The regression results constitute one of the scenarios for the possible societal effects of future mass reduction in LTVs.

However, NHTSA cautions that some of the regression coefficients, even by NHTSA's preferred method, might not accurately model the historical trend in the data, possibly due to near multicollinearity of curb weight and footprint or because of the interaction of both of these variables with LTV type.[144] Based on supplementary analyses and discussion in Subsections 3.3 and 3.4, the new report defines an additional upper-estimate scenario that NHTSA believes may more accurately reflect the historical trend in the data and a lower-estimate scenario that may come closer to the effects of mass *per se.* All three scenarios, however, attribute a societal fatality reduction to mass reduction in the heavier LTVs.

Overall effects of mass reduction while maintaining footprint in cars and LTVs: The immediate purpose of the new report's analyses of relationships between fatality risk, mass, and footprint is to develop the four parameters that the Volpe model needs in order to predict the safety effects, if any, of the modeled mass reductions in MYs 2012–2016 cars and LTVs over the lifetime of those vehicles. The four numbers are the overall percentage increases or decreases, per 100-pound mass reduction while holding footprint constant, in crash fatalities involving: (1) Cars < 2,950 pounds (which was the median curb weight of cars in MY 1991–1999), (2) cars ≥ 2,950 pounds, (3) LTVs < 3,870 pounds (which was the median curb weight of LTVs in those model years), and (4) LTVs ≥ 3,870 pounds. Here are the percentage effects for each of the three alternative scenarios, again, the "upper-estimate scenario" and the "lower-estimate scenario" have been developed based on NHTSA's expert opinion as a vehicle safety agency:

FATALITY INCREASE PER 100-POUND REDUCTION (%) [145]

	Actual regression result scenario	NHTSA expert opinion upper-estimate scenario [146]	NHTSA expert opinion lower-estimate scenario
Cars < 2,950 pounds	2.21	2.21	1.02
Cars ≥ 2,950 pounds	0.90	0.90	0.44
LTVs < 3,870 pounds	0.17	0.55	0.41
LTVs ≥ 3,870 pounds	−1.90	−0.62	−0.73

In all three scenarios, the estimated effects of a 100-pound mass reduction while maintaining footprint are an increase in fatalities in cars < 2,950 pounds, substantially smaller increases in cars ≥ 2,950 pounds and LTVs < 3,870 pounds, and a societal benefit for LTVs ≥ 3,870 pounds (because it reduces fatality risk to occupants of cars and lighter LTVs they collide with). These are the estimated effects of reducing each vehicle by exactly 100pounds. However, the actual mass reduction will vary by make, model, and year. The aggregate effect on fatalities can only be estimated by attempting to forecast, as NHTSA has using inputs to the Volpe model, the mass reductions by make and model. It should be noted, however, that a 100-pound reduction would be 5 percent of the mass of a 2000-pound car but only 2 percent of a 5000-pound LTV. Thus, a forecast that mass will decrease by an equal or greater percentage in the heavier vehicles than in the lightest cars would be proportionately more influenced by the benefit for mass reduction in the heavy LTVs than by the fatality increases in the other groups; it is likely to result in an estimated net benefit under one or more of the scenarios. It should also be noted, again, that the

[143] Footprint-based standards do not specify how or where to remove mass while maintaining footprint, nor do they categorically forbid footprint reductions, even if they discourage them.

[144] For example, mid-size SUVs of the 1990s typically had high mass relative to their short wheelbase and footprint (and exceptionally high rates of fatal rollovers); minivans typically have low mass relative to their footprint (and low fatality rates); heavy-duty pickup trucks used extensively for work tend to have more mass, for the same footprint, as basic full-sized pickup trucks that are more often used for personal transportation.

[145] Reducing mass by 100 pounds in these vehicles is estimated to have the listed percentage effect on fatalities in crashes involving these vehicles. For example, if these vehicles are involved in crashes that result in 10,000 fatalities, 2.21 means that if mass is reduced by 100 pounds, fatalities will increase to 10,221 and −0.73 means fatalities will decrease to 9,927. In the scenario based on actual regression results, the 1.96-sigma sampling errors in the above estimates are ±0.91 percentage points for cars < 2,950 pounds and also for cars ≥ 2,950 pounds, ±0.82 percentage points for LTVs < 3,870 pounds, and ±1.18 percentage points for LTVs ≥ 3,870 pounds. In other words, the fatality increase in the cars < 2,950 pounds and the societal fatality reduction attributed to mass reduction in the LTVs ≥ 3,870 pounds are statistically significant. The sampling errors associated with the scenario based on actual regression results perhaps also indicate the general level of statistical noise in the other two scenarios.

[146] For passenger cars, the upper-estimate scenario *is* the actual-regression-result scenario.

three scenarios are point estimates and are subject to uncertainties, such as the sampling errors associated with the regression results. In the scenario based on actual regression results, the 1.96-sigma sampling errors in the above estimates are ± 0.91 percentage points for cars < 2,950 pounds and also for cars ≥ 2,950 pounds, ± 0.82 percentage points for LTVs < 3,870 pounds, and ± 1.18 percentage points for LTVs ≥ 3,870 pounds. In other words, the fatality increase in the cars < 2,950 pounds and the societal fatality reduction attributed to mass reduction in the LTVs ≥ 3,870 pounds are statistically significant. The sampling errors associated with the scenario based on actual regression results perhaps also indicate the general level of statistical noise in the other two scenarios.

4. What are the estimated safety effects of this Final Rule?

The table below shows the estimated safety effects of the modeled reduction in vehicle mass provided in the NPRM and in this final rule in order to meet the MYs 2012–2016 standards, based on the analysis described briefly above and in much more detail in Chapter IX of the FRIA. These are combined results for passenger cars and light trucks. A positive number is an estimated increase in fatalities and a negative number (shown in parentheses) is an estimated reduction in fatalities over the lifetime of the model year vehicles compared to the MY 2011 baseline fleet.

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
NPRM "Worst Case"	34	54	194	313	493
NHTSA Expert Opinion Final Rule Upper Estimate	9	14	26	24	22
NHTSA Expert Opinion Final Rule Lower Estimate	2	4	(17)	(53)	(80)
Actual Regression Result Scenario	0	2	(94)	(206)	(301)

NHTSA emphasizes that the table above is based on the NHTSA's assumptions about how manufacturers might choose to reduce the mass of their vehicles in response to the final rule, which are very similar to EPA's assumptions. In general, as discussed above, the agencies assume that mass will be reduced by as much as 10 percent in the heaviest LTVs but only by as much as 5 percent in other vehicles and that substantial mass reductions will take place only in the year that models are redesigned. The actual mass reduction that is likely to occur in response to the standards will of course vary by make and model, depending on each manufacturer's particular approach, with likely more opportunity for the largest LTVs that still use separate frame construction.

The "upper estimate" presented above, as discussed in the FRIA, assumes only that manufacturers will reduce vehicle mass without reducing footprint. Thus, under such a scenario, safety effects could be somewhat adverse if, for example, manufacturers chose to reduce crush space associated with vehicle overhang as a way of reducing mass without changing footprint. The "lower estimate," in turn, is based on the assumption that manufacturers will reduce vehicle mass solely through methods like material substitution, which (under these assumptions) fully maintain not only footprint but also all structural integrity, and other aspects of vehicle safety. Under these scenarios, safety effects could be worse if mass reduction was not undertaken thoughtfully to maintain existing safety levels, but could also be better if it was undertaken with a thorough and extensive vehicle redesign to maximize both mass reduction and safety.

And finally, while NHTSA does not believe that the "worst-case" scenario presented in the NPRM is likely to occur during the MYs 2012–2016 timeframe, we cannot guarantee that manufacturers will never choose to reduce vehicle footprint, particularly if market forces lead to increased sales of small vehicles in response to sharp increases in the price of petroleum, though this situation would not be in direct response to the CAFE/GHG standards. Thus, we cannot completely reject the worst-case scenario for all vehicles, although we can and do recognize that the footprint-based standards will significantly limit the likelihood of its occurrence within the context of this rulemaking.

In summary, the agencies recognize the balancing inherent in achieving higher levels of fuel economy and lower levels of CO_2 emissions through reduction of vehicle mass. Based on the 2010 Kahane analysis that attempts to separate the effects of mass reductions and footprint reductions, and to account better for the possibility that mass reduction will be accomplished entirely through methods that preserves structural strength and vehicle safety, the agencies now believe that the likely deleterious safety effects of the MYs 2012–2016 standards may be much lower than originally estimated. They may be close to zero, or possibly beneficial if mass reduction is carefully undertaken in the future and if the mass reduction in the heavier LTVs is greater (in absolute terms) than in passenger cars. In light of these findings, we believe that the balancing is reasonable.

5. How do the agencies plan to address this issue going forward?

NHTSA and EPA believe that it is important for the agencies to conduct further study and research into the interaction of mass, size and safety to assist future rulemakings. The agencies intend to begin working collaboratively and to explore with DOE, CARB, and perhaps other stakeholders an interagency/intergovernmental working group to evaluate all aspects of mass, size and safety. It would also be the goal of this team to coordinate government supported studies and independent research, to the extent possible, to help ensure the work is complementary to previous and ongoing research and to guide further research in this area. DOE's EERE office has long funded extensive research into component advanced vehicle materials and vehicle mass reduction. Other agencies may have additional expertise that will be helpful in establishing a coordinated work plan. The agencies are interested in looking at the weight-safety relationship in a more holistic (complete vehicle) way, and thanks to this CAFE rulemaking NHTSA has begun to bring together parts of the agency—crashworthiness, and crash avoidance rulemaking offices and the agency's Research & Development office—in an interdisciplinary way to better leverage the expertise of the agency. Extending this effort to other agencies will help to ensure that all aspects of the weight-safety relationship are considered completely and carefully with our future research. The agencies also intend to carefully consider comments received in response to the NPRM in developing plans for future studies and research and to solicit input from stakeholders.

The agencies also plan to watch for safety effects as the U.S. light-duty vehicle fleet evolves in response both to the CAFE/GHG standards and to consumer preferences over the next several years. Additionally, as new and advanced materials and component smart designs are developed and commercialized, and as manufacturers implement them in more vehicles, it will be useful for the agencies to learn more about them and to try to track these vehicles in the fleet to understand the relationship between vehicle design and injury/fatality data. Specifically, the agencies intend to follow up with study and research of the following:

First, NHTSA is in the process of contracting with an independent institution to review the statistical methods that NHTSA and DRI have used to analyze historical data related to mass, size and safety, and to provide recommendation on whether the existing methods or other methods should be used for future statistical analysis of historical data. This study will include a consideration of potential near multicollinearity in the historical data and how best to address it in a regression analysis. This study is being initiated because, in response to the NPRM, NHTSA received a number of comments related to the methodology NHTSA used for the NPRM to determine the relationship between mass and safety, as discussed in detail above.

Second, NHTSA and EPA, in consultation with DOE, intend to begin updating the MYs 1991–1999 database on which the safety analyses in the NPRM and final rule are based with newer vehicle data in the next several months. This task will take at least a year to complete. This study is being initiated in response to the NPRM comments related to the use of data from MYs 1991–1999 in the NHTSA analysis, as discussed in detail above.

Third, in order to assess if the design of recent model year vehicles that incorporate various mass reduction methods affect the relationships among vehicle mass, size and safety, NHTSA and EPA intend to conduct collaborative statistical analysis, beginning in the next several months. The agencies intend to work with DOE to identify vehicles that are using material substitution and smart design. After these vehicles are identified, the agencies intend to assess if there are sufficient data for statistical analysis. If there are sufficient data, statistical analysis would be conducted to compare the relationship among mass, size and safety of these smart design vehicles to vehicles of similar size and mass with more traditional designs. This study is being initiated because, in response to the NPRM, NHTSA received comments related to the use of data from MYs 1991–1999 in the NHTSA analysis that did not include new designs that might change the relationship among mass, size and safety, as discussed in detail above.

NHTSA may initiate a two-year study of the safety of the fleet through an analysis of the trends in structural stiffness and whether any trends identified impact occupant injury response in crashes. Vehicle manufacturers may employ stiffer light weight materials to limit occupant compartment intrusion while controlling for mass that may expose the occupants to higher accelerations resulting in a greater chance of injury in real-world crashes. This study would provide information that would increase the understanding of the effects on safety of newer vehicle designs.

In addition, NHTSA and EPA, possibly in collaboration with DOE, may conduct a longer-term computer modeling-based design and analysis study to help determine the maximum potential for mass reduction in the MYs 2017–2021 timeframe, through direct material substitution and smart design while meeting safety regulations and guidelines, and maintaining vehicle size and functionality. This study may build upon prior research completed on vehicle mass reduction. This study would further explore the comprehensive vehicle effects, including dissimilar material joining technologies, manufacturer feasibility of both supplier and OEM, tooling costs, and crash simulation and perhaps eventual crash testing.

III. EPA Greenhouse Gas Vehicle Standards

A. Executive Overview of EPA Rule

1. Introduction

The Environmental Protection Agency (EPA) is establishing GHG emissions standards for the largest sources of transportation GHGs—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 emissions of the six gases discussed above (Section I.A). This action represents the first-ever EPA rule to regulate vehicle GHG emissions under the Clean Air Act (CAA) and will establish standards for model years 2012–2016 and later light vehicles sold in the United States.

EPA is adopting 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 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 will be measured over the EPA city and highway tests. The rule 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 325 grams per mile while the average vehicle fleetwide average CO_2 emissions compliance level for the 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 finalizing 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 standards is to limit any potential increases of tailpipe emissions of these compounds in the future but not to force reductions relative to today's low levels.

This final rule responds to the Supreme Court's 2007 decision in *Massachusetts* v. *EPA* [147] which found that greenhouse gases fit within the definition of air pollutant in 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 making these decisions, the EPA Administrator is required to follow the language of section 202(a) of the CAA. The case was remanded back to the Agency for reconsideration in light of the court's decision.

The Administrator has responded to the remand by issuing two findings under section 202(a) of the Clean Air

[147] 549 U.S.C. 497 (2007). For further information on *Massachusetts* v. *EPA* see the Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) the Clean Air Act, published in the Federal Register on December 15, 2009 (74 FR 66496). 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. This information is also available at: *http://www.epa.gov/climatechange/endangerment.html.*

Act.[148] First, the Administrator found that the science supports a positive endangerment finding that the mix of six 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 endangers the public health and welfare of current and future generations. This is referred to as the endangerment finding. Second, the Administrator found that the combined emissions of the same six gases 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. Motor vehicles and new motor vehicle engines emit carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons. EPA provides more details below on the legal and scientific bases for this final rule.

As discussed in Section I, this GHG rule is part of a joint National Program such that a large majority of the projected benefits are achieved jointly with NHTSA's CAFE rule which is described in detail in Section IV of this preamble. EPA projects total CO_2 equivalent emissions savings of approximately 960 million metric tons as a result of the rule, and oil savings of 1.8 billion barrels over the lifetimes of the MY 2012–2016 vehicles subject to the rule. EPA projects that over the lifetimes of the MY 2012–2016 vehicles, the rule will cost $52 billion but will result in benefits of $240 billion at a 3 percent discount rate, or $192 billion at a 7 percent discount rate (both values assume the average SCC value at 3%, *i.e.,* the $21/ton SCC value in 2010). Accordingly, these light vehicle greenhouse gas emissions standards represent an important contribution under the Clean Air Act toward meeting long-term greenhouse gas emissions and import oil reduction goals, while providing important economic benefits as well. The results of our analysis of 2012–2016 MY vehicles, which we refer to as our "model year analysis," are summarized in Tables III.H.10–4 to III.H.10–7.

We have also looked beyond the lifetimes of 2012–2016 MY vehicles at annual costs and benefits of the program for the 2012 through 2050 timeframe. We refer to this as our "calendar year" analysis (as opposed to the costs and benefits mentioned above which we refer to as our "model year analysis"). In our calendar year analysis, the new 2016 MY standards are assumed to apply to all vehicles sold in model years 2017 and later. The net present values of annual costs for the 2012 through 2050 timeframe are $346 billion for new vehicle technology which will provide $1.5 billion in fuel savings, both values at a 3 percent discount rate. At a 7 percent discount rate over the same period, the technology costs are estimated at $192 billion which will provide $673 billion in fuel savings. The social benefits during the 2012 through 2050 timeframe are estimated at $454 billion and $305 billion at a 3 and 7 percent discount rate, respectively. Both of these benefit estimates assume the average SCC value at 3% (*i.e.,* the $21/ ton SCC value in 2010). The net benefits during this time period are then $1.7 billion and $785 million at a 3 and 7 percent discount rate, respectively. The results of our "calendar year" analysis are summarized in Tables III.H 10–1 to III.H.10–3.

2. Why is EPA establishing this Rule?

This rule 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 GHG 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 their 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 compliance and fuel economy determinations, which would require only minor modifications to accommodate greenhouse gas emissions regulations. Finally, this rule is an important step in responding to the Supreme Court's ruling in *Massachusetts* v. *EPA,* which applies to other emissions sources in addition to light-duty vehicles. In fact, EPA is currently evaluating controls for motor vehicles other than those covered by this rule, and is also reviewing seven motor vehicle related 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 that are directly emitted by human activities 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 the cause of most of the observed global warming over the last 50 years.[149] 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 promulgated Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act.[150]

Mobile sources represent a large and growing share of United States greenhouse gases and include light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, heavy duty trucks, airplanes, railroads, marine vessels and a variety of other sources. In 2007, all mobile sources emitted 31% of

[148] *See* 74 FR 66496 (Dec. 15, 2009), "Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act".

[149] "Technical Support Document for Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act" Docket: EPA–HQ–OAR–2009–0472–11292.

[150] 74 FR 66496 (Dec. 15, 2009). Both the **Federal Register** Notice and the Technical Support Document for Endangerment and Cause or Contribute Findings are found in the public docket No. EPA–OAR–2009–0171, in the public docket established for this rulemaking, and at *http://epa.gov/climatechange/endangerment.html.*

all U.S. GHGs, and were the fastest-growing source of U.S. GHGs in the U.S. since 1990. Transportation sources, which do not include certain off-highway sources such as farm and construction equipment, account for 28% of U.S. GHG emissions, and Section 202(a) sources, which include light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, heavy-duty trucks, buses, and motorcycles account for 23% of total U.S. GHGs.[151]

Light vehicles emit 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.[152] 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).[153] 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.[154] 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.[155]

b. Basis for Action Under the 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 found that the elevated concentrations of greenhouse gases in the atmosphere may reasonably be anticipated to endanger public health and welfare.[156] The Administrator defined the "air pollution" referred to in CAA section 202(a) to be the combined mix of six long-lived and directly emitted 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 found under CAA section 202(a) that emissions of the single air pollutant defined as the aggregate group of these same six greenhouse gases from new motor vehicles and new motor vehicle engines contribute to air pollution. As a result of these findings, section 202(a) requires EPA to issue standards applicable to emissions of that air pollutant. New motor vehicles and engines emit CO_2, methane, N_2O and HFC. This preamble describes the provisions that control emissions of CO_2, HFCs, nitrous oxide, and methane. For further discussion of EPA's authority under section 202(a), see Section I.C.2 of the preamble to the proposed rule (74 FR at 49464–66).

There are a variety of other CAA Title II provisions that are relevant to standards established under section 202(a). The standards are applicable to motor vehicles for their useful life. EPA has the discretion in determining what standard applies over the vehicles' useful life and has exercised that discretion in this rule. See Section III*.E.*4 below.

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 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). Section III.E describes the rule's certification, compliance, and enforcement mechanisms.

c. EPA's Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act

On December 7, 2009 EPA's Administrator signed an action with two distinct findings regarding greenhouse gases under section 202(a) of the Clean Air Act. On December 15, 2009, the final findings were published in the Federal Register. This action is called the Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act (Endangerment Finding).[157] Below are the two distinct findings:

- Endangerment Finding: The Administrator finds that the current and projected concentrations of the six key well-mixed 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.
- Cause or Contribute Finding: The Administrator finds that the combined emissions of these well-mixed greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas pollution which threatens public health and welfare.

Specifically, the Administrator found, after a thorough examination of the scientific evidence on the causes and impact of current and future climate change, and careful review of public comments, 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 finding, the Administrator relied heavily upon the major findings and conclusions from the

[151] Inventory of U.S. Greenhouse Gases and Sinks: 1990–2007.

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

[153] 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.

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

[155] 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.

[156] 74 FR 66496 (Dec. 15, 2009).

[157] 74 FR 66496 (Dec. 15, 2009)

recent assessments of the U.S. Climate Change Science Program and the U.N. Intergovernmental Panel on Climate Change.[158] The Administrator made 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 finding focused on impacts within the U.S. but noted that the evidence concerning risks and impacts occurring outside the U.S. provided further support for the finding.

The key scientific findings supporting the 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.

The Administrator found that emissions of the single air pollutant defined as the aggregate group of these same six greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the air pollution and hence to the threat of climate change. Key facts supporting this 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.[159] As noted above, these findings require EPA to issue standards under section 202(a) "applicable to emission" of the air pollutant that EPA found causes or contributes to the air pollution that endangers public health and welfare. The final emissions standards satisfy this requirement for greenhouse gases from light-duty vehicles. Under section 202(a) the Administrator has significant discretion in how to structure the standards that apply to the emission of the air pollutant at issue here, the aggregate group of six greenhouse gases. EPA has the discretion under section 202(a) to adopt separate standards for each gas, a single composite standard covering various gases, or any combination of these. In this rulemaking EPA is finalizing 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 emission of the single air pollutant, the aggregate group of six greenhouse gases. EPA is not setting any standards for perfluorocarbons (PFCs) or sulfur hexafluoride (SF_6) as they are not emitted by motor vehicles.

3. What is EPA adopting?

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

The following section provides an overview of EPA's final rule. The key public comments are not discussed here, but are discussed in the sections that follow which provide the details of the program. Comments are also discussed in the Response to Comments document.

The CO_2 emissions standards are by far the most important of the three standards and are the primary focus of this summary. As proposed, EPA is adopting an attribute-based approach for the CO_2 fleet-wide standard (one for cars and one for trucks), using 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 finalizing for model years (MY) 2012 and later:

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

Standard/covered compounds	Form of standard	Level of standard	Credits	Test cycles
CO_2 Standard:[160] Tailpipe CO_2.	Fleetwide average footprint CO_2-curves for cars and trucks.	Projected Fleetwide CO_2 level of 250 g/mi (See footprint curves in Sec. III.B.2).	CO_2-e credits[161]	EPA 2-cycle (FTP and HFET test cycles).[162]
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.

* For N_2O and CH_4, manufacturers may optionally demonstrate compliance with a CO_2-equivalent standard equal to its footprint-based CO_2 target level, using the FTP and HFET tests.

One important flexibility associated with the CO_2 standard is the option for

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

[159] This figure includes the greenhouse gas contributions of light vehicles, heavy duty vehicles, and remaining on-highway mobile sources. Light-duty vehicles are responsible for over 70 percent of Section 202(a) mobile source GHGs, or about 17% of total U.S. greenhouse gas emissions. U.S. EPA.2009 Technical Support Document for Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act. Washington, DC. pp. 180–194. Available at *http://epa.gov/climatechange/endangerment/downloads/Endangerment%20TSD.pdf*.

[160] 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 III.B.

[161] 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.

[162] 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

Continued

manufacturers to obtain credits associated with improvements in their air conditioning systems. EPA is adopting the air conditioning provisions with minor modifications. 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 will be reflected in the EPA FTP or HFET tests. These improvements will 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 use this flexibility to earn air conditioning-related credits for MY 2012–2016 vehicles such that the average credit earned is about 11 grams per mile CO_2-equivalent in 2016.

A second flexibility, being finalized essentially as 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 allowing comparable CO_2 credits for flexible fuel vehicles through MY 2015, but for MY 2016 and beyond, the GHG rule treats 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 the alternative fuel, and on a manufacturer's demonstration of 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 will be achieved by manufacturer compliance with the GHG standards for MY 2012–2016.

For MY 2011, Table III.A.3–2 uses the NHTSA projections of the average fuel economy level that will be achieved by the MY 2011 fleet of 30.8 mpg for cars and 23.3 mpg for trucks, converted to an equivalent combined car and truck CO_2 level of 326 grams per mile.[163] EPA believes this is a reasonable estimate with which to compare the MY 2012–2016 CO_2 emission standards. Identifying the proper MY 2011 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 MY 2011 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 MY 2011 projected CAFE achieved 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 promulgated CO_2-footprint curves and projected footprint values, and will decrease each year to 250 grams per mile (g/mi) in MY 2016. For MY 2012–2016, 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. 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 MY 2016 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 MY 2016, the projected A/C credit of 10.6 g/mi represents 14 percent of the 76 g/mi CO_2 emissions reductions associated with the final standards. The Projected 2-cycle CO_2 Emissions column shows the projected CO_2 emissions as measured over the EPA 2-cycle tests, which will allow compliance with the standard assuming projected utilization of the FFV, TLAAS, and A/C credits.

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				(326)		(326)
2012	295	6.5	1.2	303	3.5	307
2013	286	5.8	0.9	293	5.0	298
2014	276	5.0	0.6	282	7.5	290
2015	263	3.7	0.3	267	10.0	277
2016	250	0.0	0.1	250	10.6	261

EPA is also finalizing 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 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 MY 2009–2011, credit for "off-cycle" CO_2 reductions from new and innovative technologies that are not reflected in CO_2/fuel economy tests, as

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. Separate mechanisms apply for A/C credits.

[163] As discussed in Section IV of this preamble.

well as the carry-forward and carry-backward of credits, and the ability to transfer credits between a manufacturer's car and truck fleets. These flexibilities are being adopted with only very minor changes from the proposal, as discussed in Section III.C.

EPA is finalizing an incentive to encourage the commercialization of advanced GHG/fuel economy control technologies, including electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs), for model years 2012–2016. EPA's proposal included an emissions compliance value of zero grams/mile for EVs and FCVs, and the electric portion of PHEVs, and a multiplier in the range of 1.2 to 2.0, so that each advanced technology vehicle would count as greater than one vehicle in a manufacturer's fleet-wide compliance calculation. Several commenters were very concerned about these credits and upon considering the public comments on this issue, EPA is finalizing an advanced technology vehicle incentive program to assign a zero gram/mile emissions compliance value for EVs and FCVs, and the electric portion of PHEVs, for up to the first 200,000 EV/PHEV/FCV vehicles produced by a given manufacturer during MY 2012–2016. For any production greater than this amount, the compliance value for the vehicle will be greater than zero gram/mile, set at a level that reflects the vehicle's average net increase in upstream greenhouse gas emissions in comparison to the gasoline or diesel vehicle it replaces. EPA is not finalizing a multiplier based on the concerns potentially excessive credits using that incentive. EPA agrees that the multiplier, in combination with the zero grams/mile compliance value, would be excessive. EPA will also allow this early advanced technology incentive program beginning in MYs 2009 through 2011. Further discussion on the advanced technology vehicle incentives, including more detail on the public comments and EPA's response, is found in Section III.C.

EPA is also finalizing a temporary lead-time allowance (TLAAS) for manufacturers that sell vehicles in the U.S. in MY 2009 and for which U.S. vehicle sales in that model year are below 400,000 vehicles. This allowance will be available only during the MY 2012–2015 phase-in years of the program. A manufacturer that satisfies the threshold criteria will be able to treat a limited number of vehicles as a separate averaging fleet, which will be subject to a less stringent GHG standard.[164] Specifically, a standard of 125 percent of the vehicle's otherwise applicable foot-print target level will 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 setting 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 will no longer be eligible for a different standard). EPA discusses this in more detail in Section III.B of the preamble.

EPA received comments from several smaller manufacturers that the TLAAS program was insufficient to allow manufacturers with very limited product lines to comply. These manufacturers commented that they need additional lead-time to meet the standards, because their CO_2 baselines are significantly higher and their vehicle product lines are even more limited, reducing their ability to average across their fleets compared even to other TLAAS manufacturers. EPA fully summarizes the public comments on the TLAAS program, including comments not supporting the program, in Section III.B. In summary, in response to the lead time issues raised by manufacturers, EPA is modifying the TLAAS program that applies to manufacturers with between 5,000 and 50,000 U.S. vehicle sales in MY 2009. These manufactures would have an increased allotment of vehicles, a total of 250,000, compared to 100,000 vehicles for other TLAAS-eligible manufacturers. In addition, the TLAAS program for these manufacturers would be extended by one year, through MY 2016 for these vehicles, for a total of five years of eligibility. The other provisions of the TLAAS program would continue to apply, such as the restrictions on credit trading and the level of the standard. Additional restrictions would also apply to these vehicles, as discussed in Section III.B.5. In addition, for the smallest volume manufacturers, those with U.S. sales of below 5,000 vehicles, EPA is not setting standards at this time but is instead deferring standards until a future rulemaking. This is the same approach we are using for small businesses. The unique issues involved with these manufacturers will be addressed in that future rulemaking. Further discussion of the public comment on these issues and details on these changes from the proposed program are included in Section III.B.6. The agency received comments on its compliance with the Regulatory Flexibility Act. As stated in Section III.I.3, small entities are not significantly impacted by this rulemaking.

EPA is also adopting 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 late model 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 costs or benefits associated with these standards.

EPA has attempted to build on existing practice wherever possible in designing a compliance program for the GHG standards. In particular, the program structure 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 emissions and CAFE programs.

EPA received numerous comments on issues related to the impacts on stationary sources, due to the Clean Air Act's provisions for permitting requirements related to the issuance of the proposed GHG standards for new motor vehicles. Some comments suggested that EPA had underestimated the number of stationary sources that may be subject to GHG permitting requirements; other comments suggested that EPA did not adequately consider the permitting impact on small business sources. Other comments related to EPA's interpretation of the CAA's provisions for subjecting stationary sources to permit regulation after GHG standards are set. EPA's response to these comments is contained in the Response to Comments document; however, many of these comments pertain to issues that EPA is addressing in its consideration of the final Greenhouse Gas Permit Tailoring

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

Rule, Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule; Proposed Rule, 74 FR 55292 (October 27, 2009) and will thus be fully addressed in that rulemaking.

Some of the comments relating to the stationary source permitting issues suggested that EPA should defer setting GHG standards for new motor vehicles to avoid such stationary source permitting impacts. EPA is issuing these final GHG standards for light-duty vehicles as part of its efforts to expeditiously respond to the Supreme Court's nearly three year old ruling in *Massachusetts* v. *EPA,* 549 U.S. 497 (2007). In that case, the Court held that greenhouse gases fit within the definition of air pollutant in the Clean Air Act, and that EPA is therefore compelled to respond to the rulemaking petition under section 202(a) by determining 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 stated that under section 202(a), "[i]f EPA makes [the endangerment and cause or contribute findings], the Clean Air Act requires the agency to regulate emissions of the deleterious pollutant." 549 U.S. at 534. As discussed above, EPA has made the two findings on contribution and endangerment. 74 FR 66496 (December 15, 2009). Thus, EPA is required to issue standards applicable to emissions of this air pollutant from new motor vehicles.

The Court properly noted that EPA retained "significant latitude" as to the "timing * * * and coordination of its regulations with those of other agencies" (id.). However it has now been nearly three years since the Court issued its opinion, and the time for delay has passed. In the absence of these final standards, there would be three separate Federal and State regimes independently regulating light-duty vehicles to increase fuel economy and reduce 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 EPA–NHTSA program will allow automakers to meet all of these requirements with a single national fleet because California has indicated that it will accept compliance with EPA's GHG standards as compliance with California's GHG standards. 74 FR at 49460. California has not indicated that it would accept NHTSA's CAFE standards by themselves. Without EPA's vehicle GHG standards, the states will not offer the Federal program as an alternative compliance option to automakers and the benefits of a harmonized national program will be lost. California and several other states have expressed strong concern that, without comparable Federal vehicle GHG standards, the states will not offer the Federal program as an alternative compliance option to automakers. Letter dated February 23, 2010 from Commissioners of California, Maine, New Mexico, Oregon and Washington to Senators Harry Reid and Mitch McConnell (Docket EPA–HQ–OAR–2009–0472–11400). The automobile industry also strongly supports issuance of these rules to allow implementation of the national program and avoid "a myriad of problems for the auto industry in terms of product planning, vehicle distribution, adverse economic impacts and, most importantly, adverse consequences for their dealers and customers." Letter dated March 17, 2010 from Alliance of Automobile Manufacturers to Senators Harry Reid and Mitch McConnell, and Representatives Nancy Pelosi and John Boehner (Docket EPA–HQ–OAR–2009–0472–11368). Thus, without EPA's GHG standards as part of a Federal harmonized program, important GHG reductions as well as benefits to the automakers and to consumers would be lost.[165] In addition, delaying the rule would impose significant burdens and uncertainty on automakers, who are already well into planning for production of MY 2012 vehicles, relying on the ability to produce a single national fleet. Delaying the issuance of this final rule would very seriously disrupt the industry's plans.

Instead of delaying the LDV rule and losing the benefits of this rule and the harmonized national program, EPA is directly addressing concerns about stationary source permitting in other actions that EPA is taking with regard to such permitting. That is the proper approach to address the issue of stationary source permitting, as compared to delaying the issuance of this rule for some undefined, indefinite time period.

Some parties have argued that EPA's issuance of this light-duty vehicle rule amounts to a denial of various administrative requests pending before EPA, in which parties have requested that EPA reconsider and stay the GHG endangerment finding published on December 15, 2009. That is not an accurate characterization of the impact of this final rule. EPA has not taken final action on these administrative requests, and issuance of this vehicle rule is not final agency action, explicitly or implicitly, on those requests. Currently, while we carefully consider the pending requests for reconsideration on endangerment, these final findings on endangerment and contribution remain in place. Thus under section 202(a) EPA is obligated to promulgate GHG motor vehicle standards, although there is no statutory deadline for issuance of the light-duty vehicle rule or other motor vehicle rules. In that context, issuance of this final light-duty vehicle rule does no more than recognize the current status of the findings—they are final and impose a rulemaking obligation on EPA, unless and until we change them. In issuing the vehicle rule we are not making a decision on requests to reconsider or stay the endangerment finding, and are not in any way prejudicing or limiting EPA's discretion in making a final decision on these administrative requests.

For discussion of comments on impacts on small entities and EPA's compliance with the Regulatory Flexibility Act, see the discussion in Section III.I.3.

b. Environmental and Economic Benefits and Costs of EPA's 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 percent and a 7 percent discount rate. As discussed previously, EPA recognizes that much of these same costs and benefits are also attributable to the CAFE standard contained in this joint final rule.

[165] As discussed elsewhere, EPA's GHG standards achieve greater overall reductions in GHGs than NHTSA's CAFE standards.

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

[In million 2007$]

	2020	2030	2040	2050	NPV, 3% [a]	NPV, 7% [a]
Quantified Annual Costs [b]	−$20,100	−$64,000	−$101,900	−$152,200	−$1,199,700	−$480,700
Benefits From Reduced CO_2 Emissions at Each Assumed SCC Value [c d e]						
Avg SCC at 5%	900	2,700	4,600	7,200	34,500	34,500
Avg SCC at 3%	3,700	8,900	14,000	21,000	176,700	176,700
Avg SCC at 2.5%	5,800	14,000	21,000	30,000	299,600	299,600
95th percentile SCC at 3%	11,000	27,000	43,000	62,000	538,500	538,500
Other Impacts						
Criteria Pollutant Benefits [f g h i]	B	1,200–1,300	1,200–1,300	1,200–1,300	21,000	14,000
Energy Security Impacts (price shock)	2,200	4,500	6,000	7,600	81,900	36,900
Reduced Refueling	2,400	4,800	6,300	8,000	87,900	40,100
Value of Increased Driving [j]	4,200	8,800	13,000	18,400	171,500	75,500
Accidents, Noise, Congestion	−2,300	−4,600	−6,100	−7,800	−84,800	−38,600
Quantified Net Benefits at Each Assumed SCC Value [c d e]						
Avg SCC at 5%	27,500	81,500	127,000	186,900	1,511,700	643,100
Avg SCC at 3%	30,300	87,700	136,400	200,700	1,653,900	785,300
Avg SCC at 2.5%	32,400	92,800	143,400	209,700	1,776,800	908,200
95th percentile SCC at 3%	37,600	105,800	165,400	241,700	2,015,700	1,147,100

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

[b] Quantified annual costs are negative because of fuel savings (see Table III.H.10–1 for a breakdown of the vehicle technology costs and fuel savings). The fuel savings outweigh the vehicle technology costs and, therefore, the costs are presented here are negative values.

[c] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC Technical Support Document (TSD) notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

[d] Section III.H.6 notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5–$16; for Average SCC at 3%: $21–$45; for Average SCC at 2.5%: $35–$65; and for 95th percentile SCC at 3%: $65–$136. Section III.H.6 also presents these SCC estimates.

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

[f] Note that "B" indicates unquantified criteria pollutant benefits in the year 2020. For the final rule, we only modeled the rule's $PM_{2.5}$- and ozone-related impacts in the calendar year 2030. For the purposes of estimating a stream of future-year criteria pollutant benefits, we assume that the benefits out to 2050 are equal to, and no less than, those modeled in 2030 as reflected by the stream of estimated future emission reductions. The NPV of criteria pollutant-related benefits should therefore be considered a conservative estimate of the potential benefits associated with the final rule.

[g] The benefits presented in this table include an estimate of PM-related premature mortality derived from Laden et al., 2006, and the ozone-related premature mortality estimate derived from Bell et al., 2004. If the benefit estimates were based on the ACS study of PM-related premature mortality (Pope et al., 2002) and the Levy et al., 2005 study of ozone-related premature mortality, the values would be as much as 70% smaller.

[h] The calendar year benefits presented in this table assume either a 3% discount rate in the valuation of PM-related premature mortality ($1,300 million) or a 7% discount rate ($1,200 million) to account for a twenty-year segmented cessation lag. Note that the benefits estimated using a 3% discount rate were used to calculate the NPV using a 3% discount rate and the benefits estimated using a 7% discount rate were used to calculate the NPV using a 7% discount rate. For benefits totals presented at each calendar year, we used the mid-point of the criteria pollutant benefits range ($1,250).

[i] Note that the co-pollutant impacts presented here do not include the full complement of endpoints that, if quantified and monetized, would change the total monetized estimate of impacts. The full complement of human health and welfare effects associated with PM and ozone remain unquantified because of current limitations in methods or available data. We have not quantified a number of known or suspected health effects linked with ozone and PM for which appropriate health impact functions are not available or which do not provide easily interpretable outcomes (*e.g.,* changes in heart rate variability). Additionally, we are unable to quantify a number of known welfare effects, including reduced acid and particulate deposition damage to cultural monuments and other materials, and environmental benefits due to reductions of impacts of eutrophication in coastal areas.

[j] Calculated using pre-tax fuel prices.

4. Basis for the 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 of the proposed rule (74 FR at 49464–65). The following is a summary of the basis for the final GHG 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 adopting 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 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 standards indicates that manufacturers will be able to meet the standards by employing a wide variety of technologies that are already commercially available and can be incorporated into their vehicles at the time of redesign. In addition to the consideration 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 standards can be met using technology that will be available in the lead-time provided. At the same time, it must be noted that because technology is commercially available today does not mean it can automatically be incorporated fleet-wide during the model years in question. As discussed below, and in detail in Section III.D.7, EPA and NHTSA carefully analyzed issues of adequacy of lead time in determining the level of the standards, and the agencies are convinced both that lead time is sufficient to meet the standards but that major further additions of technology across the fleet is not possible during these model years.

To account for additional lead-time concerns for various manufacturers of typically higher performance vehicles, EPA is adopting a Temporary Lead-time Allowance similar to that proposed 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 is deferring standards pending later rulemaking.

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 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 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 960 million metric tons CO_2 eq. and fuel reductions of 1.8 billion barrels of oil. These are important and significant reductions. 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 standards, to the extent practicable. Our analysis to date indicates that the overall quantified benefits of the standards far outweigh the projected costs. Utilizing a 3% discount rate, 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.[166] These values are estimated at $136 billion and $787 billion, respectively, using a 7% discount rate and the SCC discounted at 3 percent.[167]

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 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 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 (DC Cir. 2001) (great discretion to balance statutory factors in considering level of technology-based standard, and statutory requirement "to [give appropriate] consideration to the cost of applying * * * technology" does not mandate a specific method of cost analysis); see also *Hercules Inc.* v. *EPA,* 598 F. 2d 91, 106 (DC Cir. 1978) ("In reviewing a numerical standard 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 (DC Cir. 2002) (same).

EPA recognizes that the vast majority of technologies which we are considering for purposes of setting standards under section 202(a) are 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 rule, would result from the increased use of these technologies. EPA also recognizes that this 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 therefore evaluated two sets of alternative standards, one more stringent than the promulgated standards and one less stringent.

The alternatives are 4% per year increase in standards which would be less stringent and a 6% per year increase in the standards which would be more stringent. EPA is not adopting either of these. As discussed in Section III.D.7, the 4% per year forgoes CO_2 reductions which can be achieved at reasonable cost 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 penetration which appears inappropriate 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 adopting either of the alternatives.) EPA also believes that the no backsliding standards it is adopting

[166] Based on the mean SCC at 3 percent discount rate, which is $21 per metric ton CO_2 in 2010 rising to $45 per metric ton CO_2 in 2050.

[167] SCC was discounted at 3 percent to maintain internal consistency in the SCC calculations while all other benefits were discounted at 7 percent. Specifically, the same discount rate used to discount the value of damages from future CO_2 emissions is used to calculate net present value of SCC.

for N_2O and CH_4 are appropriate under section 202(a).

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

EPA is finalizing new emission standards to control greenhouse gases (GHGs) from light-duty vehicles. First, EPA is finalizing an emission standard for carbon dioxide (CO_2) on a gram per mile (g/mile) basis that will apply to a manufacturer's fleet of cars, and a separate standard that will apply to a manufacturer's fleet of trucks. CO_2 is the primary greenhouse gas 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 finalizing separate emissions standards for two other GHGs: Methane (CH_4) and nitrous oxide (N_20). 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 will be set as a cap that will limit emissions increases and prevent backsliding from current emission levels. The final standards described below will 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."[168]

EPA's program includes a number of credit opportunities and other flexibilities to help manufacturers comply, especially in the early years of the program. 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 including A/C credits as an aspect of the standards, as mentioned above. EPA is also including several additional credit provisions that apply only in the initial model years of the program. These include flex fuel vehicle credits, incentives for the early commercialization of certain advanced technology vehicles, credits for new and innovative "off-cycle" technologies that are not captured by the current test procedures, and generation of credits prior to model year 2012. The A/C credits and additional credit opportunities are described in Section III.C. These credit programs will provide flexibility to manufacturers, which may be especially important during the early transition years of the program. EPA will also allow a manufacturer to carry a credit deficit into the future for a limited number of model years. A parallel provision, referred to as credit carry-back, will be part of the CAFE program. Finally, EPA is finalizing an optional compliance flexibility, the Temporary Leadtime Allowance Alternative Standard program, for intermediate volume manufacturers, and is deferring standards for the smallest manufacturers, as discussed in Sections III.B.5 and 6 below.

1. What fleet-wide emissions levels correspond to the CO_2 standards?

The attribute-based CO_2 standards are projected to achieve a national fleet-wide average, covering both light cars and trucks, of 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 will begin with MY 2012, with a generally linear increase in stringency from MY 2012 through MY 2016. EPA will have 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 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, EPA discusses the year-by-year estimate of emissions reductions that are projected to be achieved by the standards.

In general, the 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.[169] Note that 2016 is the final model year in which standards become more stringent. The 2016 CO_2 standards will 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 2016 MY standards will 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 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 provides these estimates for each manufacturer.[170]

As a result of public comments and updated economic and future fleet projections, the attribute based curves have been updated for this final rule, as discussed in detail in Section II.B of this preamble and Chapter 2 of the Joint TSD. This update in turn affects costs, benefits, and other impacts of the final standards—thus EPA's overall projection of the impacts of the final rule standards have been updated and the results are different than for the NPRM, though in general not by a large degree.

[168] As described in Section III.B.2., GHG emissions standards will use the same vehicle category definitions as are used in the CAFE program.

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

[170] 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.1–1—ESTIMATED FLEET CO_2-EQUIVALENT LEVELS CORRESPONDING TO THE STANDARDS FOR CARS

[g/mile]

Manufacturer	Model year				
	2012	2013	2014	2015	2016
BMW	266	259	250	239	228
Chrysler	269	262	254	243	232
Daimler	274	267	259	249	238
Ford	267	259	251	240	229
General Motors	268	261	252	241	230
Honda	260	252	244	233	222
Hyundai	260	254	246	233	222
Kia	263	255	247	235	224
Mazda	260	252	243	232	221
Mitsubishi	257	249	241	230	219
Nissan	263	256	248	237	226
Porsche	244	237	228	217	206
Subaru	253	246	237	226	215
Suzuki	245	238	230	218	208
Tata	288	280	272	261	250
Toyota	259	251	243	232	221
Volkswagen	256	249	240	229	219

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

[g/mile]

Manufacturer	Model year				
	2012	2013	2014	2015	2016
BMW	330	320	310	297	283
Chrysler	342	333	323	309	295
Daimler	343	332	323	308	294
Ford	354	344	334	319	305
General Motors	364	354	344	330	316
Honda	327	318	309	295	281
Hyundai	325	316	307	292	278
Kia	335	327	318	303	289
Mazda	319	308	299	285	271
Mitsubishi	316	306	297	283	269
Nissan	343	334	323	308	294
Porsche	334	325	315	301	287
Subaru	315	305	296	281	267
Suzuki	320	310	300	286	272
Tata	321	310	301	287	272
Toyota	342	333	323	308	294
Volkswagen	341	331	322	307	293

These estimates were aggregated based on projected production volumes into the fleet-wide averages for cars and trucks (Table III.B.1–3).[171]

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

Model year	Cars	Trucks
	CO_2 (g/mi)	CO_2 (g/mi)
2012	263	346
2013	256	337
2014	247	326
2015	236	312
2016 and later	225	298

As shown in Table III.B.1–3, fleet-wide CO_2-equivalent emission levels for cars under the approach are projected to decrease from 263 to 225 grams per mile between MY 2012 and MY 2016. Similarly, fleet-wide CO_2-equivalent

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

emission levels for trucks are projected to decrease from 346 to 398 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 Regulatory Impact Analysis (RIA).

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 STANDARDS

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

As noted above, EPA is finalizing standards that will 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. Comments from the Center for Biological Diversity (CBD) challenged EPA to increase the stringency of the standards for all of the years of the program, and even argued that 2016 standards should be feasible in 2012. Other commenters noted the non-linear increase in the standards from 2011 (CAFE) to the 2012 GHG standards. As explained in greater detail in Section III.D below and the relevant support documents, EPA believes that the 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 averaging, banking and trading provisions, as well as other credit-generating mechanisms, allow manufacturers further flexibilities which reduce the cost of the 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 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 RIA. EPA also presents the estimated costs and benefits of the car and truck CO_2 standards in Section III.H. In developing the final rule, 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 will 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 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 final rule, as it will avoid the much higher costs that will occur if manufacturers needed to add or change technology at times other than these scheduled redesigns. This time period will also provide manufacturers the opportunity to plan for compliance using a multi-year time frame, again in accord with their normal business practice. Further details on lead time, redesigns and feasibility can be found in Section III–D.

Consistent with the requirement of CAA section 202(a)(1) that standards be applicable to vehicles "for their useful life," EPA is finalizing CO_2 vehicle standards that will 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.[172] Tier 2 refers to EPA's standards for criteria pollutants such as NO_X, HC, and CO. EPA is finalizing new CO_2 standards for the same group of vehicles, and therefore the Tier 2 useful life will apply for CO_2 standards as well. The in-use emission standard will be 10% higher than the model-level certification emission test results, to address issues of production variability and test-to-test variability. The in-use standard is discussed in Section II*I.E.*

EPA is requiring manufacturers 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 Test (HFET or "highway" test).[173] 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 using these test procedures for the CO_2 standards in this final rule, given the lack of data on control technology effectiveness under these procedures.[174] There were a number of commenters that advocated for a change in either the test procedures or the fuel economy calculation weighting factors. The U.S. Coalition for Advanced Diesel Cars urged a changing of the city/highway weighting factors from their current values of 45/55 to 43/57 to be more consistent with the EPA (5-cycle) fuel economy labeling rule. EPA has decided that such a change would not be appropriate, nor consistent with the technical analyses supporting the 5-cycle fuel economy label rulemaking. The city/highway weighting of 43/57 was found to be appropriate when the city fuel economy is based on a combination of Bags 2 and 3 of the FTP and the city portion of the US06 test cycle, and when the highway fuel economy is based on a combination of the HFET and the highway portion of the US06 cycle. When city and highway fuel economy are based on the FTP and HFET cycles, respectively, the appropriate city/highway weighting is not 43/57, but very close to 55/45. Therefore, the weighting of the city and

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

[173] 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. 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.

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

highway fuel economy values contained in this rule is appropriate for and consistent with the use of the FTP and HFET cycles to measure city and highway fuel economy.

The American Council for an Energy-Efficient Economy (ACEEE), Cummins, and Sierra Club all suggested using more real-world test procedures. It is not feasible at this time to base the final CO_2 standards on EPA's five-cycle fuel economy formulae. Consistent with its name, these formulae require vehicle testing over five test cycles, the two cycles associated with the proposed CO_2 standards, plus the cold temperature FTP, the US06 high speed, high acceleration cycle and the SC03 air conditioning test. EPA considered employing the five-cycle calculation of fuel economy and GHG emissions for this rule, but there were a number of reasons why this was not practical. As discussed extensively in the Joint TSD, setting the appropriate levels of CO_2 standards requires extensive knowledge of the CO_2 emission control effectiveness over the certification test cycles. Such knowledge has been gathered over the FTP and HFET cycles for decades, but is severely lacking for the other three test cycles. EPA simply lacks the technical basis to project the effectiveness of the available technologies over these three test cycles and therefore, could not adequately support a rule which set CO_2 standards based on the five-cycle formulae. The benefits of today's rule do presume a strong connection between CO_2 emissions measured over the FTP and HFET cycles and onroad operation. Since CO_2 emissions determined by the five-cycle formulae are believed to correlate reasonably with onroad emissions, this implies a strong connection between emissions over the FTP and HFET cycles and the five cycle formulae. However, while we believe that this correlation is reasonable on average for the vehicle fleet, it may not be reasonable on a per vehicle basis, nor for any single manufacturer's vehicles. Thus, we believe that it is reasonable to project a direct relationship between the percentage change in CO_2 emissions over the two certification cycles and onroad emissions (a surrogate of which is the five-cycle formulae), but not reasonable to base the certification of specific vehicles on that untested relationship. Furthermore, EPA is allowing for off-cycle credits to encourage technologies that may not be not properly captured on the 2-cycle city/highway test procedure (although these credits could apply toward compliance with EPA's standards, not toward compliance with the CAFE standards). For future analysis, EPA will consider examining new drive cycles and test procedures for fuel economy.[175]

EPA is finalizing standards that 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 will 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 is finalizing the same vehicle category definitions that are used in the CAFE program for the 2011 model year standards.[176] This approach allows EPA's CO_2 standards and the CAFE standards to be harmonized across all vehicles. In other words, vehicles will 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. The CAFE vehicle category definitions differ slightly from the EPA definitions for cars and light trucks used for the Tier 2 program and other EPA vehicle programs. However, EPA is not changing the vehicle category definitions for any other light-duty mobile source programs, except the GHG standards.

EPA is finalizing 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.

Some commenters requested a single or converging curve for both cars and trucks.[177] EPA is not finalizing 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.[178] Due to these differences, it is reasonable to separate the light-duty vehicle fleet into two groups. Second, EPA wishes 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. As discussed in Section IV, EPCA does not preclude NHTSA from issuing converging standards if its analysis indicates that these are the appropriate standards under the statute applicable separately to each fleet.

Finally, most of the advantages of a single standard for all light duty vehicles are also present in the two-fleet standards finalized here. Because EPA is allowing 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 will 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 finalizing separate car and truck fleet standards. However, it is possible that in the future, recent trends may continue such that cars may become more truck-like and trucks may become more car-like. Therefore, EPA will reconsider whether it is appropriate to use converging curves if justified by future analysis.

For model years 2012 and later, EPA is finalizing a series of CO_2 standards that are described mathematically by a family of piecewise linear functions

[175] There were also a number of comments on air conditioner test procedures; these will be discussed in Section III.C and the RIA.

[176] *See* 49 CFR 523.

[177] CBD, ICCT and NESCAUM supported a single curve and the students at UC Santa Barbara commented on converging curves.

[178] There is a distinction between body-on-frame trucks and unibody cars and trucks that make them technically different in a number of ways. Also, 2WD vehicles tend to have lower CO_2 emissions than their 4WD counterparts (all other things being equal). More discussion of this can be found in the TSD and RIA.

(with respect to vehicle footprint).[179] The form of the function is as follows:

CO_2 = a, if x ≤ l

CO_2 = cx + d, if l < x ≤ 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 parameter values that define the family of functions for the 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	244	315	4.72	50.5	41	56
2013	237	307	4.72	43.3	41	56
2014	228	299	4.72	34.8	41	56
2015	217	288	4.72	23.4	41	56
2016 and later	206	277	4.72	12.7	41	56

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	294	395	4.04	128.6	41	66
2013	284	385	4.04	118.7	41	66
2014	275	376	4.04	109.4	41	66
2015	261	362	4.04	95.1	41	66
2016 and later	247	348	4.04	81.1	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.

The EPA received a number of comments on both the attribute and the shape of the curve. For reasons described in Section IIC and Chapter 2 of the TSD, the EPA feels that footprint is the most appropriate choice of attribute for this rule. More background discussion on other alternative attributes and curves EPA explored can be found in the EPA RIA. 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 a footprint-based program will harmonize EPA's program and the CAFE program as a single national program, resulting in reduced compliance complexity for manufacturers. EPA's reasons for using an attribute based standard are discussed in more detail in the Joint TSD. Also described in these other sections are the reasons why EPA is finalizing the slopes and the constraints as shown above. For future analysis, EPA will consider other options and suggestions made by commenters.

EPA also received public comments from three manufacturers, General Motors, Ford Motor Company, and Chrysler, suggesting that the GHG program should harmonize with an EPCA provision that allows a manufacturer to exclude emergency vehicles from its CAFE fleet by providing written notice to NHTSA.[180] These manufacturers believe this provision is necessary because law enforcement vehicles (*e.g.,* police cars) must be designed with special performance and features necessary for police work—but which tend to raise GHG emissions and reduce fuel economy relative to the base vehicle. These commenters provided several examples of features unique to these special purpose vehicles that negatively impact GHG emissions, such as heavy-duty suspensions, unique engine and transmission calibrations, and heavy-duty components (*e.g.,* batteries, stabilizer bars, engine cooling). These manufacturers believe consistency in addressing these vehicles between the EPA and NHTSA programs is critical, as a manufacturer may be challenged to continue providing the performance needs of the Federal, State, and local government purchasers of emergency vehicles.

EPA is not finalizing such an emergency vehicle provision in this rule, since we believe that it is feasible for manufacturers to apply the same types of technologies to the base emergency vehicle as they would to other vehicles in their fleet. However, EPA also recognizes that, because of the unique "performance upgrading" needed to convert a base vehicle into one that meets the performance demands of the law enforcement community—which tend to reduce GHGs relative to the base vehicles—there could be situations where a manufacturer is more challenged in meeting the GHG standards than the CAFE standards, simply due to inclusion of these higher-emitting vehicles in the GHG program fleet. While EPA is not finalizing such an exclusion for emergency vehicles today, we do believe it is important to assess this issue in the future. EPA plans to assess the unique characteristics of these emergency vehicles and whether special provisions for addressing them are warranted. EPA plans to undertake this evaluation as part of a follow-up rulemaking in the next 18 months (this rulemaking is discussed in the context of small

[179] *See* final regulations at 40 CFR 86.1818–12.

[180] 49 U.S.C. 32902(e).

volume manufacturers in Section III.B.6. below).

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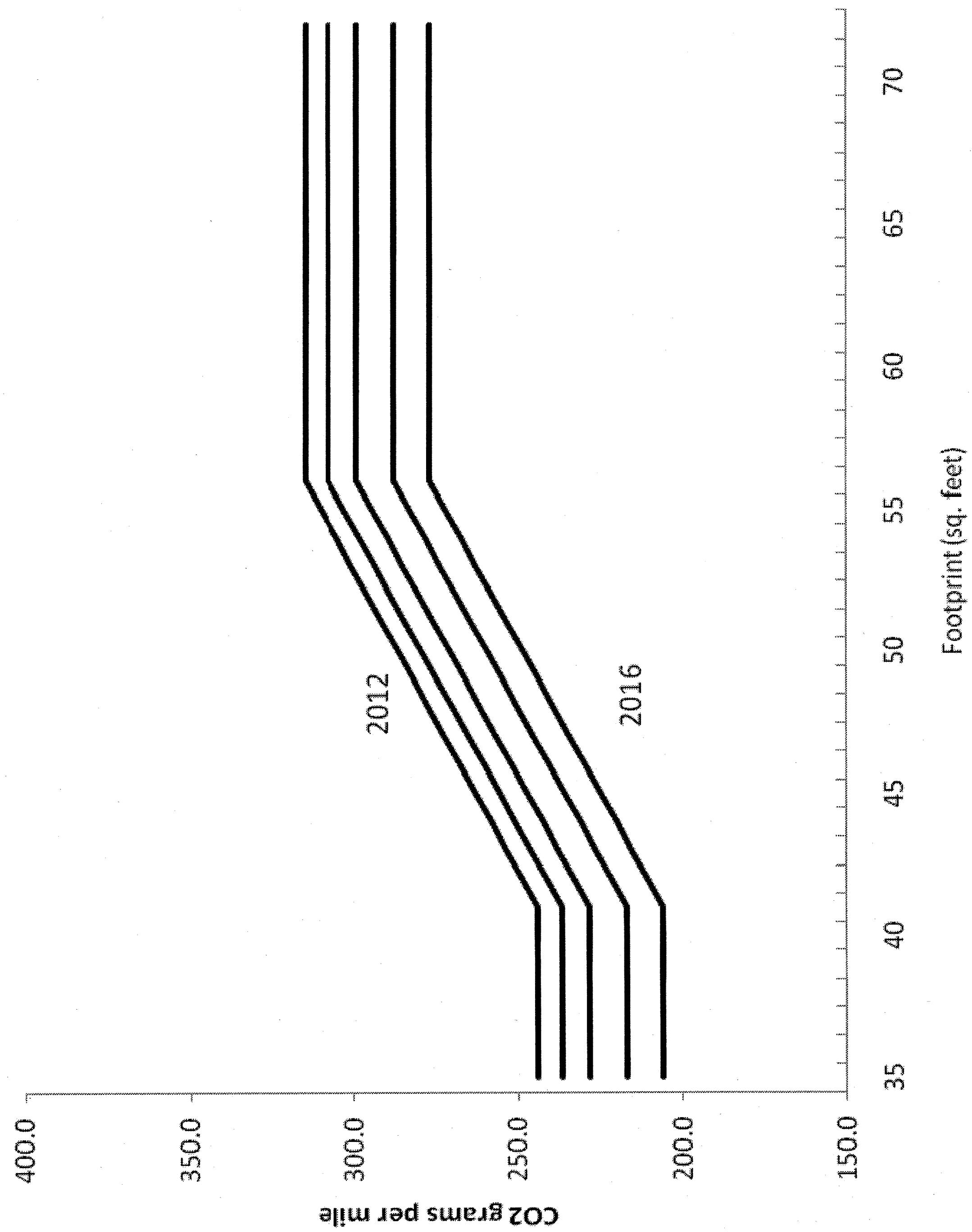

Figure III.B.2-1. CO_2 (g/mi) Car standard curves.

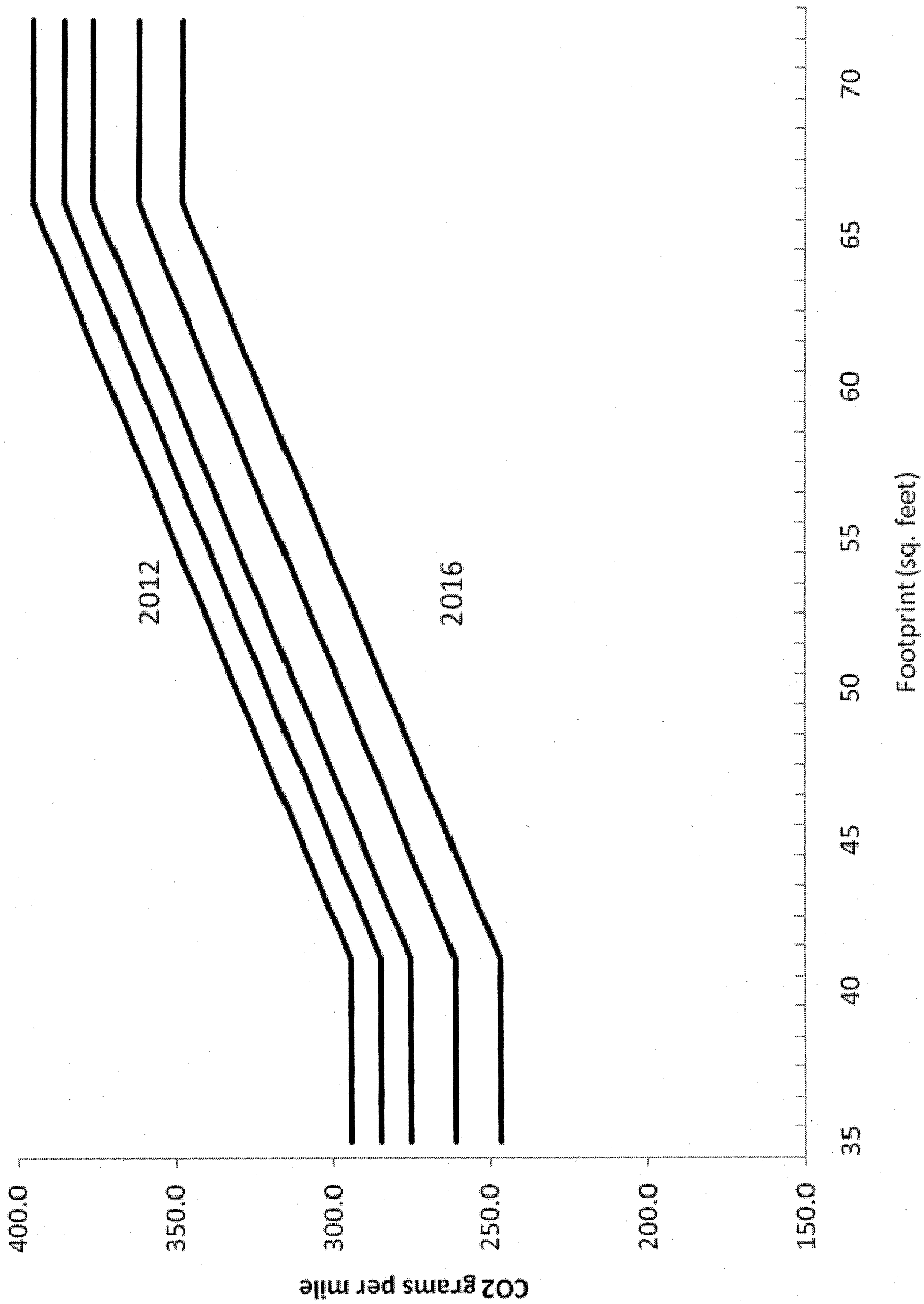

Figure III.B.2-2. CO_2 (g/mi) Truck standard curves.

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

This section provides a brief overview of how EPA will implement the CO_2 standards. Section III.E explains EPA's approach to certification and compliance in detail. As proposed, EPA is finalizing two kinds of standards—fleet average standards determined by a manufacturer's fleet makeup, and in-use standards that will apply to the individual vehicles 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 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 is retaining the Tier 2 approach of requiring manufacturers to demonstrate in good faith at the time of certification that vehicles in a test group will meet applicable standards throughout useful life. EPA is also retaining 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. These differences and resulting modifications to EPA's certification protocols are summarized below and are described in detail in Section II*I.E.*

EPA will continue to certify test groups as it does for Tier 2, and the CO_2 emission results for the test vehicle will serve as the initial or default standard for all of the vehicles in the test group. However, manufacturers will later collect and submit data for individual vehicle model types[181] within each test group, based on the extensive fuel economy testing that occurs through the course of the model year. This model type data will be used to assign a distinct certification level for each model type, thus replacing the initial test group data as the compliance value for each model. It is these model type values that will be used to calculate the fleet average after the end of the model year.[182] The option to substitute model type data for the test group data is at the manufacturer's discretion, except they are required, as they are under the CAFE test protocols, to submit sufficient vehicle test data to represent no less than 90 percent of their actual model year production. The test group emissions data will continue to apply for any model type that is not covered by vehicle test data specific to that model type.

EPA's CO_2 standards also differ from Tier 2 in that the fleet average calculation for Tier 2 is based on test group bin levels and test group sales whereas under the CO_2 program the CO_2 fleet average could be based on a combination of test group and model type emissions and model type production. For the new CO_2 standards, the final regulations use production rather than sales in calculating the fleet average in order to closely conform with the CAFE program, which is a production-based program.[183] Production as defined in the regulations is relatively easy for manufacturers to track, but once the vehicle is delivered to dealerships the manufacturer becomes once step removed from the sale to the ultimate customer, and it becomes more difficult to track that final transaction. There is no environmental impact of using production instead of actual sales, and many commenters supported maintaining alignment between EPA's program and the CAFE program where possible.

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

As explained above, EPA is finalizing a fleet average CO_2 program for passenger cars and light trucks. EPA has previously 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.[184] The program will operate much like EPA's existing averaging programs in that manufacturers will calculate production-weighted fleet average emissions at the end of the model year and compare their fleet average with a fleet average emission standard to determine compliance. As in other EPA averaging programs, the Agency is also finalizing 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, consistent with their typical redesign schedules.[185]

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

[181] "Model type" is defined in 40 CFR 600.002–08 as "* * * a unique combination of car line, basic engine, and transmission class." A "car line" is essentially a model name, such as "Camry," "Malibu," or "F150." The fleet average is calculated on the basis of model type emissions.

[182] The final in-use vehicle standards for each vehicle will also be based on the testing used to determine the model type values. As discussed in Section II*I.E.*4, an in-use adjustment factor will be applied to the vehicle test results to determine the in-use standard that will apply during the useful life of the vehicle.

[183] "Production" is defined as "vehicles produced and delivered for sale" and is not a measure of the number of vehicles actually sold.

[184] 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).

[185] *See* final regulations at 40 CFR 86.1865–12.

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 and at the same time it increases flexibility and reduces costs for the regulated industry. A wide range of commenters expressed general support for the ABT provisions. Some commenters noted issues regarding specific provisions of the ABT program, which will be discussed in the appropriate context below. Several commenters requested that EPA publicly release manufacturer-specific ABT data to improve the transparency of credit transactions. These comments are addressed in Section II*I.E.*

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. The final rule includes a variety of additional ways credits may be generated by manufacturers. Section III.C describes these additional opportunities to generate credits in detail. Manufacturers may earn credits 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, early credits can be generated prior to the program's MY 2012 start date. The credits will be used to determine a manufacturer's compliance at the end of the model year. These credit generating opportunities are described below in Section III.C.

As explained earlier, manufacturers will determine the fleet average standard that applies to their car fleet and the standard for their truck fleet from the applicable attribute-based curve. A manufacturer's credit or debit balance will be determined by comparing their fleet average with the manufacturer's CO_2 standard for that model year. The standard will be calculated from footprint values on the attribute curve and actual production levels of vehicles at each footprint. A manufacturer will generate credits if its car or truck fleet achieves a fleet average CO_2 level lower than its standard and will generate debits if its fleet average CO_2 level is above that standard. At the end of the model year, each manufacturer will 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 will generate credits, and if its fleet average CO_2 level is above that standard its fleet will generate debits.

The regulations will 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's standards 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 accounting 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 may be freely exchanged between car and truck compliance categories without the need for adjustment. Additional detail regarding this approach, including a discussion of the vehicle lifetime mileage estimates for cars and trucks can be found in Section II*I.E.*5. A discussion of the derivation of the estimated vehicle lifetime miles traveled can be found in Chapter 4 of the Joint Technical Support Document.

A manufacturer that generates credits in a given year and vehicle category may 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 in terms of lead time and orderly redesign by a manufacturer, thus promoting and not reducing the environmental benefits of the program.

First, EPA proposed that the manufacturer must use any credits earned to offset any deficit that had accrued in the current year or in a prior model year that had been carried over to the current model year. NRDC commented that such a provision is necessary to prevent credit "shell games" from delaying the adoption of new technologies. EPA's Tier 2 program includes such a restriction, and EPA is applying an identical restriction to the GHG program. Simply stated, a manufacturer may not bank (or carry forward) credits if that manufacturer is also carrying a deficit. In such a case, the manufacturer is obligated to use any current model year credits to offset that deficit. Using current model year credits to offset a prior model year deficit is referred to in the CAFE program as credit carry-back. EPA's deficit carry-forward, or credit carry-back provisions are described further, below.

Second, after satisfying any needs to offset pre-existing deficits, remaining credits may be banked, or saved for use in future years. Credits generated in this program will be available to the manufacturer for use in any of the five model years after the model year in which they were generated, consistent with the CAFE program under EISA. This is also referred to as a credit carry-forward provision.

EPA received a number of comments regarding the credit carry-back and carry-forward provisions. Many supported the proposed consistency of these provisions with EISA and the flexibility provided by these provisions, and several offered qualified or tentative support. For example, NRDC encouraged EPA to consider further restrictions in the 2017 and later model years. Public Citizen expressed concern regarding the complexity of the program and how these provisions might obscure a straightforward determination of compliance in any given model year. At least two automobile manufacturers suggested modeling the program after California, which allows credits to be carried forward for three additional years following a discounting schedule.

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 finalizing reasonable restrictions on credit life in this new program. The Agency believes 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, early credits generated by a manufacturer are also be subject to the five year credit carry-forward restriction based on the year in which they are generated. This limits the effect of the early credits on the long-term emissions reductions anticipated to result from the new standards.

Third, the new program enables 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 may 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 provides important additional flexibility in the transition to emissions control technology without affecting overall emission reductions. Comments regarding the credit transfer provisions expressed general support, noting that it does not matter to the environment whether a gram of greenhouse gas is generated from a car or a truck. Additional comments regarding EPA's streamlined megagram approach and method of accounting for expected vehicle lifetime miles traveled are summarized in Section II*I.E.*

Finally, accumulated credits may be traded to another vehicle manufacturer. As with intra-company credit use, such inter-company credit trading provides flexibility in the transition to emissions control technology without affecting overall emission reductions. Trading credits to another vehicle manufacturer could be a straightforward process between the two manufacturers, but could also involve third parties that could serve as credit brokers. Brokers may 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. Comments generally reflected support for the credit trading flexibility, although some questioned the extent to which trading might actually occur. As noted above, comments regarding program transparency are addressed in Section II*I.E.*

If a manufacturer has accrued a deficit at the end of a model year—that is, its fleet average level failed to meet the required fleet average standard—the manufacturer may 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. 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.[186] As noted above, such a deficit carry-forward may only occur after the manufacturer has applied any banked credits or credits from another averaging set. If a deficit still remains after the manufacturer has applied all available credits, and the manufacturer did not obtain credits elsewhere, the deficit may be carried forward for up to three model years. No deficit may be carried into the fourth model year after the model year in which the deficit occurred. Any deficit from the first model year that remains after the third model year will constitute a violation of the condition on the certificate, which will constitute a violation of the Clean Air Act and will be subject to enforcement action.

The averaging, banking, and trading provisions are generally consistent with those included in the CAFE program, with a few notable exceptions. As with EPA's approach, CAFE allows five year carry-forward of credits and three year carry-back. Under CAFE, 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 did not propose, and is not finalizing, these constraints on the use of transferred credits.

Additional details regarding the averaging, banking, and trading provisions and how EPA will implement these provisions can be found in Section II*I.E.*

5. CO_2 Temporary Lead-Time Allowance Alternative Standards

EPA proposed adopting 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. As noted in the proposal, this option was 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 final rule. The other situation involves manufacturers who have a limited line of vehicles and are therefore unable to average emissions performance across a full line of production. For example, some smaller volume manufacturers produce only vehicles with emissions above the corresponding CO_2 footprint target, and do not have other types of vehicles (that exceed their compliance targets) 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 through payment of civil penalties is impermissible for the GHG standards under the CAA, both of these types of manufacturers need additional lead time to upgrade vehicles and meet the standards. EPA proposed that this subset of manufacturers be allowed to

[186] EPA emission control programs that incorporate ABT provisions (*e.g.,* the Tier 2 program and the Mobile Source Air Toxics program) have provided this three-year deficit carry-forward provision for this reason. *See* 65 FR 6745 (February 10, 2000), and 71 FR 8427 (February 26, 2007).

produce up to 100,000 vehicles over model years 2012–2015 that would be subject to a somewhat less stringent CO_2 standard of 1.25 times the standard that would otherwise apply to those vehicles. Only manufacturers with total U.S. sales of less than 400,000 vehicles per year in MY 2009 would be eligible for this allowance. Those manufacturers would have to exhaust designated program flexibilities in order to be eligible, and credit generating and trading opportunities for the eligible vehicles would be restricted. *See* 74 FR 49522–224.

EPA is finalizing the optional TLAAS provisions, with certain limited modifications, 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.[187] EPA is finalizing modified provisions to address the unique lead-time issues of smaller volume manufacturers. One provision involves additional flexibility under the TLAAS program for manufacturers below 50,000 U.S. vehicle sales, as discussed further in Section III.B.5.b below. Another provision defers the CO_2 standards for the smallest volume manufacturers, those below 5,000 U.S. vehicle sales, as discussed in Section III.B.6.

Comments from several manufacturers strongly supported the TLAAS program as critical to provide the lead time needed for manufacturers to meet the standards. Volkswagen commented that TLAAS is an important aspect of EPA's proposal and that it responds to the needs of some smaller manufacturers for additional lead time and flexibility under the CAA. Daimler Automotive Group commented that TLAAS is a critical element of the program and falls squarely within EPA's discretion to provide appropriate lead time to limited-line low-volume manufacturers. BMW also commented that TLAAS is needed because most of the companies with limited lines will have to meet a more stringent fleet standard by 2016 than full-line manufacturers because they sell "feature-dense" vehicles (as opposed to light-weight large wheel-base vehicles) and no pick-up trucks. BMW commented that their MY 2016 footprint-based standard is projected to be 4 percent more stringent than the fleet average standard of 250 g/mile. The Alliance of Automobile Manufacturers supported the flexibilities proposed by EPA, including TLAAS. As discussed in detail below, EPA received extensive comments from many smaller volume manufacturers that the proposed TLAAS program was insufficient to address lead time and feasibility issues they will face under the program.

In contrast, EPA also received comments from the Center for Biological Diversity opposing the TLAAS program, commenting that an exception for high performance vehicles is not allowed under EPCA or the CAA and that it rewards manufacturers that pay penalties under CAFE and penalizes those that have complied with CAFE. This commenter suggests that manufacturers could decrease vehicle mass or power output of engines, purchase credits from another manufacturer, or earn off-cycle credits. EPA responds to these comments below.

After carefully considering the public comments, EPA continues to believe that the TLAAS program is essential in providing necessary lead time and flexibility to eligible manufacturers in the early years of the standards. First, EPA believes that it is acting well within its legal authority in adopting the various TLAAS provisions. EPA is required to provide sufficient lead time for industry as a whole for standards under section 202(a)(1), which mandates that standards 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." Thus, although section 202(a)(1) does not explicitly authorize this or any other specific lead time provision, it affords ample leeway for EPA to craft provisions designed to provide adequate lead time, and to tailor those provisions as appropriate. We show below that the types of technology penetrations required for TLAAS-eligible vehicles in the program's earlier years raise critical issues as to adequacy of lead time. As discussed in the EPA feasibility analysis provided in Section III.D.6 and III.D.7 several manufacturers eligible for TLAAS are projected to face a compliance shortfall in MY 2016 without the TLAAS program, even with the full application of technologies assumed by the OMEGA Model, including hybrid use of up to 15 percent. These include BMW, Jaguar Land Rover, Daimler, Porsche, and Volkswagen In addition, the smaller volume manufacturers of this group (*i.e.,* Jaguar Land Rover and Porsche) face the greatest shortfall (see Table III.D.6–4). Even with TLAAS, these manufacturers will need to take technology steps to comply with standards above and beyond those of other manufacturers. These manufacturers have relatively few models with high baseline emissions and this flexibility allows them additional lead time to adapt to a longer term strategy of meeting the final standards within their vehicle redesign cycles.

Second, EPA has carefully evaluated other means of eligible manufacturers to meet the standards, such as utilizing available credit opportunities. Indeed, eligibility for the TLAAS, and for temporary deferral of regulation for very small volume manufacturers, is conditioned on first exhausting the various programmatic flexibilities including credit utilization. At the same time, a basic reason certain manufacturers are faced with special lead time difficulties is their inability to generate credits which can be then be averaged across their fleet because of limited product lines. And although purchasing credits is an option under the program, there are no guarantees that credits will be available. Historic practice in fact suggests that manufacturers do not sell credits to competitors. While some of the smaller manufacturers covered by the TLAAS program may be in a position to obtain credits, they are not likely to be available for the TLAAS manufacturers across the board in the volume needed to comply without the TLAAS provisions. At the same time the TLAAS provisions have been structured such that any credits that do become available would likely be used before a manufacturer would turn to the more restricted and limiting TLAAS provisions.

As discussed in Section III.C., off-cycle credits are available if manufacturers are able to employ new and innovative technologies not already in widespread use, which provide real-world emissions reductions not captured on the current test cycles. Further, these credits are eligible only for technologies that are newly introduced on just a few vehicle models, and are not yet in widespread use across the fleet. The magnitude of these credits are highly uncertain because they are based on new technologies, and EPA is not aware of any such technologies that would provide enough credits to bring these manufacturers into compliance without TLAAS lead time flexibility. Manufacturers first must develop these technologies and then demonstrate their emissions reductions capabilities, which will require lead time. Moreover, the technologies mentioned in the proposal which are the most likely to be eligible based on present knowledge, including solar panels and active

[187] *See* final regulations at 40 CFR 86.1818–12(e).

aerodynamics, are likely to provide only small incremental emissions reductions.

We agree with the comment that reducing vehicle mass or power are potential methods for reducing emissions that should be employed by TLAAS-eligible manufacturers to help them meet standards. However, based on our assessment of the lead time needed for these manufacturers to comply with the standards, especially given their more limited product offerings and higher baseline emissions, we believe that additional time is needed for them to come into compliance. EPA can permissibly consider the TLAAS and other manufacturers' lead time, cost, and feasibility issues in developing the primary standards and has discretion in setting the overall stringency of the standards to account for these factors. *Natural Resources Defense Council* v. *Thomas,* 805 F. 2d 410, 421 (DC Cir. 1986) (even when implementing technology-forcing provisions of Title II, EPA may base standards on an industry-wide capability "taking into account the broad spectrum of technological capabilities as well as cost and other factors" across the industry). EPA is not legally required to set standards that drive these manufacturers or their products out of the market, nor is EPA legally required to preserve a certain product line or vehicle characteristic. Instead EPA has broad discretion under section 202(a)(1) to set standards that reasonably balance lead time needs across the industry as a whole and vehicle availability. In this rulemaking, EPA has consistently emphasized the importance of obtaining very significant reductions in emissions of GHGs from the industry as a whole, and obtaining those reductions through regulatory approaches that avoid limiting the ability of manufacturers to provide model availability and choice for consumers. The primary mechanism to achieve this is the use of a footprint attribute curve in setting the increasingly stringent model year standards. The TLAAS provisions are a temporary and strictly limited modification to these attribute standards allowing the TLAAS manufacturers lead time to upgrade their product lines to meet the 2016 GHG standards. EPA has made a reasonable choice here to preserve the overall stringency of the program, and to afford increased flexibility in the program's early years to a limited class of vehicles to assure adequate lead time for all manufacturers to meet the strictest of the standards by MY 2016.

As described below, EPA also carefully considered the comments of smaller volume manufacturers and believes additional lead time is needed. Therefore, EPA is finalizing the TLAAS program, similar to that proposed, and is also finalizing an additional TLAAS option for manufacturers with annual U.S. sales under 50,000 vehicles. EPA is also deferring standards for manufacturers with annual sales of less than 5,000 vehicles. These new TLAAS provisions and the small volume manufacturer deferment are discussed in detail below and in Section III.B.6.

a. Base TLAAS Program

As proposed, EPA is establishing the TLAAS program for a specified subset of manufacturers. This alternative standard is an option only for 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. For manufacturers with annual U.S. sales of 50,000 or more but less than 400,000 vehicles, EPA is finalizing the TLAAS program largely as proposed. EPA proposed that under the TLAAS, qualifying manufacturers would be allowed to produce up to 100,000 vehicles that would be subject to a somewhat less stringent CO_2 standard of 1.25 times the standard that would otherwise apply to those vehicles. 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. EPA is retaining this limit for manufacturers with baseline MY 2009 sales of 50,000 but less than 400,000. In addition, as discussed further below, EPA is finalizing a variety of restrictions on the use of the TLAAS program, to ensure that only manufacturers who need more lead time for the kinds of reasons noted above are likely to use the program.

Volvo and Saab commented that basing eligibility strictly on MY 2009 sales would be problematic for these companies, which are being spun-off from larger manufacturer in the MY 2009 time frame due to the upheaval in the auto industry over the past few years. These commenters offered a variety of suggestions including using MY 2010 as the eligibility cut-off instead of MY 2009, reassessing eligibility on a year-by-year basis as corporate relationships change, or allowing companies separated from a larger parent company by the end of 2010 to use their MY 2009 branded U.S. sales to qualify for TLAAS. In response to these concerns, EPA recognizes that these companies currently being sold by larger manufacturers will share the same characteristics of the manufacturers for which the TLAAS program was designed. As newly independent companies, these firms will face the challenges of a narrower fleet of vehicles across which to average, and may potentially be in a situation, at least in the first few years, of paying fines under CAFE. Lead time concerns in the program's initial years are in fact particularly acute for these manufacturers since they will be newly independent, and thus would have even less of an opportunity to modify their vehicles to meet the standards. Therefore, EPA is finalizing an approach that allows manufacturers with U.S. "branded sales" in MY 2009 under the umbrella of a larger manufacturer that become independent by the end of calendar year 2010 to use their MY 2009 branded sales to qualify for TLAAS eligibility. In other words, a manufacturer will be eligible for TLAAS if it produced vehicles for the U.S. market in MY 2009, its branded sales of U.S. vehicles were less than 400,000 in MY 2009 but whose vehicles were sold as part of a larger manufacturer, and it becomes independent by the end of calendar year 2010, if the new entity has sales below 400,000 vehicles.

Manufacturers with no U.S. sales in MY 2009 are not eligible to utilize the TLAAS program. EPA does not support the commenter's suggestion of a year-by-year eligibility determination because it opens up the TLAAS program to an unknown universe of potential eligible manufacturers, with the potential for gaming. EPA does not believe the TLAAS program should be available to new entrants to the U.S. market since these manufacturers are not transitioning from the CAFE regime which allows fine paying as a means of compliance to a CAA regime which does not, and hence do not present the same types of lead time issues. Manufacturers entering the U.S. market for the first time thus will be fully subject to the GHG fleet-average standards.

As proposed, manufacturers qualifying for TLAAS will be allowed to meet slightly less stringent standards for a limited number of vehicles. An eligible manufacturer could have a total of up to 100,000 units of cars or trucks combined over model years 2012–2015 which 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. 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 necessary lead time 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.

Finally, for manufacturers of 50,000 but less than 400,000 U.S. vehicles sales during 2009, the program expires at the end of MY 2015 as proposed. EPA continues to believe the program reasonably addresses a real world lead time constraint for these manufacturers, and does so in a way that balances the need for more lead time with the need to minimize any resulting loss in potential emissions reductions. In MY 2016, the TLAAS option thus ends for all but the smallest manufacturers opting for TLAAS, and manufacturers must comply with the same CO_2 standards as non-TLAAS manufacturers; 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 almost all except the smallest companies beginning in MY 2016. This option, even with the modifications being adopted, thereby results in more fuel savings and CO_2 reductions than would be the case under the CAFE program by itself.

EPA proposed that manufacturers meeting the cut-point of below 400,000 sales for MY 2009 but whose U.S. sales grew above 400,000 in any subsequent model years would remain eligible for the TLAAS program. The total sales number applies at the corporate level, so if a corporation owns several vehicle brands the aggregate sales for the corporation must 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 (except in the case of a manufacturer being sold by a larger manufacturer by the end of calendar year 2010, as discussed above). In other words, corporations grouped together for purposes of meeting CAFE standards in MY 2009, must be grouped together for determining whether or not they are eligible under the 400,000 vehicle cut point. EPA is finalizing these provisions with the following modifications. EPA recognizes the dynamic corporate restructuring occurring in the auto industry and believes it is important to structure additional provisions to ensure there is no ability to game the TLAAS provisions and to ensure no unintended loss of feasible environmental benefits. Therefore, EPA is finalizing a provision that if two or more TLAAS eligible companies are later merged, with one company having at least 50% or more ownership of the other, or if the companies are combined for the purposes of EPA certification and compliance, the TLAAS allotment is not additive. The merged company will only be allowed the allotment for what is considered the parent company under the new corporate structure. Further, if the newly formed company would have exceeded the 400,000 vehicle cut point based on combined MY 2009 sales, the new entity is not eligible for TLAAS in the model year following the merger. EPA believes that such mergers and acquisitions would give the parent company additional opportunities to average across its fleet, eliminating one of the primary needs for the TLAAS program. This provision will not be retroactive and will not affect the TLAAS program in the year of the merger or for previous model years. EPA believes these additional provisions are essential to ensure the integrity of the TLAAS program by ensuring that it does not become available to large manufacturers through mergers and acquisitions.

As proposed, the TLAAS vehicles will be separate car and truck fleets for that model year and subject to the less stringent footprint-based standards of 1.25 times the primary fleet average that would otherwise apply. The manufacturer will determine what vehicles are assigned to these separate averaging sets for each model year. As proposed, credits from the primary fleet average program can be transferred and used in the TLAAS program. Credits generated within the TLAAS program may also be transferred between the TLAAS car and truck averaging sets (but not to the primary fleet as explained below) for use through MY 2015 when the TLAAS ends.

EPA is finalizing a number of restrictions on credit trading within the TLAAS program, as proposed. EPA is concerned that if credit use in the TLAAS program were unrestricted, some manufacturers would be able to place relatively clean vehicles in the TLAAS fleet, and generate credits for the primary program fleet. First, credits generated under TLAAS may not be transferred or traded to the primary program. Therefore, any unused credits under TLAAS expire after model year 2015 (or 2016 for manufacturers with annual sales less than 50,000 vehicles). 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 where it is not needed. EPA continues to believe 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. Second, EPA is finalizing two additional restrictions on the use of 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 comply with the primary standard before accessing the TLAAS—*i.e.,* TLAAS eligibility is not available to those manufacturers with other readily-available means of compliance. Specifically, before using the TLAAS a manufacturer must: (1) Use any banked emission credits from previous model years; 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, the company must make use of any available intra-manufacturer credit transfers first. Finally, EPA is restricting the use of banking and trading between companies of credits in the primary program in years in which the TLAAS is being used. No such restriction is in place for years when the TLAAS is not being used.

EPA received several comments in support of these credit restrictions for the TLAAS program. On the negative side, one manufacturer commented that the restrictions were not necessary, saying that the restrictions are counter to providing manufacturers with flexibility and that the emissions impacts estimated by EPA due to the full use of the program are small. However, EPA continues to believe that the restrictions are appropriate to prevent the potential gaming described above, and to ensure that the TLAAS program is used only by those manufacturers that have exhausted all other readily available compliance mechanisms and consequently have legitimate lead time issues.

One manufacturer commented that the program is restrictive due to the requirement that manufacturers must decide prior to the start of the model year whether or not and how to use the TLAAS program. EPA did not intend for manufactures to have to make this determination prior to the start of the model year. EPA expects that manufacturers will provide a best estimate of their plans to use the TLAAS program during certification based on projected model year sales, as part of their pre model year report projecting their overall plan for compliance (as required by § 600.514–12 of the regulations). Manufacturers must determine the program's actual use at the end of the model year during the process of demonstrating year-end compliance. EPA recognizes that depending on actual sales for a given model year, a manufacturer's use of TLAAS may change from the projections used in the pre-model year report.

b. Additional TLAAS Flexibility for Manufacturers With MY 2009 Sales of Less Than 50,000 Vehicles

EPA received extensive comments that the TLAAS program would not provide sufficient lead time and flexibility for companies with sales of significantly less than 400,000 vehicles. Jaguar Land Rover, which separated from Ford in 2008, commented that it sells products only in the middle and large vehicle segments and that its total product range remains significantly more limited in terms of segments in comparison with its main competitors which typically have approximately 75% of their passenger car fleet in the small and middle segments. Jaguar Land Rover also commented that it has already committed $1.3 billion of investment to reducing CO_2 from its vehicle fleet and that this investment is already delivering a range of technologies to improve the fuel economy and CO_2 performance of its existing vehicles. Jaguar Land Rover submitted confidential business information regarding their future product plans and emissions performance capabilities of their vehicles which documents their assertions.

Porsche commented that their passenger car footprint-based standard is the most stringent of any manufacturer and this, combined with their high baseline emissions level, means that it would need to reduce emissions by about 10 percent per year over the 2012–2016 time-frame. Porsche commented that such reductions were not feasible. They commented that their competitors will be able to continue to offer their full line of products because the competitors have a wider range of products with which to average. Porsche further commented that their product development cycles are longer than larger competitors. Porsche recommended for small limited line niche manufacturers that EPA require an annual 5 percent reduction in emissions from baseline up to a total reduction of 25 percent, or to modify the TLAAS program to require such reductions. Porsche noted that this percent reduction would be in line with the average emissions reductions required for larger manufacturers.

EPA also received comments from several very small volume manufacturers that, even with the TLAAS program, the proposed standards are not feasible for them, certainly not in the MY 2012–2016 MY time frame. These manufacturers included Aston Martin, McLaren, Lotus, and Ferrari. Their comments consistently focused on the need for separate, less stringent standards for small volume manufacturers. The manufacturers commented that they are willing to make progress in reducing emissions, but that separate, less-stringent small volume manufacturer standards are needed for them to remain in the U.S. market. The commenters note that their product line consists entirely of high end sports cars. Most of these manufacturers have only a few vehicle models, have annual sales on the order of a few hundred to a few thousand vehicles, and several have average baseline CO_2 emissions in excess of 500 g/mile—nearly twice the industry average. McLaren commented that its vehicle model to be introduced in MY 2011 will have class leading CO_2 performance but that it would not be able to offer the vehicle in the U.S. market because it does not have other vehicle models with which to average. Similarly, Aston Martin commented that it is of utmost importance that it is not required to reduce emissions significantly more than equivalent vehicles from larger manufacturers, which would render them uncompetitive due purely to the size of its business. Manufacturers also noted that they launch new products less frequently than larger manufacturers (*e.g.,* Ferrari noted that their production period for models is 7–8 years), and that suppliers serve large manufacturers first because they can buy in larger volumes. Some manufacturers also noted that they would be willing to purchase credits at a reasonable price, but they believed that credit availability from other manufacturers was highly unlikely due to the competitive nature of the auto industry. Several of these manufacturers provided confidential business information indicating their preliminary plans for reducing GHG emissions across their product lines through MY 2016 and beyond.

The Association of International Automobile Manufacturers (AIAM) also commented that, because of their essential features, vehicles produced by small volume manufacturers would not be able to meet the proposed greenhouse gas standards. AIAM commented that "while it is possible that these small volume manufacturers (SVMs) might be able to comply with greenhouse gas standards by purchasing credits from other manufacturers, this is far too speculative a solution. The market for credits is unpredictable at this point. Other than exiting the U.S. market, therefore, the only other possible solution for an independent SVM would be to sell an equity interest in the company to a larger, full-line manufacturer, so that the emissions of the luxury vehicles could be averaged in with the much larger volume of other vehicles produced by the major manufacturer. This cannot possibly be the outcome EPA intends, especially when measured against the minimal, if any, environmental benefit that would result." AIAM commented further that "there is ample legal authority for EPA to provide SVMs a more generous lead-time allowance or an alternative standard. Indeed, EPA recognizes such authority in the proposal for a small entity exemption (for those companies defined under the Small Business Administration's regulations), *see* 74 FR at 49574, and in the TLAAS. These provisions are consistent with previous EPA rulemaking under the Clean Air Act which offer relief to SVMs." AIAM recommended deferring standards for SVMs to a future rulemaking, providing EPA with adequate time to assess relevant product plans and technology feasibility information from SVMs, conduct the necessary reviews and modeling that may be needed, and consult with the stakeholders.

These commenters noted that standards for the smallest manufacturers were deferred in the California program until MY 2016 and that California's program would have established standards for small volume manufacturers in MY 2016 at a level that would be technologically feasible.

The commenters also suggested that California's approach is similar to the approach being taken by EPA for small business entities. Further, these commenters noted that in Tier 2 and other light-duty vehicle programs, EPA has allowed small volume manufacturers (SVMs) until the end of the phase-in period to comply with standards. The commenters recommended that EPA should defer standards for SVMs, and conduct a future rulemaking to establish appropriate standards for SVMs starting in model year 2016. Alternatively, some manufacturers recommended establishing much less stringent standards for SVMs as part of the current rulemaking.

In summary, the manufacturers commented that their range of products was insufficient to allow them to meet the standards in the time provided, even with the proposed TLAAS program. Many of these manufacturers have baseline emissions significantly higher than their larger-volume competitors, and thus the CO_2 reductions required from baseline under the program are larger for many of these companies than for other companies. Although they are investing substantial resources to reduce CO_2 emissions, they believe that they will not be able to achieve the standards under the proposed approach.

EPA also received comments urging us not to expand the TLAAS program. The commenters are concerned about the loss of benefits that would occur with any expansion.

EPA has considered the comments carefully and concludes that additional flexibility is needed for these companies. After assessing the issues raised by commenters, EPA believes there are two groups of manufacturers that need additional lead time. The first group includes manufacturers with annual U.S. sales of less than 5,000 vehicles per year. Standards for these small volume manufacturers are being deferred until a future rulemaking in the 2012 timeframe, as discussed in Section III.B.6, below. This will allow EPA to determine the appropriate level of standards for these manufacturers, as well as the small business entities, at a later time. The second group includes manufacturers with MY 2009 U.S. sales of less than 50,000 vehicles but above the 5,000 vehicle threshold being established for small volume manufacturers. EPA has selected a cut point of 50,000 vehicles in order to limit the additional flexibility to only the smaller manufacturers with much more limited product lines over which to average. EPA has tailored these provisions as narrowly as possible to provide additional lead time only as needed by these smaller manufacturers. We estimate that the TLAAS program, including the changes below will result in a total decrease in overall emissions reductions of about one percent of the total projected GHG program emission benefits. These estimates are provided in RIA Chapter 5 Appendix A.

For some of the companies, the reduction from baseline CO_2 emissions required to meet the standards is clearly greater than for other TLAAS-eligible manufacturers. Compared with other TLAAS-eligible manufacturers, these companies also have more limited fleets across which to average the standards. Some companies have only a few vehicle models all of a similar utility, and thus their averaging abilities are extremely limited posing lead time issues of greater severity than other TLAAS-eligible manufacturers. EPA's feasibility analysis provided in Section III.D., shows that these companies face a compliance shortfall significantly greater than other TLAAS companies (see Table III.D.6–4). This shortfall is primarily due to their narrow product lines and more limited ability to average across their vehicle fleets. In addition, with fewer models with which to average, there is a higher likelihood that phase-in requirements may conflict with normal product redesign cycles.

Therefore, for manufacturers with MY 2009 U.S. sales of less than 50,000 vehicles, EPA is finalizing additional TLAAS compliance flexibility through model year 2016. These manufacturers will be allowed to place up to 200,000 vehicles in the TLAAS program in MY 2012–2015 and an additional 50,000 vehicles in MY 2016. To be eligible for the additional allotment above the base TLAAS level of 100,000 vehicles, manufacturers must annually demonstrate that they have diligently made a good faith effort to purchase credits from other manufacturers in order to comply with the base TLAAS program, but that sufficient credits were not available. Manufacturers must secure credits to the extent they are reasonably available from other manufacturers to offset the difference between their emissions reductions obligations under the base TLAAS program and the expanded TLAAS program. Manufacturers must document their efforts to purchase credits as part of their end of year compliance report. All other aspects of the TLAAS program including the 1.25x adjustment to the standards and the credits provision restrictions remain the same as described above for the same reasons. This will still require the manufacturers to reduce emissions significantly in the 2012–2016 time-frame and to meet the final emissions standards in MY 2017. The standards remain very challenging for these manufacturers but these additional provisions will allow them the necessary lead time for implementing their strategy for compliance with the final, most stringent standards.

The eligibility limit of 50,000 vehicles will be treated in a similar way as the 400,000 vehicle eligibility limit is treated, as described above. Manufacturers with model year 2009 U.S. sales of less than 50,000 vehicles are eligible for the expanded TLAAS flexibility. Manufacturers whose sales grow in later years above 50,000 vehicles without merger or acquisition will continue to be eligible for the expanded TLAAS program. However, manufacturers that exceed the 50,000 vehicle limit through mergers or acquisitions will not be eligible for the expanded TLAAS program in the model year following the merger or acquisition, but may continue to be eligible for the base TLAAS program if the MY 2009 sales of the new company would have been below the 400,000 vehicle eligibility cut point. The use of TLAAS by all the entities within the company in years prior to the merger must be counted against the 100,000 vehicle limit of the base program. If the 100,000 vehicle limit has been exceeded, the company is no longer eligible for TLAAS.

6. Deferment of CO_2 Standards for Small Volume Manufacturers With Annual Sales Less Than 5,000 Vehicles

In the proposal, in the context of the TLAAS program, EPA recognized that there would be a wide range of companies within the eligible manufacturers with sales less than 400,000 vehicles in model year 2009. As noted in the proposal, 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, such as Aston Martin. EPA anticipated that there is a small number of such smaller volume manufacturers, which may face greater challenges in meeting the standards due to their limited product lines across which to average. EPA requested comment on whether the proposed TLAAS program would provide sufficient lead-time for these smaller firms to incorporate the technology needed to comply with the proposed GHG standards. *See* 74 FR at 49524.

EPA received comments from several very small volume manufacturers that the TLAAS program would not provide sufficient lead time, as described above. EPA agrees with comments that the standards would be extremely challenging and potentially infeasible for these small volume manufacturers, absent credits from other manufacturers, and that credit availability at this point is highly uncertain—although these companies are planning to introduce significant GHG-reducing technologies to their product lines, they are still highly unlikely to meet the standards by MY 2016. Because the products produced by these manufacturers are so unique, these manufacturers were not included in EPA's OMEGA modeling assessment of the technology feasibility and costs to meet the proposed standards. As noted above, these manufacturers have only a few models and have very high baseline emissions. TLAAS manufacturers are projected to be required to reduce emissions by up to 39%, whereas SVMs in many cases would need to cut their emissions by more than half to comply with MY 2016 standards.

Given the unique feasibility issues raised for these manufacturers, EPA is deferring establishing CO_2 standards for manufacturers with U.S. sales of less than 5,000 vehicles.[188] This will provide EPA more time to consider the unique challenges faced by these manufacturers. EPA expects to conduct this rulemaking in the 2012 timeframe. The deferment only applies to CO_2 standards and SVMs must meet N_2O and CH_4 standards. EPA plans to set standards for these manufacturers as part of a future rulemaking in the next 18 months. This future rulemaking will allow EPA to fully examine the technologies and emissions levels of vehicles offered by small manufacturers and to determine the potential emissions control capabilities, costs, and necessary lead time. This timing may also allow a credits market to develop, so that EPA may consider the availability of credits during the rulemaking process. See *State of Mass.* v. *EPA,* 549 U.S. at 533 (EPA retains discretion as to timing of any regulations addressing vehicular GHG emissions under section 202(a)(1)). We expect that standards would begin to be implemented in the MY 2016 timeframe. This approach is consistent with that envisioned by California for these manufacturers. EPA estimates that eligible small volume manufacturers currently comprise less than 0.1 percent of the total light-duty vehicle sales in the U.S., and therefore the deferment will have a very small impact on the GHG emissions reductions from the standards.

In addition to the 5,000 vehicle per year cut point, to be eligible for deferment each year, manufacturers must also demonstrate due diligence in attempting to secure credits from other manufacturers. Manufacturers must make a good faith effort to secure credits to the extent they are reasonably available from other manufacturers to offset the difference between their baseline emissions and what their obligations would be under the TLAAS program starting in MY 2012.

Eligibility will be determined somewhat differently compared to the TLAAS program. Manufacturers with either MY 2008 or MY 2009 U.S. sales of less than 5,000 vehicles will be initially eligible. This includes "branded sales" for companies that sold vehicles under a larger manufacturer but has become independent by the end of calendar year 2010. EPA is including MY 2008 as well as MY 2009 because some manufacturers in this market segment have such limited sales that they often drop in and out of the market from year to year.

In determining eligibility, manufacturers must be aggregated according to the provisions of 40 CFR 86.1838–01(b)(3), which requires the sales of different firms to be aggregated in various situations, including where one firm has a 10% or more equity ownership of another firm, or where a third party has a 10% or more equity ownership of two or more firms. EPA received public comment from a manufacturer requesting that EPA should allow a manufacturer to apply to EPA to establish small volume manufacturer status based on the independence of its research, development, testing, design, and manufacturing from another firm that may have an ownership interest in that manufacturer. EPA has reviewed this comment, but is not finalizing such a provision at this time. EPA believes that this issue likely presents some competitive issues, which we would like to be fully considered through the public comment process. Therefore, EPA plans to consider this issue and seek public comments in our proposal for small volume manufacturer CO_2 standards, which we expect to complete within 18 months.

To remain eligible for the deferral from standards, the rolling average of three consecutive model years of sales must remain below 5,000 vehicles. EPA is establishing the 5,000 vehicle threshold to allow for some sales growth by SVMs, as SVMs typically have annual sales of below 2,000 vehicles. However, EPA wants to ensure that standards for as few vehicles as possible are deferred and therefore believes it is appropriate that manufacturers with U.S. sales growing to above 5,000 vehicles per year be required to comply with standards (including TLAAS, as applicable). Manufacturers with unusually strong sales in a given year would still likely remain eligible, based on the three year rolling average. However, if a manufacturer takes steps to expand in the U.S. market on a permanent basis such that they consistently sell more than 5,000 vehicles per year, they must meet the TLAAS standards. EPA believes a manufacturer will be able to consider these provisions, along with other factors, in its planning to significantly expand in the U.S. market.

For manufacturers exceeding the 5,000 vehicle rolling average through mergers or acquisitions of other manufacturers, those manufacturers will lose eligibility in the MY immediately following the last year of the rolling average. For manufacturers exceeding this level through sales growth, but remaining below a 50,000 vehicle threshold, the manufacturer will lose eligibility for the deferred standards in the second model year following the last year of the rolling average. For example, if the rolling average of MYs 2009–2011 exceeded 5,000 vehicles but was below 50,000 vehicles, the manufacturer would not be eligible for the deferred standards in MY 2013. For manufacturers with a 3-year rolling average exceeding 50,000 vehicles, the manufacturer would lose eligibility in the MY immediately following the last model year in the rolling average. For example, if the rolling average of MYs 2009–2011 exceeded 50,000 vehicles, the manufacturer would not be eligible for the deferred standards in MY 2012. Such manufacturers may continue to be eligible for TLAAS, or the expanded TLAAS program, per the provisions described above. EPA believes these provisions are needed to ensure that the SVM deferment remains targeted to true small volume manufacturers and does not become available to larger manufacturers through mergers or acquisitions. EPA is including the 50,000 vehicle criteria to differentiate between manufacturers that may slowly gain more sales and manufacturers that have taken major steps to significantly increase their presence in the U.S. market, such as by introducing new vehicle models. EPA believes manufacturers selling more than 50,000

[188] *See* final regulations at 40 CFR 86.1801–12(k).

vehicles should not be able to take advantage of the deferment, as they should be able to meet the applicable TLAAS standards through averaging across their larger product line.

EPA is requiring that potential SVMs submit a declaration to EPA containing a detailed written description of how the manufacturer qualifies as a small volume manufacturer. The declaration must contain eligibility information including MY 2008 and 2009 U.S. sales, the last three completed MYs sales information, detailed information regarding ownership relationships with other manufacturers, and documentation of efforts to purchase credits from other manufacturers. Because such manufacturers are not automatically exempted from other EPA regulations for light-duty vehicles and light-duty trucks, entities are subject to the greenhouse gas control requirements in this program until such a declaration has been submitted and approved by EPA. The declaration must be submitted annually at the time of vehicle emissions certification under the EPA Tier 2 program, beginning in MY 2012.

7. Nitrous Oxide and Methane Standards

In addition to fleet-average CO_2 standards, as proposed, EPA is establishing separate per-vehicle standards for nitrous oxide (N_2O) and methane (CH_4) emissions.[189] The agency's 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 typical of today's vehicles. EPA proposed to cap N_2O at a level of 0.010 g/mi and to cap CH_4 at a level of 0.03 g/mi. Both of these compounds are more potent contributors to global warming than CO_2; N_2O has a global warming potential, or GWP, of 298 and CH_4 has a GWP of 25.[190]

EPA received many comments on the proposed N_2O and CH_4 standards. A range of stakeholders supported the proposed approach of "cap" standards and the proposed emission levels, including most states and environmental organizations that addressed this topic, and the Manufacturers of Emissions Control Association. These commenters stated that EPA needs to address all mobile GHGs under the Clean Air Act, and N_2O and CH_4 are both more potent contributors to global warming than CO_2. The Center for Biological Diversity commented that in light of the potency of these GHGs, EPA should develop standards which reduce emissions over current levels and that EPA had not analyzed either the technologies or the costs of doing so. EPA discusses these comments and our responses below and in the Response to Comments Document.

Auto manufacturers generally did not support standards for these GHGs, stating that the levels of these GHGs from current vehicles are too small to warrant standards at this time. These commenters also stated that if EPA were to proceed with "cap" standards, the stringency of the proposed levels could restrict the introduction of some new technologies. Commenters specifically raised this concern with the examples of diesel and lean-burn gasoline for N_2O, or natural gas and ethanol fueled vehicles for CH_4. Only one manufacturer, Volkswagen, submitted actual test data to support these claims; very limited emission data on two concept vehicles—a CNG vehicle and a flexible-fuel vehicle—indicated measured emission levels near or above the proposed standards, but included no indication of whether any technological steps had been taken to reduce emissions below the cap levels. Many commenters support an approach of establishing a CO_2-equivalent standard, where N_2O and CH_4 could be averaged with CO_2 emissions to result in an overall CO_2-equivalent compliance value, similar to the approach California has used for its GHG standards [191] Under such an approach, the auto industry commenters supported using a default value for N_2O emissions in lieu of a measured test value. Several auto manufacturers also had concerns that a new requirement to measure N_2O would require significant equipment and facility upgrades and would create testing challenges with new measurement equipment with which they have little experience.

EPA has considered these comments and is finalizing the cap standards for N_2O and CH_4 as proposed. EPA agrees with the NGO, State, and other commenters that light-duty vehicle emissions are small but important contributors to the U.S. N_2O and CH_4 inventories, and that in the absence of a limitation, the potential for significant emission increases exists with the evolution of new vehicle and engine technologies. (Indeed, the industry commenters concede as much in stating that they are contemplating introducing vehicle technologies that could result in emissions exceeding the cap standard levels). EPA also believes that in most cases N_2O and CH_4 emissions from light-duty vehicles will remain well below the cap standards. Therefore, we are setting cap standards for these GHGs at the proposed levels. However, as described below, the agency is incorporating several provisions intended to address industry concerns about technological feasibility and leadtime, including an optional CO_2-equivalent approach and, for N_2O, more leadtime before testing will be required to demonstrate compliance with the emissions standard (in interim, manufacturers may certify based on a compliance statement based on good engineering judgment).

a. Nitrous Oxide (N_2O) Exhaust Emission Standard

As stated above, N_2O is a global warming gas with a high global warming potential.[192] It accounts for about 2.3% of the current greenhouse gas emissions from cars and light trucks.[193] EPA is setting a per-vehicle N_2O emission standard of 0.010 g/mi, measured over the traditional FTP vehicle laboratory test cycles. The standard will become effective in model year 2012 for all light-duty cars and trucks. The standard is designed to prevent increases in N_2O emissions from current levels; *i.e.,* it is 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 for criteria pollutants. As several auto manufacturer comments noted, N_2O is a more significant concern with diesel vehicles, and potentially future gasoline lean-burn engines, equipped with advanced catalytic NO_X

[189] *See* final regulations at 40 CFR 86.1818–12(f).

[190] The global warming potentials (GWP) used in this rule are consistent with the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4).

[191] 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.

[192] N_2O has a GWP of 298 according to the IPCC Fourth Assessment Report (AR4).

[193] *See* RIA Chapter 2.

emissions control systems. In the absence of N_2O emission standards, these systems could be designed in a way that emphasizes efficient NO_X control while at the same time 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 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 setting an N_2O emission standard that the agency believes will be met by current-technology gasoline vehicles at essentially no cost. As just noted, N_2O formation in current catalyst systems occurs, but the emission levels are relatively 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 standard will ensure that the design of advanced NO_X control systems, especially for future diesel and lean-burn gasoline vehicles, will control N_2O emission levels. While current NO_X control approaches used on current Tier 2 diesel vehicles do not tend to favor the formation of N_2O emissions, EPA believes that this N_2O standard will discourage new emission control designs that achieve criteria emissions compliance at the cost of increased N_2O emissions. Thus, the standard will 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 will not increase their emission levels, and that the cap will ensure that future vehicle designs will be appropriately controlled for N_2O emissions.

The level of the N_2O standard 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. EPA has not previously regulated N_2O emissions, and available data on current vehicles is limited. However, EPA derived the standard from a combination of emission factor values used in modeling light duty vehicle emissions and limited recent EPA test data.[194] [195] Because the standard represents a level 100 percent higher than the average current N_2O level, we continue to believe that most if not all Tier 2 compliant gasoline and diesel vehicles will easily be able to meet the standards. 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 EPA expects that manufacturers will use a similar approach for N_2O emission compliance. EPA did not propose and is not finalizing a more stringent standard for current vehicles because we believe that the stringent Tier 2 program and the associated NO_X fleet average requirement already result in significant N_2O control, and the agency does not expect current N_2O levels to rise for these vehicles. Moreover, EPA believes that the CO_2 standards will be challenging for the industry and that these standards should be the industry's chief focus in this first phase of vehicular GHG emission controls. See *Massachusetts* v. *EPA,* 549 U.S. at 533 (EPA has significant discretion as to timing of GHG regulations); *see* also *Sierra Club* v. *EPA, 325 F. 3d 374, 379 (DC Cir. 2003)* (upholding anti-backsliding standards for air toxics under technology-forcing section 202 (l) because it is reasonable for EPA to assess the effects of its other regulations on the motor vehicle sector before aggressively regulating emissions of toxic vehicular air pollutants.

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 N_2O standard will likely require these 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.

In the proposal, EPA sought comment on an approach of expressing N_2O and CH_4 in common terms of CO_2-equivalent emissions and combining them into a single standard along with CO_2 emissions. 74 FR at 49524. California's "Pavley" program adopted such a CO_2-equivalent emissions standards approach to GHG emissions.[196] EPA was primarily concerned that such an approach could undermine the stringency of the CO_2 standards, as the proposed standards were designed to "cap" N_2O and CH_4 emissions, rather than reflecting a level either that is the industry fleet-wide average or that would effect reductions in these GHGs.

As noted above, several auto manufacturers expressed interest in such a CO_2-equivalent approach, due to concerns that the caps could be limiting for some advanced technology vehicles. While we continue to believe that the vast majority of light-duty vehicles will be able to easily meet the standards, we acknowledge that advanced diesel or lean-burn gasoline vehicles of the future may face slightly greater challenges. Therefore, after considering these comments, EPA is finalizing an optional compliance approach to provide flexibility for any advanced technologies that may have challenges in meeting the N_2O or CH_4 cap standards.

In lieu of complying with the separate N_2O and CH_4 cap standards, a manufacturer may choose to comply with a CO_2-equivalent standard. A manufacturer choosing this option will convert its N_2O and CH_4 test results (or, as described below, a default N_2O value for MY 2012–2014) into CO_2-equivalent values and add this sum to their CO_2 emissions. This CO_2-equivalent value will still need to comply with the manufacturer's footprint-based CO_2 target level. In other words, a manufacturer could offset any N_2O emissions (or any CH_4 emissions) by taking steps to further reduce CO_2. A manufacturer choosing this option will need to apply this approach to all of the test groups in its fleet. This approach is more environmentally protective overall than the cap standard approach, since the manufacturer will need to reduce its CO_2 emissions to offset the higher N_2O (or CH_4) levels, but will not be allowed to increase CO_2 above its footprint target level by reducing N_2O (or CH_4).

The compliance level in g/mi for the optional CO_2-equivalent approach for gasoline vehicles is calculated as $CO_2 + (CWF/0.273 \times NMHC) + (1.571 \times CO) + (298 \times N_2O) + (25 \times CH_4)$.[197] The N_2O and CH_4 values are the measured emission values for these GHGs, except N_2O in model years 2012 through 2014. For these model years, manufacturers may use a default N_2O value of 0.010

[194] Memo to docket "Derivation of Proposed N_2O and CH_4 Cap Standards," Tad Wysor, EPA, November 19, 2009. Docket EPA–HQ–OAR–2009–0472–6801.

[195] Memo to docket "EPA NVFEL N_2O Test Data," Tony Fernandez, EPA.

[196] 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.

[197] This equation will differ depending upon the fuel; see the final regulations for equations for other fuels.

g/mi, the same value as the N_2O cap standard. For MY 2015 and later, the manufacturer would need to provide actual test data on the emission data vehicle for each test group. (That is, N_2O data would not be required for each model type, since EPA believes that there will likely be little N_2O variability among model types within a test group.) EPA believes that its selection of 0.010 g/mi as the N_2O default value is an appropriately protective level, on the high end of current technologies, as further discussed below. Consistent with the other elements of the equation, N_2O and CH_4 must be included at full useful life deteriorated values. This requires testing using the highway test cycle in addition to the FTP during the manufacturer's deterioration factor (DF) development program. However, EPA recognizes that manufacturers may not be able to develop DFs for N_2O and CH_4 for all their vehicles in the 2012 model year, and thus EPA is allowing the use of alternative values through the 2014 model year. For N_2O the alternative value is the DF developed for NO_X emissions, and for CH_4 the alternative value is the DF developed for NMOG emissions. Finally, for manufacturers using this option, the CO_2-equivalent emission level would also be the basis for any credits that the manufacturer might generate.

Manufacturers expressed concerns about their ability to acquire and install N_2O analytical equipment. However, the agency continues to believe that such burdens, while not trivial, will also not be excessive. While many manufacturers do not appear to have invested yet in adding N_2O measurement equipment to their test facilities, EPA is not aware of any information to indicate that that suppliers will have difficulty providing sufficient hardware, or that such equipment is unusually expensive or complex compared to existing measurement hardware. EPA allows N_2O measurement using any of four methods, all of which are commercially available today. The costs of certification and other indirect costs of this rule are accounted for in the Indirect Cost Multipliers, discussed in Section III.H below.

Still, given the short lead-time for this rule and the newness of N_2O testing to this industry, EPA proposed that manufacturers be able to apply for a certificate of conformity with the N_2O standard for model year 2012 provided that they supply a compliance statement based on good engineering judgment. Under the proposal, beginning in MY 2013, manufacturers would have needed to base certification on actual N_2O testing data. This approach was intended to reasonably ensure that the emission standards are being met, while allowing manufacturers lead-time to purchase new N_2O emissions measurement equipment, modify certification test facilities, and begin N_2O testing. After consideration of the comments, EPA agrees with manufacturers that one year of additional lead-time to begin actual N_2O measurement across their vehicle fleets may still be insufficient for manufacturers to efficiently make the necessary facility changes and equipment purchases. Therefore, EPA is extending the ability to certify based on a compliance statement for two additional years, through model year 2014. For 2015 and later model years, manufacturers will need to submit measurements of N_2O for compliance purposes.

b. Methane (CH_4) Exhaust Emission Standard

Methane (CH_4) is a greenhouse gas with a high global warming potential.[198] It accounts for about 0.2% of the greenhouse gases from cars and light trucks.[199]

EPA is setting 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 will be met by current gasoline and diesel vehicles, and will prevent large increases in future CH_4 emissions. This is particularly a concern in the event that alternative fueled vehicles with high methane emissions, like some past dedicated compressed natural gas (CNG) vehicles and some flexible-fueled vehicles when operated on E85 fuel, 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.[200] However, CH_4 emissions levels in the gasoline and diesel car and light truck fleet have nevertheless generally been controlled by the Tier 2 standards for non-methane organic gases (NMOG). However, without an emission standard for CH_4, there is no guarantee that future emission levels of CH_4 will remain at current levels as vehicle technologies and fuels evolve.

The standard will cap CH_4 emission levels, with the expectation that emissions levels of current gasoline and diesel vehicles meeting the Tier 2 emission standards will not increase. The level of the standard will generally be achievable for typical vehicles through normal emission control methods already required to meet the Tier 2 emission standards for NMOG. Also, since CH_4 is already measured under the current Tier 2 regulations (so that it may be subtracted to calculate non-methane hydrocarbons), we believe that the standard will not result in any additional testing costs. Therefore, EPA is not attributing any costs to this part of this program. Since CH_4 is produced during fuel combustion in gasoline and diesel engines similarly to other hydrocarbon components, controls targeted at reducing overall NMOG levels are generally also effective in reducing CH_4 emissions. Therefore, for typical gasoline and diesel vehicles, manufacturer strategies to comply with the Tier 2 NMOG standards have to date tended to prevent increases in CH_4 emissions levels. The CH_4 standard will ensure that emissions will be addressed if in the future there are increases in the use of natural gas or other alternative fuels or technologies that may result in higher CH_4 emissions.

As with the N_2O standard, EPA is setting the level of the CH_4 standard to be approximately two times the level of average CH_4 emissions from Tier 2 gasoline passenger cars and light-duty trucks. EPA believes the standard will easily be met by current gasoline vehicles, and that flexible fuel vehicles operating on ethanol can be designed to resolve any potential CH_4 emissions concerns. Similarly, since current diesel vehicles generally have even lower CH_4 emissions than gasoline vehicles, EPA believes that diesels will also meet the CH_4 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 and is inappropriate for that reason (and untimely as well, given the challenge of meeting the CO_2 standards, as noted above).

Some CNG-fueled vehicles have historically produced significantly higher CH_4 emissions than gasoline or diesel vehicles. This is because CNG fuel is essentially methane and any unburned fuel that escapes combustion and is not oxidized by the catalyst is emitted as methane. However, in recent model years, the few dedicated CNG vehicles sold in the U.S. meeting the Tier 2 standards have had CH_4 control as effective as that of gasoline or diesel vehicles. Still, even if these vehicles meet the Tier 2 NMOG standard and appear to have effective CH_4 control by

[198] CH_4 has a GWP of 25 according to the IPCC Fourth Assessment Report (AR4).

[199] *See* RIA Chapter 2.

[200] 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)).

nature of the NMOG controls, Tier 2 standards do not require CH_4 control. Although EPA believes that in most cases that the 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.

Some manufacturers have also expressed some concerns about CH_4 emissions from flexible-fueled vehicles operating on E85 (85% ethanol, 15% gasoline). However, we are not aware of any information that would indicate that if engine-out CH_4 proves to be higher than for a typical gasoline vehicle, that such emissions could not be managed by reasonably available control strategies (perhaps similar to those used in dedicated CNG vehicles).

As described above, in response to the comments, EPA will also allow manufacturers to choose to comply with a CO_2-equivalent standard in lieu of complying with a separate CH_4 cap standard. A manufacturer choosing this option would convert its N_2O and CH_4 test results into CO_2-equivalent values (using the respective GWP values), and would then compare this value to the manufacturer's footprint-based CO_2 target level to determine compliance. However, as with N_2O, this approach will not permit a manufacturer to increase its CO_2 by reducing CH_4; the company's footprint-based CO_2 target level would remain the same.

8. Small Entity Exemption

As proposed, EPA is exempting from GHG emissions standards small entities meeting the Small Business Administration (SBA) size criteria of a small business as described in 13 CFR 121.201.[201] EPA will instead consider appropriate GHG standards for these entities as part of a future regulatory action. This includes both U.S.-based and foreign 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) size criterion of a small business. EPA estimates there currently are approximately two small volume manufacturers, eight ICIs, and three alternative fuel vehicle converters in the light-duty vehicle market. Further detail is provided in Section III.I.3, below. 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 exemption will have a negligible impact on the GHG emissions reductions from the standards.

To ensure that EPA is aware of which companies would be exempt, EPA proposed to require 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. EPA has reconsidered the need for this additional submission under the regulations and is deleting it as not necessary. We already have information on the limited number of small entities that we expect would receive the benefits of the exemption, and do not need the proposed regulatory requirement to be able to effectively implement this exemption for those parties who in fact meet its terms. 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 did not receive adverse comments regarding the proposed small entity exemption. EPA received comments concerning whether or not the small entity exemption applies to foreign manufacturers. EPA clarifies that foreign manufacturers meeting the SBA size criteria are eligible for the exemption, as was EPA's intent during the proposal.

C. Additional Credit Opportunities for CO_2 Fleet Average Program

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

The provisions described below provide additional flexibility, especially in the early years of the program. This 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. EPA is finalizing 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 and are 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 incentives, to incentivize the introduction of those vehicle technologies) and are verifiable. In addition, EPA believes that these credit programs do not provide an opportunity for manufacturers to earn "windfall" credits. Comments on the proposed EPA credit programs are summarized below along with EPA's response, and are detailed in the Response to Comments document.

1. Air Conditioning Related Credits

Manufacturers will 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 (or otherwise to be able to bank or trade the credits). 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 (city/highway) 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. 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 rule 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 5.1% 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.

[201] *See* final regulations at 40 CFR 86.1801–12(j).

The emissions that are associated with leakage reductions are the direct leakage and the leakage associated with maintenance and servicing. Together these are equivalent to CO_2 emissions of approximately 13.6 g/mi per car and light-truck. 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 GHG emissions.[202] This is equivalent to CO_2 emissions of approximately 14.2 g/mi per vehicle. The derivation of these figures can be found in Chapter 2.2 of the EPA RIA.

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 mechanical power to the A/C system. With leakage, it is the high global warming potential (GWP) of the current automotive refrigerant (HFC–134a, with a GWP of 1430) that results in the CO_2-equivalent impact of 13.6 g/mi.[203] 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 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, as discussed below.[204] 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 the 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.[205]

Manufacturers can make very feasible improvements to their A/C systems to address A/C system leakage and efficiency. EPA is finalizing two separate credit approaches to address leakage reductions and efficiency improvements independently. A leakage reduction credit will 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. An efficiency improvement credit will account for the various types of hardware and control of that hardware available to increase the A/C system efficiency. For purposes of use of A/C credits at certification, manufacturers will be required to attest to 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 emission control technologies are similar (including hose materials and connections). There are, however, some fundamental differences between the systems that require a different approach, both to controlling and to documenting that control. The most notable difference is that A/C systems are completely closed systems and always under significant pressure, 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. As a result, these emissions are typically too low to accurately measure in most current SHED chambers designed for fuel evaporative emissions measurement, especially for A/C systems that are new or early in life.

A few commenters suggested that we allow manufacturers, as an option, to use an industry-developed "mini-shed" test procedure (SAE J2763—Test Procedure for Determining Refrigerant Emissions from Mobile Air Conditioning Systems) to measure and report annual refrigerant leakage.[206] However, while EPA generally prefers performance testing, for an individual vehicle A/C system or component, there is not a strong inherent correlation between a performance test using SAE J2763 and the design-based approach we are adopting (based on SAE J2727, as discussed below).[207] Establishing such a correlation would require testing of a fairly broad range of current-technology systems in order to establish the effects of such factors as production variability and assembly practices (which are included in J2727 scores, but not in J2763 measurements). To EPA's knowledge, such a correlation study has not been done. At the same time, as discussed below, there are indications that much of the industry will eventually be moving toward alternative refrigerants with very low GWPs. EPA believes such a transition would diminish the value of any correlation

[202] *See* Chapter 2, Section 2.2.1.2 of the RIA.

[203] The global warming potentials (GWP) used in this rule are consistent with Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). (At this time, the IPCC Second Assessment Report (SAR) GWP values are used in the official U.S. greenhouse gas inventory submission to the climate change framework.)

[204] 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.

[205] We chose not to address 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 by the primary CO_2 standards (Section III.B above).

[206] Honeywell and Volvo supported this view; most other commenters did not.

[207] However, there is a correlation in the fleet between J2763 measurements and J2727 scores.

studies that might be done to confirm the appropriateness of the SAE J2763 procedure as an option in this rule. For these reasons, EPA is therefore not adopting such an optional direct measurement approach to addressing refrigerant leakage at this time.

Instead, as proposed, EPA is adopting a design-based method for manufacturers to demonstrate improvements in their A/C systems and components.[208] Manufacturers implementing system designs expected to result in reduced refrigerant leakage will be eligible for credits that could then be used to meet their CO_2 emission compliance requirements (or otherwise banked or traded). The A/C Leakage Credit provisions will generally assign larger credits to system designs that would result in greater leakage reductions. In addition, proportionately larger A/C Leakage Credits will be available to manufacturers that substitute a refrigerant with lower GWP than the current HFC–134a refrigerant.

Our 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 approach, manufacturers will choose from a menu of A/C equipment and components used in their vehicles in order to establish leakage scores which will characterize their A/C system leakage performance. Credits will be generated from leakage reduction improvements that exceed average fleetwide leakage rates.

EPA believes that the design-based approach will result in estimates of leakage emissions reductions that will be comparable to those that will eventually result from performance-based testing. We believe that this method appropriately approximates the real-world leakage rates for the expected MY 2012–2016 A/C systems.

The cooperative industry and government Improved Mobile Air Conditioning (IMAC) program[209] 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.

As proposed, a manufacturer wishing to generate A/C Leakage Credits will compare the components of its A/C system with a set of leakage-reduction technologies and actions based closely on that developed through IMAC and the Society of Automotive Engineers (as SAE Surface Vehicle Standard J2727, August 2008 version). The J2727 approach was developed from laboratory testing of a variety of A/C related components, and EPA believes that the J2727 leakage scoring system generally represents a reasonable correlation with average real-world leakage in new vehicles. The EPA credit approach addresses the same A/C components as does SAE J2727 and associates each component with the same gram-per-year leakage rate as the SAE method, although, as described below, EPA limits the credits allowed and also modifies it for other factors such as alternative refrigerants.

A manufacturer choosing to generate A/C Leakage Credits will sum the leakage values for an A/C system for a total A/C leakage score according to the following formula. Because the primary GHG program standards are expressed in terms of vehicle exhaust CO_2 emissions as measured in grams per mile, the credits programs adopted in this rule, including A/C related credits, must ultimately be converted to a common metric for proper calculation of credits toward compliance with the primary vehicle standards. This formula describes the conversion of 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:

$$\text{A/C Leakage Credit} = (\text{MaxCredit}) * [1 - (\text{LeakScore/AvgImpact}) * (\text{GWPRefrigerant}/1430)]$$

Where:

MaxCredit is 12.6 and 15.6 g/mi CO_2eq for cars and trucks, respectively. These values become 13.8 and 17.2 for cars and trucks, respectively, if low-GWP refrigerants are used, since this would generate additional credits from reducing emissions during maintenance events, accidents, and at end-of-life.

LeakScore is the leakage score of the A/C system as measured according to the EPA leakage method (based on the J2727 procedure, as discussed above) in units of g/yr. The minimum score that EPA considers feasible is fixed at 8.3 and 10.4 g/yr for cars and trucks respectively (4.1 and 5.2 g/yr for systems using electric A/C compressors) as discussed below.

Avg Impact is the average current A/C leakage emission rate, which is 16.6 and 20.7 g/yr for cars and trucks, respectively.

GWPRefrigerant is the global warming potential (GWP) for direct radiative forcing of the refrigerant. For purposes of this rule, the GWP of HFC–134a is 1430, the GWP of HFC–152a is 124, the GWP of HFO–1234yf is 4, and the GWP of CO_2 as a refrigerant is 1.

The EPA Final RIA elaborates further on the development of each of the values incorporated in the A/C Leakage Credit formula above, as summarized here. First, as proposed, EPA estimates that leakage emission rates for systems using the current refrigerant (HFC–134a) could be feasibly reduced to rates no less than 50% of current rates—or 8.3 and 10.4 g/yr for cars and trucks, respectively—based on the conclusions of the IMAC study as well as consideration of refrigerant emissions over the full life of the vehicle.

Also, some commenters noted that A/C compressors powered by electric motors (*e.g.* as used today in several hybrid vehicle models) were not included in the IMAC study and yet allow for leakage emission rate reductions beyond EPA's estimates for systems with conventional belt-driven compressors. EPA agrees with these comments, and we have incorporated lower minimum emission rates into the formula above—4.1 and 5.2 g/yr for cars and trucks, respectively—in order to allow additional leakage reduction credits for vehicles that use sealed electric A/C compressors. The maximum available credits for these two approaches are summarized in Table III.C.1–1 below.

AIAM commented that EPA should not set a lower limit on the leakage score, even for non-electric compressors. EPA has determined not to do so. First, although there do exist vehicles in the Minnesota data with lower scores than our proposed (and now final) minimum scores, there are very few car models that have scores less than 8.3, and these range from 7.0 to about 8.0 and the difference are small compared to our minimum score.[210] More important, lowering the leakage limit would necessarily increase credit opportunities for equipment design changes, and EPA believes that these changes could discourage the environmentally optimal result of using low GWP refrigerants. Introduction of low GWP refrigerants could be discouraged because it may be less costly to reduce leakage than to replace many of the A/C system components. Moreover, due to the likelihood of in-use factors, even a leakless (according to

[208] *See* final regulations at 40 CFR 86.1866–12(b).

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

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

J2727) R134a system will have some emissions due to manufacturing variability, accidents, deterioration, maintenance, and end of life emissions, a further reason to cap the amount of credits available through equipment design. The only way to guarantee a near zero emission system in-use is to use a low GWP refrigerant. The EPA has therefore decided for the purposes of this final rule to not change the minimum score for belt driven compressors due to the reason cited above and to the otherwise overwhelming support for the program as proposed from commenters.

In addition, as discussed above, EPA recognizes that substituting a refrigerant with a significantly lower GWP will 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 and CO_2 with a GWP of 1—are under serious development and have been demonstrated in prototypes by A/C component suppliers. The European Union has enacted regulations phasing in alternative refrigerants with GWP less than 150 starting this year, and the State of California proposed providing credits for alternative refrigerant use in its GHG rule. Within the timeframe of MYs 2012–2016, EPA is not expecting widespread use of low-GWP refrigerants. However, EPA believes that these developments are promising, and, as proposed, has included in the A/C Leakage Credit formula above a factor to account for the effective GHG reductions that could be expected from refrigerant substitution. The A/C Leakage Credits that will be available will be a function of the GWP of the alternative refrigerant, with the largest credits being available for refrigerants with GWPs at or approaching a value of 1. For a hypothetical alternative refrigerant with a GWP of 1 (*e.g.,* CO_2 as a refrigerant), effectively eliminating leakage as a GHG concern, our credit calculation method could result in maximum credits equal to total average emissions, or credits of 13.8 and 17.2 g/mi CO_2eq for cars and trucks, respectively, as incorporated into the A/C Leakage Credit formula above as the "MaxCredit" term.

Table III.C.1–1 summarizes the maximum A/C leakage credits available to a manufacturer, according to the formula above.

TABLE III.C.1–1—MAXIMUM LEAKAGE CREDIT AVAILABLE TO MANUFACTURERS

	Car (g/mi)	Truck (g/mi)
R–134a refrigerant with belt-driven compressor	6.3	7.8
R–134a refrigerant with electric motor-driven compressor	9.5	11.7
Lowest-GWP refrigerant (GWP=1)	13.8	17.2

It is possible that alternative refrigerants could, without compensating action by the manufacturer, reduce the efficiency of the A/C system (see related discussion of the A/C Efficiency Credit below.) However, as noted at proposal and discussed further in the following section, 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 due to the use of alternative refrigerants.

Beyond the comments mentioned above, commenters generally supported or were silent about EPA's refrigerant leakage methodology (as based on SAE J2727), including the maximum leakage credits available, the technologies eligible for credit and their associated leakage reduction values, and the potential for alternative refrigerants. All comments related to A/C credits are addressed in the Response to Comments Document.

b. A/C Efficiency Credits

Manufacturers that make improvements in their A/C systems to increase efficiency and thus reduce CO_2 emissions due to A/C system operation may 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 (or otherwise bank and trade the credits).

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 RIA.

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 system 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.1–2 below lists some of these technologies and their respective efficiency improvements.

As discussed in the proposal, EPA is adopting a design-based "menu" approach for estimating efficiency improvements and, thus, quantifying A/C Efficiency Credits.[211] However, EPA's ultimate preference is performance-based standards and credit mechanisms (*i.e.,* using actual measurements) as typically providing a more accurate measure of performance. However, EPA has concluded that a practical, performance-based procedure for the purpose of accurately quantifying A/C-related CO_2 emission reductions, and thus efficiency improvements for assigning credits, is not yet available. Still, EPA is introducing a new specialized performance-based test for the more limited purpose of demonstrating that

[211] *See* final regulations at 40 CFR 86.1866–12(c).

actual efficiency improvements are being achieved by the design improvements for which a manufacturer is seeking A/C credits. As discussed below, beginning in MY 2014, manufacturers wishing to generate A/C Efficiency Credits will need to show improvement on the new A/C Idle Test in order to then use the "menu" approach to quantify the number of credits attributable to those improvements.

In response to comments concerning the applicability and effectiveness of technologies that were or were not included in our analysis, we have made several changes to the design-based menu.[212] First, we have separated the credit available for 'recirculated air' [213] technologies into those with closed-loop control of the air supply and those with open-loop control. By "closed-loop" control, we mean a system that uses feedback from a sensor, or sensors, (*e.g.,* humidity, glass fogging, CO_2, etc.) to actively control the interior air quality. For those systems that use "open-loop" control of the air supply, we project that since this approach cannot precisely adjust to varying ambient humidity or passenger respiration levels, the relative effectiveness will be less than that for systems using closed-loop control.

Second, many commenters indicated that the electronic expansion valve, or EXV, should not be included in the menu of technologies, as its effectiveness may not be as high as we projected. Commenters noted that the SAE IMAC report stated efficiency improvements for an EXV used in conjunction with a more efficient compressor, and not as a stand alone technology and that no manufacturers are considering this technology for their products within the timeframe of this rulemaking. We believe other technologies (improved compressor controls for example) can achieve the same benefit as an EXV, without the need for this unique component, and therefore are not adopting it as an option in the design menu of efficiency-improving A/C technologies.

Third, many commenters requested that an internal heat exchanger, or IHX, be added to the design menu. EPA initially considered adding this technology, but in our initial review of studies on this component, we had understood that the value of the technology is limited to systems using the alternative refrigerant HFO–1234yf. Some manufacturers, however, commented that an IHX can also be used with systems using the current refrigerant HFC–134a to improve efficiency, and that they plan on implementing this technology as part their strategy to improve A/C efficiency. Based on these comments, and projections in a more recent SAE Technical Paper, we project that an IHX in a conventional HFC–134a system can improve system efficiency by 20%, resulting in a credit of 1.1 g/mi.[214] Further discussion of IHX technology can be found in the RIA.

Fourth, we have modified the definition of 'improved evaporators and condensers' to recognize that improved versions of these heat exchangers may be used separately or in conjunction with one another, and that an engineering analysis must indicate a COP improvement of 10% or better when using either or both components (and not a 10% COP improvement for each component). Furthermore, we have modified the regulation text to clarify what is considered to be the 'baseline' components for this analysis. We consider the baseline component to be the version which a manufacturer most recently had in production on the same vehicle or a vehicle in a similar EPA vehicle classification. The dimensional characteristics (*e.g.* tube configuration/thickness/spacing, and fin density) of the baseline components are then compared to the new components, and an engineering analysis is required to demonstrate the COP improvement.

For model years 2012 and 2013, a manufacturer wishing to generate A/C Efficiency Credits for a group of its vehicles with similar A/C systems will compare several of its vehicle A/C-related components and systems with a list of efficiency-related technology improvements (see Table III.C.1–2 below). Based on the technologies the manufacturer chooses, an A/C Efficiency Credit value will be established. This design-based approach will recognize the relationships and synergies among efficiency-related technologies. Manufacturers could receive credits 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 will be the total of these values, up to a maximum allowable credit of 5.7 g/mi CO_2eq. This will be the maximum improvement from current average efficiencies for A/C systems (see the RIA for a full discussion of our derivation of the 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. A/C Efficiency Credits as adopted may not exceed 5.7 g/mi CO_2eq.

TABLE III.C.1–2—EFFICIENCY-IMPROVING A/C TECHNOLOGIES AND CREDITS

Technology description	Estimated reduction in A/C CO_2 emissions (%)	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 with closed-loop control of the air supply (sensor feedback to control interior air quality) whenever the ambient temperature is 75 °F or higher (although deviations from this temperature are allowed if accompanied by an engineering analysis)	30	1.7
Default to recirculated air with open-loop control air supply (no sensor feedback) whenever the ambient temperature 75 °F or higher lower temperatures are allowed	20	1.1
Blower motor controls which limit wasted electrical energy (*e.g.,* pulse width modulated power controller)	15	0.9
Internal heat exchanger	20	1.1
Improved condensers and/or evaporators (with system analysis on the component(s) indicating a COP improvement greater than 10%, when compared to previous industry standard designs)	20	1.1

[212] Commenters included the Alliance of Automobile Manufacturers, Jaguar Land Rover, Denso, and the Motor and Equipment Manufacturers Association, among others.

[213] Recirculated air is defined as air present in the passenger compartment of the vehicle (versus outside air) available for the A/C system to cool or condition.

[214] Mathur, Gursaran D., "Experimental Investigation with Cross Fluted Double-Pipe Suction Line Heat Exchanger to Enhance A/C System Performance," SAE 2009–01–0970, 2009.

TABLE III.C.1–2—EFFICIENCY-IMPROVING A/C TECHNOLOGIES AND CREDITS—Continued

Technology description	Estimated reduction in A/C CO_2 emissions (%)	A/C efficiency credit (g/mi CO_2)
Oil separator (with engineering analysis demonstrating effectiveness relative to the baseline design)	10	0.6

The proposal requested comment on adjusting the efficiency credit for alternative refrigerants. Although a few commenters noted that the efficiency of an HFO1234yf system may differ from a current HFC–134a system,[215] we believe that this difference does not take into account any efficiency improvements that may be recovered or gained when the overall system is specifically designed with consideration of the new refrigerant properties (as compared to only substituting the new refrigerant). EPA is therefore not adjusting the credits based on efficiency differences for this rule.

As noted above, for model years 2014 and later, manufacturers seeking to generate design-based A/C Efficiency Credits will also need to use a specific new EPA performance test to confirm that the design changes are resulting in improvements in A/C system efficiency as integrated into the vehicle. As proposed, beginning in MY 2014 manufacturers will need to perform an A/C CO_2 Idle Test for each A/C system (family) for which it desires to generate Efficiency Credits. Manufacturers will need to demonstrate an improvement over current average A/C CO_2 levels (21.3 g/minute on the Idle Test) to qualify for the menu approach credits. Upon qualifying on the Idle Test, the manufacturer will be eligible to use the menu approach above to quantify the potential credits it could generate. To earn the full amount of credits available in the menu approach (limited to the maximum), the test must demonstrate a 30% or greater improvement in CO_2 levels over the current average.

For A/C systems that achieve an improvement between 0-and-30% (or a result between 21.3 and 14.9 g/minute result on the A/C CO_2 Idle Test), a credit can still be earned, but a multiplicative credit adjustment factor will be applied to the eligible credits. As shown in Figure III.C.1–1 this factor will be scaled from 1.0 to 0, with vehicles demonstrating a 30% or better improvement (14.9 g/min or lower) receiving 100% of the eligible credit (adj. factor = 1.0), and vehicles demonstrating a 0% improvement—21.3 g/min or higher result—receiving no credit (adj. factor = 0). We adopted this adjustment factor in response to commenters who were concerned that a vehicle which incorporated many efficiency-improving technologies may not achieve the full 30% improvement, and as a result would receive no credit (thus discouraging them from using any of the technologies). Because there is environmental benefit (reduced CO_2) from the use of even some of these efficiency-improving technologies, EPA believes it is appropriate to scale the A/C efficiency credits to account for these partial improvements.

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[215] Ford noted that "the physical properties of the alternative refrigerant R1234yf could result in a reduction of efficiency by 5 to 10 percent compared to R134a in use today with a similar refrigerant system and controls technology."

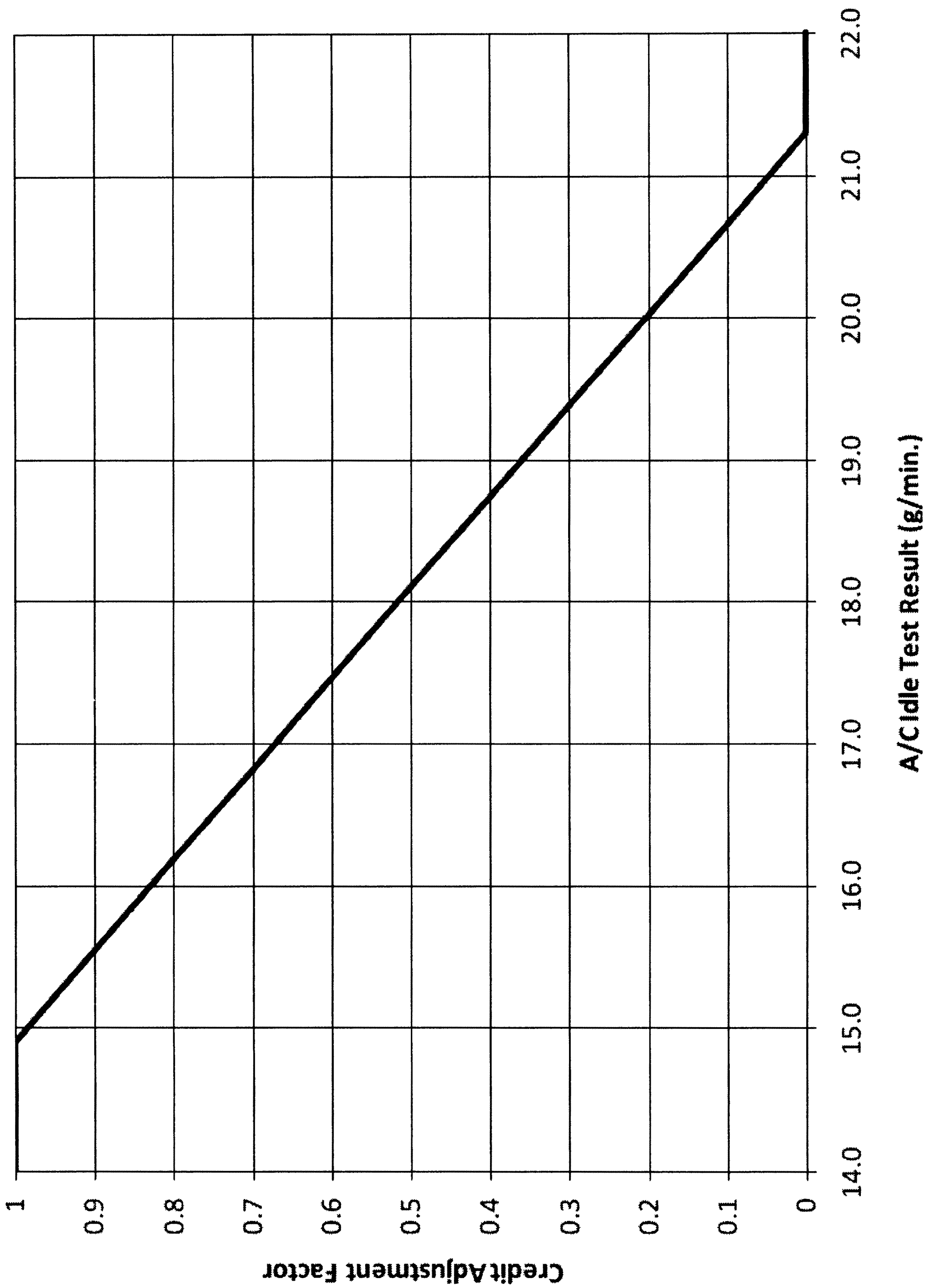

Figure III.C.1-1 A/C Credit Adjustment Factor

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EPA is adopting the A/C CO_2 Idle Test procedure as proposed in most respects. This laboratory idle test is performed while the vehicle is at idle, similar to the idle carbon monoxide (CO) test that was once a part of EPA vehicle certification. The test determines the additional CO_2 generated at idle when the A/C system is operated. The A/C CO_2 Idle Test will 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 test includes tighter restrictions on test cell temperatures and humidity levels than apply for the basic FTP test procedure in order to more closely control the loads from operation of the A/C system. EPA is also adopting additional refinements to the required in-vehicle blower fan settings for manually controlled systems to more closely represent "real world" usage patterns.

Many commenters questioned the ability of this test to measure the improved efficiency of certain A/C technologies, and stated that the test was not representative of real-world driving conditions. However, although EPA acknowledges that this test directly simulates a relatively limited range of technologies and conditions, we determined that it is sufficiently robust for the purpose of demonstrating that the system design changes are indeed implemented properly and are resulting in improved efficiency of a vehicle's A/C system, at idle as well as under a range of operating conditions. Further details of the A/C Idle Test can be found in the RIA and the regulations, as well as in the Response to Comments Document.

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 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. The Idle Test will not be required in order to generate A/C Efficiency Credits until MY 2014 to allow sufficient time for manufacturers to make the necessary facilities improvements and to gain experience with the test.

EPA also considered and invited comment on 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. EPA invited comment on using an adapted version of the SCO3, an existing test procedure that is part of the Supplemental Federal Test Procedure. EPA discussed and invited comment on the various benefits and concerns associated with using an adapted SCO3 test. There were many comments opposed to this proposal, and very few supporters. Most of the comments opposing this approach echoed the concerns made by in the NPRM. These included excessive testing burden, limited test facilities and the cost of adding new ones, and the concern that the SC03 test may not be sufficiently representative of in use A/C usage. Some commenters supported a derivative of the SCO3 test or multiple runs of other urban cycles (such as the LA–4) for quantifying A/C system efficiency. While EPA considers a test cycle that covers a broader range of vehicle speed and climatic conditions to be ideal, developing such a representative A/C test would involve the work of many stakeholders, and would require a significant amount of time, exceeding the scope of this rule. EPA expects to continue working with industry, the California Air Resources Board, and other stakeholders to move toward increasingly robust performance tests and methods for determining the efficiency of mobile A/C systems and the related impact on vehicle CO_2 emissions, including a potential adapted SC03 test.

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 A/C systems. The regulations promulgated under section 609 (40 CFR part 82, subpart B) establish standards and requirements regarding the servicing of A/C systems. These regulations include establishing standards for equipment that recovers and recycles (or, for refrigerant blends, only recovers) refrigerant from A/C systems; 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 systems must have unique fittings and a uniquely colored label for the refrigerant being used in the system.

On September 14, 2006, EPA proposed to approve R–744 (CO_2) for use in motor vehicle A/C systems (71 FR 55140) and on October 19, 2009, EPA proposed to approve the low-GWP refrigerant HFO–1234yf for these systems (74 FR 53445), both subject to certain requirements. Final action on both of these proposals is expected later this year. EPA previously issued a final rule allowing the use of HFC–152a as a refrigerant in motor vehicle A/C systems subject to certain requirements (June 12, 2008; 73 FR 33304). As discussed above, manufacturers transitioning to any of the approved refrigerants would be eligible for A/C Leakage Credits, the value of which would depend on the GWP of their refrigerant and the degree of leakage reduction of their systems.

EPA views this 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 will 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 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 will not conflict (or overlap) with the Title VI section 609 standards. EPA also believes the menu of leak control technologies described in this rule will complement the section 612 requirements, because these control technologies will help ensure that HFC–134a (or other refrigerants) will be used in a manner that further minimizes potential adverse effects on human health and the environment.

2. Flexible Fuel and Alternative Fuel Vehicle Credits

EPA is finalizing its proposal to allow flexible-fuel vehicles (FFVs) and alternative fuel vehicles to generate credits for purposes of the GHG rule starting in the 2012 model year. FFVs are vehicles that can run on both an alternative fuel and a conventional fuel. Most FFVs are E85 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). These credits are designed to complement the treatment of FFVs under CAFE, consistent with the emission reduction objectives of the CAA. As explained at proposal, EPCA includes an incentive under the CAFE program for production of dual-fueled vehicles or FFVs, and dedicated alternative fuel vehicles.[216] For FFVs and dual-fueled vehicles, the EPCA/EISA credits have three elements: (1) The assumption that the vehicle is operated 50% of the time on the conventional fuel and 50% of the time on the alternative fuel, (2) that 1 gallon of alternative fuel is treated as 0.15 gallon of fuel, essentially increasing the fuel economy of a vehicle on alternative fuel by a factor of 6.67, and (3) a "cap" provision that limits the maximum fuel economy increase that can be applied to a manufacturer's overall CAFE compliance value for all CAFE compliance categories (*i.e.,* domestic passenger cars, import passenger cars, and light trucks) to 1.2 mpg through 2014 and 1.0 mpg in 2015. 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.[217] 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.[218] Under EPCA, for dedicated alternative fuel vehicles, there are no limits or phase-out. As proposed, FFV and Alternative Fuel Vehicle Credits will 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).

Manufacturers supported the inclusion of FFV credits in the program. Chrysler noted that the credits encourage manufacturers to continue production of vehicles capable of running on alternative fuels as the production and distribution systems of such fuels are developed. Chrysler believes the lower carbon intensity of such fuels is an opportunity for further greenhouse gas reductions and increased energy independence, and the continuance of such incentives recognizes the important potential of this technology to reduce GHGs. Toyota noted that because actions taken by manufacturers to comply with EPA's regulation will, to a large extent, be the same as those taken to comply with NHTSA's CAFE regulation, it is appropriate for EPA to consider flexibilities contained in the CAFE program that clearly impact product plans and technology deployment plans already in place or nearly in place. Toyota believes that adopting the FFV credit for a transitional period of time appears to recognize this reality, while providing a pathway to eventually phase-out the flexibility.

As proposed, electric vehicles (EVs) or plug-in hybrid electric vehicles (PHEVs) are not eligible to generate this type of credit. These vehicles are covered by the advanced technology vehicle incentives 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 allowing FFV credits corresponding to the amounts allowed by the amended EPCA but only during the period from MYs 2012 to 2015. (As discussed below in Section III.E., EPA is not allowing CAFE-based FFV credits to be generated as part of the early credits program.) As noted at proposal, 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 assessing necessary lead time for the CO_2 standards. Manufacturers commented that the credits are necessary in allowing them to transition to the new 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 requiring for MY 2016 and later that manufacturers will need to reliably estimate the extent to which 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. Beginning in MY 2016, the FFV credits as described above for MY 2012–2015 will no longer be available for EPA's GHG program. Rather, GHG compliance values will be based on actual emissions performance of the FFV on conventional and alternative fuels, weighted by the actual use of these fuels in the FFVs.

As with the CAFE program, EPA will base MY 2012–2015 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.[219] In addition, the measured CO_2 emissions on the alternative fuel will 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. For example, for a flexible-fuel vehicle that emitted 330 g/mi CO_2 operating on E85 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:

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

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.

EPA notes also that the above equation and example are based on an FFV that is an E85 vehicle. EPCA, as amended by EISA, also establishes the use of this approach, including the 0.15 factor, for all alternative fuels, not just

[216] 49 U.S.C. 32905.

[217] *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. 32905(b). This is typically referred to as an FFV credit.

[218] 49 U.S.C. 32906.

[219] 49 U.S.C. 32905(b).

E85.[220] 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 dual-fueled vehicles, such as a vehicle able to operate on gasoline and CNG.[221] (For natural gas dual-fueled vehicles, EPCA establishes a factor of 0.823 gallons of fuel for every 100 cubic feet a natural gas used to calculate a gallons equivalent.[222]) The EISA'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 will use the 0.15 factor for all FFVs in order not to disrupt manufacturers' near-term compliance planning and assure sufficient lead time. EPA, in any case, expects the vast majority of FFVs to be E85 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.[223] 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 proposed, but is not adopting, credit limits based on the overall industry average CO_2 standards for cars and trucks. EPA also requested comments on basing the calculated CO_2 credit limits on the individual manufacturer fleet-average standards calculated from the footprint curves. EPA received comment from one manufacturer supporting this approach. EPA also received comments from another manufacturer recommending that the credit limits for an individual manufacturer be based instead on that manufacturer's fleet average performance. The commenter noted that this approach is in line with how CAFE FFV credit limits are applied. This is due to the fact that the GHG-equivalent of the CAFE 1.2 mpg cap will vary due to the non-linear relationship between fuel economy and GHGs/fuel consumption. EPA agrees with this approach since it best harmonizes how credit limits are determined in CAFE. EPA intended and continues to believe it is appropriate to provide essentially the same FFV credits under both programs for MYs 2012–2015. Therefore, EPA is finalizing FFV credits limits for MY 2012–2015 based on a manufacturer's fleet-average performance. For example, if a manufacturer's 2012 car fleet average emissions performance was 260 g/mile (34.2 mpg), the credit limit in CO_2 terms would be 9.5 g/mile (34.2 mpg − 1.2 mpg = 33.0 mpg = 269.5 g/mile) and if it were 270 g/mile the limit would be 10.2 g/mile.

ii. Dedicated Alternative Fuel Vehicles

As proposed, EPA will 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:

$$CO_2 = 330 \times 0.15 = 49.5\ g/mi$$

b. Model Years 2016 and Later

i. FFVs

EPA is treating FFV credits the same as under EPCA for model years 2012–2015, but is applying a different approach starting with model year 2016. EPA recognizes that under EPCA automatic FFV credits are entirely phased out of the CAFE program by MY 2020, and apply in the prior model years with certain limitations, but without a requirement that the manufacturers demonstrate actual use of the alternative fuel. 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 will treat FFVs for model years 2012–2015 the same as under EPCA, as part of providing sufficient lead time given manufacturers' compliance strategies which rely on the existence of these EPCA statutory credits, as explained above.

Starting with model year 2016, as proposed, EPA will no longer allow manufacturers to base FFV emissions on the use of the 0.15 factor credit described above, and on the use of an assumed 50% usage of alternative fuel. Instead, EPA believes the appropriate approach is to ensure that FFV emissions are based on demonstrated emissions performance. This will promote the environmental goals of the final program. EPA received several comments in support of EPA's proposal to use this approach instead of the EPCA approach for MY 2016 and later. Under the EPA program in MY 2016 and later, manufacturers will be allowed to base an FFV's emissions compliance value in part on the vehicle test values run on the alternative fuel, for that portion of its fleet for which the manufacturer demonstrates utilized the alternative fuel in the field. In other words, the default is to assume FFVs operate on 100% gasoline, and the emissions value for the FFV vehicle will be based on the vehicle's tested value on gasoline. However, if a manufacturer can demonstrate that a portion of its FFVs are using an alternative fuel in use, then the FFV emissions compliance value can be calculated based on the vehicle's tested value using the alternative fuel, prorated based on the percentage of the fleet using the alternative fuel in the field. An example calculation is described below. EPA believes this approach will provide an actual incentive to ensure that such fuels are used. The incentive arises since actual use of the flexible fuel typically results in lower tailpipe GHG emissions than use of gasoline and hence improves the vehicles' performance, making it more likely that its performance will improve a manufacturers' average fleetwide performance. Based on existing certification data, E85 FFV CO_2 emissions are typically about 5 percent lower on E85 than CO_2 emissions on 100 percent gasoline. Moreover, currently there is little incentive to optimize CO_2 performance for vehicles when running on E85. EPA believes the above approach would provide such an incentive to manufacturers and that E85 vehicles could be optimized through engine redesign and calibration to provide additional CO_2 reductions.

Under the EPCA credit provisions, there is an incentive to produce FFVs but no actual incentive to ensure that the alternative fuels are used, or that actual vehicle fuel economy improves. GHG and energy security benefits are only achieved if the alternative fuel is actually used and (for GHGs) that performance improves, and EPA's approach for MY 2016 and beyond will now provide such an incentive. This approach will promote greater use of alternative 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 basing the FFV program for MYs 2016 and thereafter 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.

[220] 49 U.S.C. 32905(c).

[221] 49 U.S.C. 32905(d).

[222] 49 U.S.C. 32905(c).

[223] 49 U.S.C. 32906(a).

For 2016 and later model years, EPA will therefore treat FFVs similarly to conventional fueled vehicles in that FFV emissions would be based on actual CO_2 results from emission testing on the fuels on which it operates. In calculating the emissions performance of an FFV, manufacturers may base FFV emissions on vehicle testing based on the alternative fuel emissions, if they can demonstrate that the alternative fuel is actually being used in the vehicles. Performance will otherwise be calculated assuming use only of conventional fuel. The manufacturer must establish the ratio of operation that is on the alternative fuel compared to the conventional fuel. The ratio will be used to weight the CO_2 emissions performance over the 2-cycle test on the two fuels. The 0.15 conversion factor will 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 E85 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, where the manufacturer intends for its performance to be calculated based on some use of alternative fuels. One option EPA is finalizing is establishing a rebuttable presumption using a national average approach based on national E85 fuel use. Manufacturers could use this value along with their vehicle emissions results demonstrating lower emissions on E85 to determine the emissions compliance values for FFVs sold by manufacturers under this program. For example, national E85 volumes and national FFV sales may be used to prorate E85 use by manufacturer sales volumes and FFVs already in-use. Upon a manufacturer's written request, EPA will 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 E85 sales, E85 usage will be assigned to each vehicle. This method accounts for the VMT of new FFVs and FFVs already in the existing fleet using VMT data in the model. The model will then be used to determine the ratio of E85 and gasoline for new vehicles being sold. Fluctuations in E85 sales and FFV sales will be taken into account to adjust the manufacturers' E85 actual use estimates annually. EPA plans to make this assigned fuel usage factor available through guidance prior to the start of MY 2016 and adjust it annually as necessary. EPA believes this is a reasonable way to apportion E85 use across the fleet.

If manufacturers decide not to use EPA's assigned fuel usage based on the national average analysis, they have a second option of presenting their own data for consideration as the basis for evaluating fuel usage. 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. Manufacturers must 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 received comments that the 2016 and later FFV emissions performance methodology should be based on the life cycle emissions (*i.e.,* including the upstream GHG emissions associated with fuel feedstocks, production, and transportation) associated with the use of the alternative fuel. Commenters are concerned that the use of ethanol will not result in lower GHGs on a lifecycle basis. After considering these comments, EPA is not including lifecycle emissions in the calculation of vehicle credits. EPA continues to believe that it is appropriate to base credits for MY 2012–2015 on the EPCA/CAFE credits and to base compliance values for MY 2016 on the demonstrated tailpipe emissions performance on gasoline and E85, and is finalizing this approach as proposed. EPA recently finalized its RFS2 rulemaking which addresses lifecycle emissions from ethanol and the upstream GHG benefits of E85 use are already captured by this program.[224]

ii. Dedicated Alternative Fuel Vehicles

As proposed, for model years 2016 and later dedicated alternative fuel vehicles, CO_2 will 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 CO_2 program. EPA did not receive comments on this approach.

3. Advanced Technology Vehicle Incentives for Electric Vehicles, Plug-in Hybrids, and Fuel Cell Vehicles

EPA is finalizing provisions that provide a temporary regulatory incentive for the commercialization of certain advanced vehicle power trains—electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs)—for model year 2012–2016 light-duty and medium-duty passenger vehicles.[225] The purpose of these provisions is to provide a temporary incentive to promote technologies which have the potential to produce very large GHG reductions in the future, but which face major challenges such as vehicle cost, consumer acceptance, and the development of low-GHG fuel production infrastructure. The tailpipe GHG emissions from EVs, PHEVs operated on grid electricity, and hydrogen-fueled FCVs are zero, and traditionally the emissions of the vehicle itself are all that EPA takes into account for purposes of compliance with standards set under section 202(a). Focusing on vehicle tailpipe emissions has not raised any issues for criteria pollutants, as upstream emissions associated with production and distribution of the fuel are addressed by comprehensive regulatory programs focused on the upstream sources of those emissions.[226] At this time, however, there is no such comprehensive program addressing upstream emissions of GHGs, and the upstream GHG emissions associated with production and distribution of electricity are higher than the corresponding upstream GHG emissions of gasoline or other petroleum based fuels. In the future, if there were a program to comprehensively control upstream GHG emissions, then the zero tailpipe levels from these vehicles have the potential to produce very large GHG reductions, and to transform the

[224] 75 FR 14670 (March 26, 2010).

[225] *See* final regulations at 40 CFR 86.1866–12(a).

[226] In this section, "upstream" means all fuel-related GHG emissions prior to the fuel being introduced to the vehicle.

transportation sector's contribution to nationwide GHG emissions.

This temporary incentive program applies only for the model years 2012–2016 covered by this final rule. EPA will reassess the issue of how to address EVs, PHEVs, and FCVs in rulemakings for model years 2017 and beyond, based on the status of advanced technology vehicle commercialization, the status of upstream GHG emissions control programs, and other relevant factors.

In the Joint Notice of Intent, EPA stated that "EPA is currently considering proposing additional credit opportunities to encourage the commercialization of advanced GHG/fuel economy control technology such as electric vehicles and plug-in hybrid electric vehicles. These 'super credits' could 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." [227] Following through, EPA proposed two mechanisms by which these vehicles would earn credits: (1) A zero grams/mile compliance value for EVs, FCVs, and for PHEVs when operated on grid electricity, and (2) a vehicle multiplier in the range of 1.2 to 2.0.[228]

The zero grams/mile compliance value for EVs (and for PHEVs when operated on grid electricity, as well as for FCVs which involve similar upstream GHG issues with respect to hydrogen production) is an incentive that operates like a credit because, while it accurately accounts for tailpipe GHG emissions, it does not reflect the increase in upstream GHG emissions associated with the electricity used by EVs compared to the upstream GHG emissions associated with the gasoline or diesel fuel used by conventional vehicles.[229] For example, based on GHG emissions from today's national average electricity generation (including GHG emissions associated with feedstock extraction, processing, and transportation) and other key assumptions related to vehicle electricity consumption, vehicle charging losses, and grid transmission losses, a midsize EV might have an upstream GHG emissions of about 180 grams/mile, compared to the upstream GHG emissions of a typical midsize gasoline car of about 60 grams/mile. Thus, the EV would cause a net upstream GHG emissions increase of about 120 grams/mile (in general, the net upstream GHG increase would be less for a smaller EV and more for a larger EV). The zero grams/mile compliance value provides an incentive because it is less than the 120 grams/mile value that would fully account for the net increase in GHG emissions, counting upstream emissions.[230] The net upstream GHG impact could change over time, of course, based on changes in electricity generation or gasoline production.

The proposed vehicle multiplier incentive would also have operated like a credit as it would have allowed an EV, PHEV, or FCV to count as more than one vehicle in the manufacturer's fleet average. For example, combining a multiplier of 2.0 with a zero grams/mile compliance value for an EV would allow that EV to be counted as two vehicles, each with a zero grams/mile compliance value, in the manufacturer's fleet average calculations. In effect, a multiplier of 2.0 would double the overall credit associated with an EV, PHEV, or FCV.

EPA explained in the proposal that the potential for large future emissions benefits from these technologies provides a strong reason for providing incentives at this time to promote their commercialization in the 2012–2016 model years. At the same time, EPA acknowledged that the zero grams/mile compliance value did not account for increased upstream GHG emissions. EPA requested comment on providing some type of incentive, the appropriateness of both the zero grams/mile and vehicle multiplier incentive mechanisms, and on any alternative approaches for addressing advanced technology vehicle incentives. EPA received many comments on these issues, which will be briefly summarized below.

Although some environmental organizations and State agencies supported the principle of including some type of regulatory incentive mechanism, almost all of their comments were opposed to the combination of both the zero grams/mile compliance value and multipliers in the higher end of the proposed range of 1.2 to 2.0. The California Air Resources Board stated that the proposed credits "are excessive" and the Union of Concerned Scientists stated that it "strongly objects" to the approach that lacks "technical justification" by not "accounting for upstream emissions." The Natural Resources Defense Council (NRDC) stated that the credits could "undermine the emissions benefits of the program and will have the unintended consequence of slowing the development of conventional cleaner vehicle emission reduction technologies into the fleet." NRDC, along with several other commenters who made the same point, cited an example based on Nissan's public statements that it plans on producing up to 150,000 Nissan Leaf EVs in the near future at its plant in Smyrna, Tennessee.[231] NRDC's analysis showed that if EVs were to account for 10% of Nissan's car fleet in 2016, the combination of the zero grams/mile and 2.0 multiplier would allow Nissan to make only relatively small improvements to its gasoline car fleet and still be in compliance. NRDC described a detailed methodology for calculating "true full fuel cycle emissions impacts" for EVs. The Sierra Club suggested that the zero grams/mile credit would "taint" EVs as the public comes to understand that these vehicles are not zero-GHG vehicles, and that the zero grams/mile incentive would allow higher gasoline vehicle GHG emissions.

Most vehicle manufacturers were supportive of both the zero grams/mile compliance value and a higher vehicle multiplier. The Alliance of Automobile Manufacturers supported zero grams/mile "since customers need to receive a clear signal that they have made the right choice by preferring an EV, PHEV, or EREV. * * * However, the Alliance recognizes the need for a comprehensive approach with shared responsibility in order to achieve an overall carbon reduction." Nissan claimed that zero grams/mile is "legally required," stating that EPA's 2-cycle test procedures do not account for upstream GHG emissions, that accounting for upstream emissions from electric vehicles but not from other vehicles would be arbitrary, and that including upstream GHG would "disrupt the careful balancing embedded into the National Program." Several other manufacturers, including Ford, Chrysler, Toyota, and Mitsubishi, also supported the proposed zero grams/mile compliance value. BMW suggested a compliance value approach similar to

[227] Notice of Upcoming Joint Rulemaking to Establish Vehicle GHG Emissions and CAFE Standards, 74 FR 24007, 24011 (May 22, 2009).

[228] 74 FR 49533–34.

[229] *See* 74 FR 49533 ("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").

[230] This 120 grams/mile value for a midsize EV is approximately similar to the compliance value for today's most efficient conventional hybrid vehicle, so the EV would not be significantly more "GHG-positive" than the most efficient conventional hybrid counterpart under a full accounting approach. It should be noted that these emission levels would still be well below the footprint targets for the vehicles in question.

[231] "Secretary Chu Announces Closing of $1.4 Billion Loan to Nissan," Department of Energy, January 28, 2010, *http://www.energy.gov/news/8581.htm.* EPA Docket EPA–HQ–OAR–2009–0472.

that used for CAFE compliance (described below), which would yield a very low, non-zero grams/mile compliance value. Honda opposed the zero grams/mile incentive. Honda suggested that EPA should fully account for upstream GHG and "should separate incentives and credits from the measurement of emissions." Automakers universally supported higher multipliers, many higher than the maximum 2.0 level proposed by EPA. Honda suggested a multiplier of 16.0 for FCVs. Mitsubishi supported the concept of larger, temporary incentives until advanced technology vehicle sales achieved a 10% market share. Finally, some commenters suggested that other technologies should also receive incentives, such as diesel vehicles, hydrogen-fueled internal combustion engines, and natural gas vehicles.

Based on a careful consideration of these comments, EPA is modifying its proposed advanced technology vehicle incentive program for EVs, PHEVs, and FCVs produced in 2012–2016. EPA is not extending the program to include additional technologies at this time. The final incentive program, and our rationale for it, are described below.

One, the incentive program retains the zero grams/mile value for EVs and FCVs, and for PHEVs when operated on grid electricity, subject to vehicle production caps discussed below. EPA acknowledges that, based on current electricity and hydrogen production processes, that EVs, PHEVs, and FCVs yield higher upstream GHG emissions than comparable gasoline vehicles. But EPA reiterates its support for temporarily rewarding advanced emissions control technologies by foregoing modest emissions reductions in the short term in order to lay the foundation for the potential for much larger emission reductions in the longer term.[232] EPA notes that EVs, PHEVs, and FCVs are potential GHG "game changers" if major cost and consumer barriers can be overcome and if there is a nationwide transformation to low-GHG electricity (or hydrogen, in the case of FCVs).

Although EVs and FCVs will have compliance values of zero grams/mile, PHEV compliance values will be determined by combining zero grams/mile for grid electricity operation with the GHG emissions from the 2-cycle test results during operation on liquid fuel, and weighting these values by the percentage of miles traveled that EPA believes will be performed on grid electricity and on liquid fuel, which will vary for different PHEVs. EPA is currently considering different approaches for determining the weighting factor to be used in calculating PHEV GHG emissions compliance values. EPA will consider the work of the Society of Automotive Engineers Hybrid Technical Standards Committee, as well as other relevant factors. EPA will issue a final rule on this methodology by the fall of 2010, when EPA expects some PHEVs to initially enter the market.

EPA agrees with the comments by the environmental organizations, States, and Honda that the zero grams/mile compliance value will reduce the overall GHG benefits of the program. However, EPA believes these reductions in GHG benefits will be relatively small based on the projected production of EVs, PHEVs, and FCVs during the 2012–2016 timeframe, along with the other changes that we are making in the incentive program. EPA believes this modest potential for reduction in near-term emissions control is more than offset by the potential for very large future emissions reductions that commercialization of these technologies could promote.

Two, the incentive program will not include any vehicle multipliers, *i.e.,* an EV's zero grams/mile compliance value will count as one vehicle in a manufacturer's fleet average, not as more than one vehicle as proposed. EPA has concluded that the combination of the zero grams/mile and multiplier credits would be excessive. Compared to the maximum multiplier of 2.0 that EPA had proposed, dropping this multiplier reduces the aggregate impact of the overall credit program by a factor of two (less so for lower multipliers, of course).

Three, EPA is placing a cumulative cap on the total production of EVs, PHEVs, and FCVs for which an individual manufacturer can claim the zero grams/mile compliance value during model years 2012–2016. The cumulative production cap will be 200,000 vehicles, except those manufacturers that sell at least 25,000 EVs, PHEVs, and FCVs in MY 2012 will have a cap of 300,000 vehicles for MY 2012–2016. This higher cap option is an additional incentive for those manufacturers that take an early leadership role in aggressively and successfully marketing advanced technology vehicles. These caps are a second way to limit the potential GHG benefit losses associated with the incentive program and therefore are another response to the concerns that the proposed incentives were excessive and could significantly undermine the program's GHG benefits. If, for example, 500,000 EVs were produced in 2012–2016 that qualified for the zero grams/mile compliance value, the loss in GHG benefits due to this program would be about 25 million metric tons, or less than 3 percent of the total projected GHG benefits of this program.[233] The rationale for these caps is that the incentive for EVs, PHEVs, and FCVs is most critical when individual automakers are beginning to introduce advanced technologies in the market, and less critical once individual automakers have successfully achieved a reasonable market share and technology costs decline due to higher production volumes and experience. EPA believes that cap levels of 200,000–300,000 vehicles over a five model year period are reasonable, as production greater than this would indicate that the manufacturer has overcome at least some of the initial market barriers to these advanced technologies. Further, EPA believes that it is unlikely that many manufacturers will approach these cap levels in the 2012–2016 timeframe.[234]

Production beyond the cumulative vehicle production cap for a given manufacturer in MY 2012–2016 would have its compliance values calculated according to a methodology that accounts in full for the net increase in upstream GHG emissions. For an EV, for example, this would involve: (1) Measuring the vehicle electricity consumption in watt-hours/mile over the 2-cycle test (in the example introduced earlier, a midsize EV might have a 2-cycle test electricity consumption of 230 watt-hours/mile), (2) adjusting this watt-hours/mile value upward to account for electricity losses during transmission and vehicle charging (dividing 230 watt-hours/mile by 0.93 to account for grid/transmission losses and by 0.90 to reflect losses during vehicle charging yields a value of 275 watt-hours/mile), (3) multiplying the adjusted watt-hours/mile value by a

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[232] EPA has adopted this strategy in several of its most recent and important mobile source rulemakings, such as its Tier 2 Light-Duty Vehicle, 2007 Heavy-Duty Highway, and Tier 4 Nonroad Diesel rulemakings.

[233] *See* Regulatory Impact Analysis, Appendix 5.B. While it is, of course, impossible to predict the number of EVs, PHEVs, and FCVs that will be produced between 2012 and 2016 with absolute certainty, EPA believes that 500,000 "un-capped" EVs is an optimistic scenario. Fewer EVs, or a combination of 500,000 EVs and PHEVs, would lessen the short-term reduction in GHG benefits. Production of more than 500,000 "un-capped" EVs would increase the short-term reduction in GHG benefits.

[234] Fundamental power train changes in the automotive market typically evolve slowly over time. For example, over ten years after the U.S. introduction of the first conventional hybrid electric vehicle, total hybrid sales are approximately 300,000 units per year.

nationwide average electricity upstream GHG emissions rate of 0.642 grams/watt-hour at the powerplant[235] (275 watt-hours/mile multiplied by 0.642 grams GHG/watt-hour yields 177 grams/mile), and 4) subtracting the upstream GHG emissions of a comparable midsize gasoline vehicle of 56 grams/mile to reflect a true net increase in upstream GHG emissions (177 grams/mile for the EV minus 56 grams/mile for the gasoline vehicle yields a net increase and EV compliance value of 121 grams/mile).[236] [237] The full accounting methodology for the portion of PHEV operation on grid electricity would use this same approach.

EPA projects that the aggregate impact of the incentive program on advanced technology vehicle GHG compliance values will be similar to the way advanced technologies are treated under DOT's CAFE program. In the CAFE program, the mpg value for an EV is determined using a "petroleum equivalency factor" that has a 1/0.15 factor built into it similar to the flexible fuel vehicle credit.[238] For example, under current regulations, an EV with a 2-cycle electricity consumption of 230 watt-hours/mile would have a CAFE rating of about 360 miles per gallon, which would be equivalent to a gasoline vehicle GHG emissions value of 25 grams/mile, which is close to EPA's zero grams/mile for EV production that is below an individual automaker's cumulative vehicle production cap. The exception would be if a manufacturer exceeded its cumulative vehicle production cap during MY 2012–2016. Then, the same EV would have a GHG compliance value of about 120 grams/mile, which would be significantly higher than the 25 gram/mile implied by the 360 mile/gallon CAFE value.

EPA disagrees with Nissan that excluding upstream GHGs is legally required under section 202(a)(1). In this rulemaking, EPA is adopting standards under section 202(a)(1), which provides EPA with broad discretion in setting emissions standards. This includes authority to structure the emissions standards in a way that provides an incentive to promote advances in emissions control technology. This discretion includes the adjustments to compliance values adopted in the final rule, the multipliers we proposed, and other kinds of incentives. EPA recognizes that we have not previously made adjustments to a compliance value to account for upstream emissions in a section 202(a) vehicle emissions standard, but that does not mean we do not have authority to do so in this case. In addition, EPA is not directly regulating upstream GHG emissions from stationary sources, but instead is deciding how much value to assign to a motor vehicle for purposes of compliance calculations with the motor vehicle standard. While the logical place to start is the emissions level measured under the test procedure, section 202(a)(1) does not require that EPA limit itself to only that level. For vehicles above the production volume cap described above, EPA will adjust the measured value to a level that reflects the net difference in upstream GHG emissions compared to a comparable conventional vehicle. This will account for the actual GHG emissions increase associated with the use of the EV. As shown above, upstream GHG emissions attributable to increased electricity production to operate EVs or PHEVs currently exceed the upstream GHG emissions attributable to gasoline vehicles. There is a rational basis for EPA to account for this net difference, as that best reflects the real world effect on the air pollution problem we are addressing. For vehicles above the cap, EPA is reasonably and fairly accounting for the incremental increase in upstream GHG emissions from both the electric vehicles and the conventional vehicles. EPA is not, as Nissan suggested, arbitrarily counting upstream emissions for electric vehicles but not for conventional fuel vehicles.

EPA recognizes that every motor vehicle fuel and fuel production process has unique upstream GHG emissions impacts. EPA has discretion in this rulemaking under section 202(a) on whether to account for differences in net upstream GHG emissions relative to gasoline produced from oil, and intends to only consider upstream GHG emissions for those fuels that have significantly higher or lower GHG emissions impacts. At this time, EPA is only making such a determination for electricity, given that, as shown above in the example for a midsize car, electricity upstream GHG emissions are about three times higher than gasoline upstream GHG emissions. For example, the difference in upstream GHG emissions for both diesel fuel from oil and CNG from natural gas are relatively small compared to differences associated with electricity. Nor is EPA arbitrarily ignoring upstream GHG emissions of flexible fuel vehicles (FFVs) that can operate on E85. Data show that, on average, FFVs operate on gasoline over 99 percent of the time, and on E85 fuel less than 1 percent of the time.[239] EPA's recently promulgated Renewable Fuel Standard Program shows that, with respect to aggregate lifecycle emissions including non-tailpipe GHG emissions (such as feedstock growth, transportation, fuel production, and land use), lifecycle emissions for ethanol from corn using advanced production technologies are about 20 percent less GHG than gasoline from oil.[240] Given this difference, and that E85 is used in FFVs less than 1 percent of the time, EPA has concluded that it is not necessary to adopt a more complicated upstream accounting for FFVs. Accordingly, EPA's incentive approach here is both reasonable and authorized under section 202(a)(1).

In summary, EPA believes that this program for MY 2012–2016 strikes a reasoned balance by providing a temporary regulatory incentive to help promote commercialization of advanced vehicle technologies which are potential game-changers, but which also face major barriers, while effectively minimizing potential GHG losses by dropping the proposed multiplier and adding individual automaker

[235] The nationwide average electricity upstream GHG emissions rate of 0.642 grams GHG/watt-hour was calculated from 2005 nationwide powerplant data for CO_2, CH_4, and N_2O emissions from eGRID2007 (*http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html*), converting to CO_2 -e using Global Warming Potentials of 25 for CH_4 and 298 for N_2O, and multiplying by a factor of 1.06 to account for GHG emissions associated with feedstock extraction, transportation, and processing (based on Argonne National Laboratory's The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model, Version 1.8c.0, available at *http://www.transportation.anl.gov/modeling_simulation/GREET/*). EPA Docket EPA–HQ–OAR–2009–0472. EPA recognizes that there are many issues involved with projecting the electricity upstream GHG emissions associated with future EV and PHEV use including, but not limited to, average vs marginal, daytime vs nighttime vehicle charging, geographical differences, and changes in future electricity feedstocks. EPA chose to use the 2005 national average value because it is known and documentable. Values appropriate for future vehicle use may be higher or lower than this value. EPA will reevaluate this value in future rulemakings.

[236] A midsize gasoline vehicle with a footprint of 45 square feet would have a MY 2016 GHG target of about 225 grams/mile; dividing 8887 grams CO_2/gallon of gasoline by 225 grams/mile yields an equivalent fuel economy level of 39.5 mpg; and dividing 2208 grams upstream GHG/gallon of gasoline by 39.5 mpg yields a midsize gasoline vehicle upstream GHG value of 56 grams/mile. The 2208 grams upstream GHG/gallon of gasoline is calculated from 19,200 grams upstream GHG/mmBtu (Renewable Fuel Standard Program, Regulatory Impact Analysis, Section 2.5.8, February 2010) and multiplying by 0.115 mmBtu/gallon of gasoline.

[237] Manufacturers can utilize alternate calculation methodologies if shown to yield equivalent or superior results and if approved in advance by the Administrator.

[238] 65 FR 36987 (June 12, 2000).

[239] Renewable Fuel Standard Program (RFS2), Regulatory Impact Analysis, Section 1.7.4, February 2010.

[240] 75 FR 14670 (March 26, 2010).

production volume caps. In the future, if there were a program to control utility GHG emissions, then these advanced technology vehicles have the potential to produce very large reductions in GHG emissions, and to transform the transportation sector's contribution to nationwide GHG emissions. EPA will reassess the issue of how to address EVs, PHEVs, and FCVs in rulemakings for model years 2017 and beyond based on the status of advanced vehicle technology commercialization, the status of upstream GHG control programs, and other relevant factors.

Finally, the criteria and definitions for what vehicles qualify for the advanced technology vehicle incentives are provided in Section III.E. These definitions for EVs, PHEVs, and FCVs ensure that only credible advanced technology vehicles are provided the incentives.

4. Off-Cycle Technology Credits

As proposed, EPA is adopting 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 significantly captured over the 2-cycle test procedure used to determine compliance with the fleet average standards (*i.e.,* "off-cycle").[241] Eligible innovative technologies are 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 do not provide novel approaches to reducing greenhouse gas emissions. Manufacturers must obtain EPA approval for new and innovative technologies at the time of vehicle certification in order to earn credits for these technologies at the end of the model year. This approval must include the testing methodology to be used for quantifying credits. Further, any credits for these off-cycle technologies must be based on real-world GHG reductions not significantly 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 by increasing A/C efficiency, eligible technologies would not be primarily active during the 2-cycle test and therefore the associated improvements in CO_2 emissions would not be significantly captured. Because these technologies are not nearly so well developed and understood, EPA is not prepared to consider them in assessing the stringency of 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. EPA believes that manufacturers should be able to generate credit for the emission reductions these technologies actually achieve, assuming these reductions can be adequately demonstrated and verified. 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, that bona fide reductions from these technologies should be considered in determining a manufacturer's fleet average, 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 received comments from a few manufacturers that the "new and innovative" criteria should be broadened. The commenters pointed out that there are technologies already in the marketplace that would provide emissions reductions off-cycle and that their use should be incentivized. One manufacturer suggested that off-cycle credits should be given for start-stop technologies. EPA does not agree that this technology, which EPA's modeling projects will be widely used by manufacturers in meeting the CO_2 standards, should qualify for off-cycle credits. Start-stop technology already achieves a significant CO_2 benefit on the current 2-cycle tests, which is why many manufacturers have announced plans to adopt it across large segments of the fleet. EPA recognizes there may be additional benefits to start-stop technology beyond the 2-cycle tests (*e.g.,* heavy idle use), and that this is likely the case for other technologies that manufacturers will rely on to meet the MY 2012–2016 standards. EPA plans to continue to assess the off-cycle potential for these technologies in the future. However, EPA does not believe that off-cycle credits should be granted for technologies which we expect manufacturers to rely on in widespread use throughout the fleet in meeting the CO_2 standards. Such credits could lead to double counting, as there is already significant CO_2 benefit over the 2-cycle tests. EPA expects that most if not all technologies that reduce CO_2 emission on the 2-cycle test will also reduce CO_2 emissions during the wide variety of in-use operation that is not directly captured in the 2-cycle test. This is no different than what occurs from the control technology on vehicles for criteria pollutants. We expect that the catalytic converter and other emission control technology will operate to reduce emissions throughout in-use driving, and not just when the vehicle is tested on the specified test procedure. The aim for this off-cycle credit provisions is to provide an incentive for technologies that normally would not be chosen as a GHG control strategy, as their GHG benefits are not measured on the specified 2-cycle test. It is not designed to provide credits for technology that does provide significant GHG benefits on the 2-cycle test and as expected will also typically provide GHG benefits in other kinds of operation. Thus, EPA is finalizing the "new and innovative" criteria as proposed. That is, the potential to earn off-cycle credits will be limited to those technologies that are new and innovative, are introduced in only a limited number of vehicle models (*i.e.,* not in widespread use), and are not captured on the current 2-cycle tests. This approach will encourage future innovation, which may lead to the opportunity for future emissions reductions.

As proposed, manufacturers would quantify CO_2 reductions associated with the use of the innovative off-cycle technologies such that the credits could be applied on a g/mile equivalent basis, as is the case with A/C system improvements. Credits must be based on real additional reductions of CO_2 emissions and must be quantifiable and verifiable with a repeatable methodology. As proposed, 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 must 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 finalizing 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 must 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

[241] *See* final regulations at 40 CFR 86.1866–12(d).

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 must follow the procedures described below (as codified in today's rules). 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. As discussed below, EPA is also providing opportunity for public comment as part of the approval process for such non-5-cycle credits.

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,[242] 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.

EPA continues to believe that the use of these supplemental cycles may provide a method by which technologies not demonstrated on the baseline 2-cycles can be quantified and is finalizing this approach as proposed. 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.

Although A/C credits for efficiency improvements will largely be captured in the A/C credits provisions through the credit menu of known efficiency improving components and controls, 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.

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 regulatory evaluation/approval process will be relatively simple. The manufacturer will simply test vehicles with and without the technology installed or operating and compare results. All 5-cycles must be tested with the technology enabled and disabled, and the test results will be used to calculate a combined city/highway CO_2 value with the technology and without the technology. These values will then be compared to determine the amount of the credit; the combined city/highway CO_2 value with the technology operating will 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 will need to be performed in order to achieve the necessary strong degree of statistical significance of the credit determination results. This will have to be done for each model type for which a credit is 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 will 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 will be multiplied by the total production of vehicles subject to that value to determine the total number of credits.

EPA received a few comments regarding the 5-cycle approach. While not commenting directly on the 5-cycle testing methodology, the Alliance raised general concerns that the proposed approach did not offer manufacturers enough certainty with regard to credit applications and testing in order to take advantage of the credits. The Alliance further commented that the proposal did not provide a level playing field to all manufacturers in terms of possible credit availability. The Alliance recommended that rather than attempting to quantify CO_2 reductions with a prescribed test procedure on unknown technologies, EPA should

[242] Fuel Economy Labeling of Motor Vehicles: Revisions to Improve Calculation of Fuel Economy Estimates; Final Rule (71 FR 77872, December 27, 2006).

handle credit applications and testing guidelines via future guidance letters, as technologies emerge and are developed.

EPA believes that 5-cycle testing methodology is one clear and objective way to demonstrate certain off-cycle emissions control technologies, as discussed above. It provides certainty with regard to testing, and is available for all manufacturers. As discussed below, there are also other options for manufactures where the 5-cycle test is not appropriate. EPA is retaining this as a primary methodology for determining off-cycle credits. For technologies not able to be demonstrated on the 5-cycle test, EPA is finalizing an approach that will include a public comment opportunity, as discussed below, which we believe addresses commenter concerns regarding maintaining a level playing field.

b. Alternative Off-Cycle Credit Methodologies

As proposed, in cases where the benefit of a technological approach to reducing CO_2 emissions can not be adequately represented using existing test cycles, manufacturers will need to develop test procedures and analytical approaches to estimate the effectiveness of the technology for the purpose of generating credits. As discussed above, the first step must be a thorough assessment of whether the 5-cycle approach can be used to demonstrate a reduction in emissions. If EPA determines that the 5-cycle process is inadequate for the specific technology being considered by the manufacturer (*i.e.,* the 5-cycle test does not demonstrate any emissions reductions), then an alternative approach may be developed and submitted to EPA for approval. The demonstration program must 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 could be 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 will be required to present a proposed methodology to EPA. EPA will approve the methodology and credits only if certain criteria are met. Baseline emissions and control emissions must 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. The analytical approach must be robust, verifiable, and capable of demonstrating the real-world emissions benefit with strong statistical significance. Data must 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 will not imply approval of the results of the program or methodology; when the testing, modeling, or analyses are complete the results will 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.

In addition, EPA received several comments recommending that the approval process include an opportunity for public comment. As noted above, some manufacturers are concerned that there be a level playing field in terms of all manufacturers having a reasonable opportunity to earn credits under an approved approach. Commenters also want an opportunity for input in the methodology to ensure the accuracy of credit determinations for these technologies. Commenters point out that there are a broad number of stakeholders with experience in the issues pertaining to the technologies that could add value in determining the most appropriate method to assess these technologies' performance. EPA agrees with these comments and is including an opportunity for public comment as part of the approval process. If and when EPA receives an application for off-cycle credits using an alternative non 5-cycle methodology, EPA will publish a notice of availability in the **Federal Register** with instructions on how to comment on draft off-cycle credit methodology. The public information available for review will focus on the methodology for determining credits but the public review obviously is limited to non-confidential business information. The timing for final approval will depend on the comments received. EPA also believes that a public review will encourage manufacturers to be thorough in their preparation prior to submitting their application for credits to EPA for approval. EPA will take comments into consideration, and where appropriate, work with the manufacturer to modify their approach prior to approving any off-cycle credits methodology. EPA will give final notice of its determination to the general public as well as the applicant. Off-cycle credits would be available in the model year following the final approval. Thus, it will be imperative for a manufacturer pursuing this option to begin the process as early as possible.

EPA also received comments that the off-cycle credits highlights the inadequacy of current test procedures, and that there is a clear need for updated certification test procedures. As discussed in Section III. B., EPA believes the current test procedures are adequate for implementing the standards finalized today. However, EPA is interested in improving test procedures in the future and believes that the off-cycle credits program has the potential to provide useful data and insights both for the 5-cycle test procedures and also other test procedures that capture off-cycle emissions.

5. Early Credit Options

EPA is finalizing a program to allow manufacturers to generate early credits in model years 2009–2011.[243] As described below, credits may 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 are subject to a five year carry-forward limit based on the model year in which they are generated. Manufacturers may transfer early credits between vehicle categories (*e.g.,* between the car and truck fleet). With the exception of MY 2009 early program credits, as discussed below, a manufacturer may trade other early credits to other manufacturers without limits. The agencies note that CAFE credits earned in MYs prior to MY 2011 will still be available to manufacturers

[243] *See* final regulations at 40 CFR 86.1867–12.

for use in the CAFE program in accordance with applicable regulations.

EPA is not adopting certification, compliance, or in-use requirements for vehicles generating early credits. Since manufacturers are already certifying MY 2010 and in some cases even MY 2011 vehicles, doing so would make certification, compliance, and in-use requirements unworkable. As discussed below, manufacturers are required to submit an early credits report to EPA for approval no later than 90 days after the end of MY 2011. This report must 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.

a. Credits Based on Early Fleet Average CO_2 Reductions

As proposed, EPA is finalizing opportunities for early credit generation in MYs 2009–2011 through over-compliance with a fleet average CO_2 baseline established by EPA. EPA is finalizing four pathways for doing so. In order to generate early CO_2 credits, manufacturers must select one of the four paths for credit generation for the entire three year period and may not switch between pathways for different model years. For two pathways, EPA is establishing the baseline 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, include credits based on over-compliance with CAFE standards in states that have not adopted the California standards.

EPA received comments from manufacturers in support of the early credits program as a necessary compliance flexibility. The Alliance commented that the early credits reward manufacturers for providing fleet performance that exceeds California and Federal standards and do not result in a windfall. AIAM commented that early credits are essential to assure the feasibility of the proposed standards and the need for such credits must be evaluated in the context of the dramatic changes the standards will necessitate in vehicle design and the current economic environment in which manufacturers are called upon to make the changes. Manufacturers also supported retaining all four pathways, commenting that eliminating pathways would diminish the flexibility of the program. EPA also received comments from many environmental organizations and states that the program would provide manufacturers with windfall credits because manufacturers will not have to take any steps to earn credits beyond those that are already planned and in some cases implemented. These commenters were particularly concerned that the California truck standards in MY 2009 are not as stringent as CAFE, so overcompliance with the California standards could be a windfall in MY 2009, and possibly even MY 2010. These commenters supported an early credits program based on overcompliance with the more stringent of either the CAFE or California standards in any given year. EPA is retaining the early credits program because EPA judges that they are not windfall credits, and manufacturers in some cases have reasonably relied on the availability of these credits, and have based early model year compliance strategies on their availability so that the credits are needed to provide adequate lead for the initial years of the program. However, as discussed below, EPA is restricting credit trading for MY 2009 credits earned under the California-based pathways.

Manufacturers selecting Pathway 1 will generate credits by over-complying with the California equivalent baseline established by EPA over the manufacturer's fleet of vehicles sold nationwide. Manufacturers selecting Pathway 2 will generate credits against the California equivalent baseline only for the fleet of vehicles sold in California and the CAA section 177 states.[244] This approach includes all CAA 177 states as of the date of promulgation of the Final Rule in this proceeding. Manufacturers are required to include both cars and trucks in the program. Under Pathways 1 and 2, EPA is requiring manufacturers to cover any deficits incurred against the baseline levels established by EPA during the three year period 2009–2011 before credits can 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 including 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. In its comments, California supported such an approach.

Table III.C.5–1 provides the California equivalent baselines EPA is finalizing to be used as the basis for CO_2 credit generation under the California-based pathways. These are the California GHG standards for the model years shown. EPA proposed to adjust the California standards by 2.0 g/mile 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. EPA received comments from one manufacturer that this adjustment is in error and should not be made. The commenter noted that EPA already includes total hydrocarbons in the carbon balance determination of carbon related exhaust emissions and therefore already accounts for CH_4. EPA also includes CO in the carbon related exhaust emissions determination which acts to offset the need for an N_20 adjustment. The commenter noted that THC and CO add about 0.8 to 3.0 g/mile to the determination of carbon related emissions and therefore EPA should not make the 2.0g/mile adjustment. The commenter is correct, and therefore the final levels shown in the table below are 2.0 g/mile higher than proposed. These comments are further discussed in the Response to Comments document. Manufacturers will 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 will need to achieve fleet levels below those shown in the table in order to earn credits, using the California vehicle category definitions.

[244] CAA 177 states refers to states that have adopted the California GHG standards. At present, there are thirteen CAA 177 states: New York, Massachusetts, Maryland, Vermont, Maine, Connecticut, Arizona, New Jersey, New Mexico, Oregon, Pennsylvania, Rhode Island, Washington, as well as Washington, DC.

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	323	439
2010	301	420
2011	267	390

Manufacturers using Pathways 1 or 2 above will use year-end car and truck sales in each category. Although production data is used for the program starting in 2012, EPA is using sales data for the early credits program in order to apportion vehicles by State. This is described further below. Manufacturers must 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 are 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, will be included in the fleet average level determination. In model year 2009, the California CO_2 standard for cars (323 g/mi CO_2) is 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 program categorize vehicles. Manufacturers are required 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 received comments that this approach will provide windfall credits to manufacturers because the MY 2009 California light truck standards are less stringent than the corresponding CAFE standards. While this could be accurate if credits were based on performance in just MY 2009, that is not how credits are determined. Credits are based on the performance over a three model year period, MY 2009–2011. As noted in the proposal, 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. Some commenters were very concerned about this issue and commented in support of restricting credit trading between firms of MY 2009 credits based on the California program. EPA requested comments on this approach and is finalizing this credit trading restriction based on continued concerns regarding the issue of windfall credits. 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. Therefore, manufacturers selecting Pathways 1, 2, or 3 will not be allowed to trade any MY 2009 credits that they may generate.

Commenters also recommended basing credits on the more stringent of the standards between CAFE and CARB, which for MY 2009, would be the CAFE standards. However, EPA believes that this would not be necessary in light of the credit provisions requiring manufacturers choosing the California based pathways to use the California pathway for all three MYs 2009–2011, and the credit trading restrictions for MY 2009 discussed above.

In addition, for Pathways 1 and 2, EPA is allowing manufacturers to include alternative compliance credits earned per the California alternative compliance program.[245] These alternative compliance credits are based on the demonstrated use of alternative fuels in flex fuel vehicles. As with the California program, the credits are available beginning in MY 2010. Therefore, these early alternative compliance credits are available under EPA's program for the 2010 and 2011 model years. FFVs are otherwise included in the early credit fleet average based on their emissions on the conventional fuel. This does not apply to EVs and PHEVs. The emissions of EVs and PHEVs are to be determined as described in Section III.C.3. Manufacturers may 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 finalizing 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 allows manufacturers to earn credits as under Pathway 2, plus earn CAFE-based credits in other states. Credits may 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 is for manufacturers choosing to forego California-based early credits entirely and earn only CAFE-based credits outside of California and CAA 177 states. Manufacturers may not include FFV credits under the CAFE-based early credit pathways since those credits do not automatically reflect actual reductions in CO_2 emissions.

The 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

[245] *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.

standards.[246] 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 will calculate a baseline using the footprints and sales of vehicles outside of California and CAA 177 states. The actual fleet CO_2 performance calculation will 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.

* Must be footprint-based standard for manufacturers selecting footprint option under CAFE.

For the CAFE-based pathways, EPA is using 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 therefore changes part way through the early credits program. EPA further recognizes that medium-duty passenger vehicles (MDPVs) are not part of the CAFE program until the 2011 model year, and therefore are not 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 requires 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.[247] As with NLEV, the determination is to be based on where the completed vehicles are delivered as a point of first sale, which in most cases would be the dealer.[248]

As noted above, manufacturers choosing to generate early CO_2 credits must select one of the four pathways for the entire early credits program and would not be able to switch among them. Manufacturers must submit their early credits report to EPA when they submit their final CAFE report for MY 2011 (which is required to be submitted no later than 90 days after the end of the model year). Manufacturers will have until then to decide which pathway to select. This gives 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 finalizing:

TABLE III.C.5–3—SUMMARY OF EARLY FLEET AVERAGE CO_2 CREDIT PATHWAYS

Common Elements	—Manufacturers 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.

[246] 74 FR 14196, March 30, 2009.

[247] 62 FR 31211, June 6, 1997.

[248] 62 FR 31212, June 6, 1997.

b. Early A/C Credits

As proposed, EPA is finalizing provisions allowing manufacturers to earn early A/C credits in MYs 2009–2011 using the same A/C system design-based EPA provisions being finalized for MYs commencing in 2012, as described in Section III.C.1, above. Manufacturers will 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 must be included in one of the California-based early credit pathways described above in III.C.5.a. EPA is finalizing 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 must 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 323 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 12 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. The early A/C credits for vehicles sold outside of California and 177 states are based on the NHTSA vehicle categories established for the model year in which early A/C credits are being earned.

c. Early Advanced Technology Vehicle Incentive

As discussed in Section III.C.3, above, EPA is finalizing an incentive for sales of advanced technology vehicles including EVs, PHEVs, and fuel cell vehicles. EPA is not including a multiplier for these vehicles. However, EPA is allowing the use of the 0 g/mile value for electricity operation for up to 200,000 vehicles per manufacturer (or 300,000 vehicles for any manufacturer that sells 25,000 or more advanced technology vehicles in MY 2012). EPA believes that providing an incentive for the sales of such vehicles prior to MY 2012 is consistent with the goal encouraging the introduction of such vehicles as early as possible. Therefore, manufacturers may use the 0 g/mile value for vehicles sold in MY 2009–2011 consistent with the approach being finalized for MY 2012–2016. Any vehicles sold prior to MY 2012 under these provisions must be counted against the cumulative sales cap of 200,000 (or 300,000, if applicable) vehicles. Manufacturers selling such vehicles in MY 2009–2011 have the option of either folding them into the early credits calculation under Pathways 1 through 4 described in III.C.5.a above, or tracking the sales of these vehicles separately for use in their fleetwide average compliance calculation in MY 2012 or later years, but may not do both as this would lead to double counting. Manufacturers tracking the sales of vehicles not folded into Pathways 1–4, may choose to use the vehicle counts along with the 0 g/mi emissions value (up to the applicable vehicle sales cap) to comply with 2012 or later standards. For example, if a manufacturer sells 1,000 EVs in MY 2011, the manufacturer would then be able to include 1,000 vehicles at 0 g/mile in their MY 2012 fleet to decrease the fleet average for that model year. Again, these 1,000 vehicles would be counted against the cumulative cap of 200,000 or 300,000, as applicable, vehicles. Also, these 1,000 EVs would not be included in the early credit pathways discussed above in Section III.C.5.a, otherwise the vehicles would be double counted. As with early credits, these early advanced technology vehicles will be tracked by model year (2009, 2010, or 2011) and subject to the 5-year carry-forward restrictions.

d. Early Off-Cycle Credits

EPA's is finalizing off-cycle innovative technology credit provisions, as described in Section III.C.4. EPA requested 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. EPA is finalizing this approach for early off-cycle credits as a way to encourage innovation to lower emissions as early as possible, including the requirements for public review described in Section III.C.4. Upon EPA approval of a manufacturer's application for credits, the credits may be earned retroactively. EPA did not receive comments specifically on early off-cycle credits.

D. Feasibility of the Final CO_2 Standards

This final rule 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 for MY 2012–2016 vehicles. 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 factors 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) To transport the vehicle, its passengers and its contents (and any towed loads), and (2) to 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, and the proposed and now final standards reflect this basic paradigm. 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 as well.

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, but this is not a necessary consequence of the rule but rather a matter of automaker choice.

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 final 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 set of 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. The Center for Biological Diversity commented on EPA's assumptions on redesign cycles, and these comments are addressed in Section III.D.7 below.

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 (and other lightweight materials) 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 final 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 final rule with the requirements of this final rule in mind. In fact, the lead time available for the start of model year 2012 (January 2011) is relatively short, less than a year. The time between this final rule and the start of 2013 model year (January 2012) production is under 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 final 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 uses 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 final rule is commercially available and already being employed to a limited extent across the fleet (although the final rule will necessitate far wider penetration of these technologies throughout the fleet). The vast majority of the emission reductions which will result from this final rule will be produced from the increased use of these technologies. EPA also believes that this final rule will encourage the development and limited use of more advanced technologies, such as PHEVs and EVs, and the final rule is structured to facilitate this result.

In developing the final 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 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 RIA. 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 will 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 (described in more detail below), and the car and truck footprint curves' relative stringency discussed in Section II to determine what technology will 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 final MY 2012–2016 standards is described below. EPA has also evaluated a set of alternative standards for these model years, one that is more stringent than the final 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.

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 final 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 will 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 Joint Technical Support Document as well as EPA's 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 final rule, it is necessary to project the GHG emissions characteristics of the future vehicle fleet absent this regulation. This is called the "reference" fleet. EPA and NHTSA develop this reference fleet using a three step process. Step one develops a set of detailed vehicle characteristics and sales for a specific model year (in this case, 2008). This is called the baseline fleet. Step two adjusts the sales of these vehicles using projections made by AEO and CSM to account for expected changes in market conditions. Step three applies fuel saving and emission control technology to these vehicles to the extent necessary for manufacturers to comply with the MY 2011 CAFE standards. Thus, the reference fleet differs from the MY 2008 baseline fleet in both the level of technology utilized and in terms of the sales of any particular vehicle.

EPA and NHTSA perform steps one and two in an identical manner. The development of the characteristics of the baseline 2008 fleet and the adjustment of sales to match AEO and CSM forecasts is described in detail in Section II.B above. The two agencies perform step three in a conceptually identical manner, but each agency utilizes its own vehicle technology and emission model to project the technology needed to comply with the 2011 CAFE standards. The agencies use the same two models to project the technology and cost of the 2012–2016 standards. Use of the same model for both pre-control and post-control costs ensures consistency.

The agencies received one comment from the Center for Biological Diversity that the use of 2008 vehicles in our baseline and reference fleets inherently includes vehicle models which already have or will be discontinued by the time this rule takes effect and will be replaced by more advanced vehicle models. This is true. However, we believe that the use of 2008 vehicle designs is still the most appropriate approach available. First, as discussed in Section II.B above, the designs of these new vehicles at the level of detail required for emission and cost modeling are not publically available. Even the confidential descriptions of these vehicle designs are usually not of sufficient detail to facilitate the level of technology and emission modeling performed by both agencies. Second, steps two and three of the process used to create the reference fleet adjust both the sales and technology of the 2008 vehicles. Thus, our reference fleet reflects the extent that completely new vehicles are expected to shift the light vehicle market in terms of both segment and manufacturer. Also, by adding technology to facilitate compliance with the 2011 CAFE standards, we account for the vast majority of ways in which these new vehicles will differ from their older counterparts.

The agencies also received a comment that some manufacturers have already announced plans to introduce technology well beyond that required by the 2011 MY CAFE standards. This commenter indicated that the agencies' approach over-estimated the technology and cost required by the proposed standards and resulted in less stringent standards being proposed than a more realistic reference fleet would have supported. First, the agencies agree that limiting the application of additional technology beyond that already on 2008 vehicles to only that required by the 2011 CAFE standards could under-estimate the use of such technology absent this rule. However, it is difficult, if not impossible, to separate future fuel economy improvements made for marketing purposes from those designed to facilitate compliance with anticipated CAFE or CO_2 emission standards. For example, EISA was signed over two years ago, which contained specific minimum limits on light vehicle fuel economy in 2020, while also requiring ratable improvements in the interim. NHTSA proposed fuel economy standards for the 2012–2015 model years under the EISA provisions in April of 2008, although NHTSA finalized only 2011 standards for passenger vehicles. It is also true that manufacturers can change their plans based on market conditions and other factors. Thus, announcements of future plans are not certain. As mentioned above, these plans do not include specific vehicle characteristics. Thus, in order to avoid under-estimating the cost associated with this rule, the agencies have limited the fuel economy improvements in the reference fleet to those projected to result from the existing CAFE standards. We disagree with the commenter that this has caused the standards being promulgated today to be less stringent than would have been the case had we been able to confidently predict additional fuel economy and CO_2 emission improvements which will occur absent this rule. The inclusion of such technology in the reference fleet would certainly have reduced the cost of this final rule, as well as the benefits, but would not have changed the final level of technology required to meet the final standards. Also, we believe that the same impacts would apply to our evaluations of the two alternative sets of standards, the 4% per year and 6% per year standards. We are confident that the vast majority of manufacturers would not comply with the least stringent of these standards (the 4% per year standards) in the absence of this rule. Thus, changes to the reference fleet would not have affected the differences in technology, cost or benefits between the final standards and the two alternatives. As described below, our rejection of the two alternatives in favor of the final standards is based primarily on the relative technology, cost and benefits associated with the three sets of standards than the absolute cost or benefit relative to the reference fleet. Thus, we do not agree with the commenter that our choice of reference fleet adversely impacted the development of the final standards being promulgated today.

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 final CO_2 emission standards. In summary, the reference fleet represents vehicle characteristics and sales in the 2012 and later model years absent this final rule. Technology is then added to these vehicles in order to reduce CO_2 emissions to achieve compliance with the final CO_2 standards. As noted above, EPA did not factor in any changes to vehicle utility or characteristics, or sales in projecting manufacturers' compliance with this final rule.

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. These groupings are the same as those used in the NPRM.

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

TABLE III.D.1–1—VEHICLE GROUPINGS [a]—Continued

Vehicle description	Vehicle type	Vehicle description	Vehicle type
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 final rule is the impact of the 2011 MY CAFE standards. 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.

As was done for the NPRM, EPA has 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 final standards. In our analysis of this final 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 final rule is reduced. As this final rule eliminates the FFV credit (for purposes of CO_2 emission compliance) starting in 2016, the net result is to increase the projected level of fuel savings from our final 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 final 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 final 2012 and later CO_2 standards. The description of this process is described in the following four sections and is essentially the same process used for the NPRM.

A more detailed description of the methodology used to develop these sales projections can be found in the Joint TSD. Detailed sales projections by model year and manufacturer can also be found in the TSD.

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 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 RIA.

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 RIA, though these savings are not included in our final cost estimates for the final rule. 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 RIA. As demonstrated in the IMAC study (and described in Section III.C as well as the RIA), 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 final rule. 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.1 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 RIA.

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 [249]	$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		
		Car	Truck	Fleet average
2012	[250] 28	3.4	3.8	3.5
2013	40	4.8	5.4	5.0
2014	60	7.2	8.1	7.5
2015	80	9.6	10.8	10.0
2016	85	10.2	11.5	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 typically apply new technologies in packages during model redesigns that occur approximately once 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, as explained at proposal, 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 configuration. Note also that these 19 vehicle types span the range of vehicle footprint (smaller footprints for smaller vehicles and larger footprints for larger vehicles) which serve as the basis for the standards being promulgated today. 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 resulting in increasing effectiveness. Important to note 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

[249] 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.

[250] We assume slightly higher A/C penetration in 2012 than was assumed in the proposal to correct for rounding that occurred in the curve setting process.

accessories, and low drag brakes.[251] 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 is 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, EPA calculated the cost and effectiveness for the package. The first step 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. This is accomplished by incorporating more ratio selections and a wider ratio span into the transmissions. Some of the engine technologies have the same goal, such as cylinder deactivation, advanced valvetrains, and turbocharging. 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 that can be applied to vehicles with several types of automatic transmissions.

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 1 of the RIA.

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 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 Joint TSD.

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%	$985
3.0L V6 + GDI + CCP + Deac	6 speed automatic	5% Mass Reduction	20.6%	1,238
2.2L I4 + GDI + Turbo + DCP	6 speed DCT	10% Mass Reduction Start-Stop	34.3%	1,903

[251] 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.

4. Manufacturer's 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.[252] In following with these industry practices, EPA has created set of vehicle technology packages that represent the entire light duty fleet.

In evaluating needed lead time, EPA has historically authorized 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.[253] 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 are already 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 final 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 final rule with the requirements of this final 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 final 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 of 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,[254] as well as IMA, powersplit and 2-mode hybrids) had a 15% penetration cap.

This is the same approach as was taken in the NPRM. EPA received several comments commending it on its approach to establishing technical feasibility via its use of the OMEGA model. The only adverse comment received regarding the application of technology was from the Center for Biological Diversity (CBD), which criticized EPA's use of the 5-year redesign cycle. CBD argued that manufacturers occasionally redesign vehicles sooner than 5 years and that EPA did not quantify the cost of shortening the redesign cycle to less than 5 years and compare this cost to the increased benefit of reduced CO_2 emissions. CBD also noted that manufacturers have been recently dropping vehicle lines and entire divisions with very little leadtime, indicating their ability to change product plans much quicker than projected above.

EPA did not explicitly evaluate the cost of reducing the average redesign cycle to less than 5 years for two reasons. One, in the past, manufacturers have usually shortened the redesign cycle to address serious problems with the current design, usually lower than anticipated sales. However, the amortized cost of the capital necessary to produce a new vehicle design will increase by 23%, from one-fifth of the capital cost to one-fourth (and assuming a 3% discount rate). This would be on top of the cost of the emission control equipment itself. The only benefit of this increase in societal cost will be earlier CO_2 emission reductions (and the other benefits associated with CO_2 emission control). The capital costs associated with vehicle redesign go beyond CO_2 emission control and potentially involve every aspect of the vehicle and can represent thousands of dollars. We believe that it would be an inefficient use of societal resources to incur such costs when they can be obtained much more cost effectively just one year later.

Two, the examples of manufacturers dropping vehicle lines and divisions with very short lead time is not relevant to the redesign of vehicles. There is no relationship between a manufacturer's ability to stop selling a vehicle model or to close a vehicle division and a manufacturer's ability to redesign a vehicle. A company could decide to stop selling all of its products within a few weeks—but it would still take a firm approximately 5 years to introduce a major new vehicle line. It is relatively easy to stop the manufacture of a particular product (though this too can

[252] The Center for Biological Diversity submitted comments disputing this distinction as well as the need for lead time. These comments are addressed in Section III.D.7.

[253] *See* discussion in Section III.D.7 with references.

[254] While diesel engines are a mature technology and not "advanced", the aftertreatment systems necessary for them in the U.S. market are advanced.

incur some cost—such as plant wind-down costs, employee layoff or relocation costs, and dealership related costs). It is much more difficult to perform the required engineering design and development, design, purchase, and install the necessary capital equipment and tooling for components and vehicle manufacturing and develop all the processes associated with the application of a new technology. Further discussion of the CBD comments can be found in III.D.7 below.

5. How is EPA projecting that a manufacturer decides between options to improve CO_2 performance to meet a fleet average standard?

EPA is generally taking the same approach to projecting the application of technology to vehicles as it did for the NPRM. With the exception of two comments, all commenters agreed with the modeling approach taken in the NPRM. One of these two comments is addressed is Section III.D.1 above, while the other is addressed in Section III.D.3. above.

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. As noted earlier, EPA developed a new vehicle model, the OMEGA model 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 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 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 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 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 final 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 final CO_2 standard which will 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 grouping 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 final 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 final 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 final regulations which 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 final 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 final 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 RIA to this final rule. When evaluating the 2016 standards using the OMEGA model, the final CO_2 standard which manufacturers will 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 will 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.

As noted above, EPA estimated separately the cost of the improved A/C systems required to generate the 11 g/mi credit. This is consistent with our final A/C credit procedures, which will 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 is likely to 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:

$$ManufCostEff = \frac{TechCost - \sum_{i=1}^{PP} \left[dFS_i \times VMT_i \right] \times \frac{1}{(1-Gap)}}{\sum_{i}^{i+35} \left[[dCO2] \times VMT_i \right] \times \frac{1}{(1-Gap)}}$$

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, and

1- Gap = Ratio of onroad fuel economy to two-cycle (FTP/HFET) fuel economy.

The OMEGA model does not currently allow for the VMT used in determining the various technology ranking factors to be a function of the rebound factor. If the user believed that the consideration of rebound VMT was important, they could increase their estimate of the payback period to simulate the impact of the rebound VMT.

EPA describes the technology ranking methodology and manufacturer-based cost effectiveness metric in greater detail in a technical memo to the Docket for this final 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 final rule, 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 1 of the RIA, 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 will retain this same percentage of value when the vehicle is five years old. However, it is less clear whether first purchasers, and thus, manufacturers consider this residual value when ranking technologies and making vehicle purchases, respectively. For this final rule, this factor was not included in our determination of manufacturer-based net cost-effectiveness in the analyses performed in support of this final rule.

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 on incremental reduction in fuel consumption depends on the CO_2 level of the vehicle prior to adding the technology. Chapter 1 of the RIA of this final rule contains further detail on the values of manufacturer-based net cost-effectiveness for the various technology packages.

6. Why are the final CO_2 standards feasible?

The finding that the final standards are technically feasible is based primarily on two factors. One is the level of technology needed to meet the final standards. The other is the cost of this technology. The focus is on the final 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.,* power-split hybrid and 2-mode hybrid) and diesel,[255] 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 final 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 as allowed under the applicable MY 2011 CAFE regulations. 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 to overhead cam engines (OHC–DEAC), adding a turbocharger and downsizing the engine (Turbo), diesel engine technology, 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 an intermediate or strong hybrid design. This last category includes three current hybrid designs: Integrated motor assist (IMA), power-split (PS), 2-mode hybrids and electric vehicles.[256]

[255] While diesel engines are not an "advanced technology" per se, diesel engines that can meet EPA's light duty Tier 2 Bin 5 NO_X standards have advanced (and somewhat costly) aftertreatment systems on them that make this technology penetration cap appropriate in addition to their relatively high incremental costs.

[256] EPA did not project reliance on the use of any plug-in hybrid or battery electric vehicles when projecting manufacturers' compliance with the 2016 standards. However, BMW did sell a battery electric vehicle in the 2008 model year, so these sales are included in the technology penetration estimates for the reference case and the final and alternative standards evaluated for 2016.

TABLE III.D.6–1—PENETRATION OF TECHNOLOGY IN 2008 VEHICLES WITH 2016 SALES: CARS AND TRUCKS

[Percent of sales]

	GDI	OHC–DEAC	Turbo	Diesel	6 Speed auto trans	Dual clutch trans	Start-stop	Hybrid
BMW	7.5	0.0	6.1	0.0	86	0.9	0	0.1
Chrysler	0.0	0.0	0.5	0.1	14	0.0	0	0.0
Daimler	0.0	0.0	6.5	5.6	76	7.5	0	0.0
Ford	0.4	0.0	2.2	0.0	29	0.0	0	0.0
General Motors	3.1	0.0	1.4	0.0	15	0.0	0	0.3
Honda	1.4	7.1	1.4	0.0	0	0.0	0	2.1
Hyundai	0.0	0.0	0.0	0.0	3	0.0	0	0.0
Kia	0.0	0.0	0.0	0.0	0	0.0	0	0.0
Mazda	13.6	0.0	13.6	0.0	26	0.0	0	0.0
Mitsubishi	0.0	0.0	0.0	0.0	10	0.0	0	0.0
Nissan	0.0	0.0	0.0	0.0	0	0.0	0	0.8
Porsche	58.6	0.0	14.9	0.0	49	0.0	0	0.0
Subaru	0.0	0.0	9.8	0.0	0	0.0	0	0.0
Suzuki	0.0	0.0	0.0	0.0	0	0.0	0	0.0
Tata	0.0	0.0	17.3	0.0	99	0.0	0	0.0
Toyota	6.8	0.0	0.0	0.0	21	0.0	0	11.6
Volkswagen	50.6	0.0	39.5	0.0	69	13.1	0	0.0
Overall	3.8	0.8	2.6	0.1	19.1	0.5	0.0	2.2

As can be seen, all of these technologies were already being used on some 2008 MY vehicles, with the exception of direct injection gasoline engines with either cylinder deactivation or turbocharging and downsizing. Transmissions with more gearsets 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 also 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, NHTSA projected that Porsche would achieve a CO_2 emission level of 304.3 g/mi instead of the required 284.8 g/mi level (29.2 mpg instead of 31.2 mpg), and pay fines in lieu of further control.

TABLE III.D.6–2—PENETRATION OF TECHNOLOGY UNDER 2011 MY CAFE STANDARDS IN 2016 SALES: CARS AND TRUCKS

[Percent of sales]

	GDI	OHC–DEAC	Turbo	6 Speed auto trans	Dual clutch trans	Start-stop	Mass reduction
BMW	44	12	30	53	37	13	2
Chrysler	0	0	0	18	0	0	0
Daimler	23	22	8	52	34	26	2
Ford	0	0	3	27	0	0	0
General Motors	3	0	1	15	0	0	0
Honda	2	6	2	0	0	0	0
Hyundai	0	0	0	3	0	0	0
Kia	0	0	0	0	0	0	0
Mazda	13	0	13	20	0	0	0
Mitsubishi	32	0	2	25	35	0	1
Nissan	0	0	0	0	0	0	0
Porsche	92	0	75	5	55	38	4
Subaru	0	0	9	0	0	0	0
Suzuki	70	0	0	3	67	67	3
Tata	85	54	20	27	73	73	6
Toyota	7	0	0	19	0	0	0
Volkswagen	89	5	81	14	78	18	3
Overall	10	2	7	16	7	3	0
Increase over 2008 MY	6	1	4	−3	6	3	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. The projected MY 2016 fraction of automatic transmission with more gearsets actually decreases slightly 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 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 lower cost mature technology projected to be 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 and no hybrid vehicles were projected. Most manufacturers do not require the level of CO_2 emission control associated with either of these technologies. The few manufacturers that would were projected to choose to pay CAFE fines in 2011 in lieu of adding diesel or hybrid technologies.

This 2008 baseline fleet, modified to meet 2011 standards, becomes our "reference" case. See Section II.B above. This is the fleet against which the final 2016 standards are compared. Thus, it is also the fleet that is 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 EPA RIA.

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 projected technology that could be added will be slightly different. The differences, however, are relatively small since most manufacturers only require modest addition of technology to meet the 2011 CAFE standards.

EPA then used the OMEGA model once again to project the level of technology needed to meet the final 2016 CO_2 emission standards. Using the results of the OMEGA model, every manufacturer was projected to be able to meet the final 2016 standards with the technology described above except for four: BMW, VW, Porsche and Tata (which is comprised of Jaguar and Land Rover vehicles in the U.S. fleet). For these manufacturers, the results presented below are those with the fully allowable application of technology available in EPA's OMEGA modeling analysis and not for the technology projected to enable compliance with the final 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 final 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.[257]

TABLE III.D.6–3—FINAL PENETRATION OF TECHNOLOGY FOR 2016 CO_2 STANDARDS: CARS AND TRUCKS

[Percent of sales]

	GDI	OHC–DEAC	Turbo	Diesel	6 Speed auto trans	Dual clutch trans	Start-stop	Hybrid	Mass Reduction
BMW	80	21	61	6	13	63	65	14	5
Chrysler	79	13	17	0	31	52	54	0	6
Daimler	76	30	53	5	12	72	67	14	5
Ford	84	21	19	0	27	60	61	0	6
General Motors	67	25	14	0	8	61	61	0	6
Honda	43	6	2	0	0	49	18	2	3
Hyundai	59	0	1	0	8	52	32	0	3
Kia	33	0	1	0	0	52	4	0	2
Mazda	60	0	14	1	17	47	41	0	4
Mitsubishi	74	0	33	0	14	74	74	0	6
Nissan	66	7	11	0	2	62	58	1	5
Porsche	83	15	62	8	5	45	62	15	4
Subaru	60	0	9	0	0	58	44	0	3
Suzuki	77	0	0	0	10	67	67	0	4
Tata	85	55	27	0	14	70	70	15	5
Toyota	26	7	3	0	13	40	7	12	2
Volkswagen	82	18	71	11	10	68	60	15	4
Overall	60	13	15	1	12	55	42	4	4
Increase over 2011 CAFE	49	11	9	1	−4	48	39	2	4

[257] Many of the technologies shown in this table are mutually exclusive. Thus, 85% penetration might not be possible. For example, any use of hybrids will reduce the DEAC, Turbo, 6SPD, DCT, and 42V S–S technologies. Additionally, not every technology is available to be used on every vehicle type.

Table III.D.6–4 shows the 2016 standards, as well as the achieved CO_2 emission levels for the five manufacturers which are not able to meet these standards under the premises of our modeling. It should be noted that the two sets of combined emission levels shown in Table III.D.6–4 are based on sales weighting car and truck emission levels.

TABLE III.D.6–4—EMISSIONS OF MANUFACTURERS UNABLE TO MEET FINAL 2016 STANDARDS (G/MI CO_2)

Manufacturer	Achieved emissions			2016 Standards			Shortfall
	Car	Truck	Combined	Car	Truck	Combined	Combined
BMW	236.3	278.7	248.5	228.4	282.5	243.9	4.6
Tata	258.6	323.6	284.2	249.9	272.5	258.8	25.4
Daimler	246.3	297.8	262.6	238.3	294.3	256.1	6.5
Porsche	244.1	332.0	273.4	206.1	286.9	233.0	40.4
Volkswagen	223.5	326.6	241.6	218.6	292.7	231.6	10.0

As can be seen, BMW and Daimler have the smallest shortfalls, 5–6 g/mi, while Porsche has the largest, 40 g/mi.

On an industry average basis, the technology penetrations are very similar to those projected in the proposal. There is a slight shift from the use of cylinder deactivation to the two advanced transmission technologies. This is due to the fact that the estimated costs for these three technologies have been updated, and thus, their relative cost effectiveness when applied to specific vehicles have also shifted. The reader is referred to Section II.E of this preamble as well as Chapter 3 of the Joint TSD for a detailed description of the cost estimates supporting this final rule and to the RIA for a description of the selection of technology packages for specific vehicle types. The other technologies shown in Table III.D.6–4 changed by 2 percent or less between the proposal and this final rule.

As can be seen, the overall average reduction in vehicle weight is projected to be 4 percent. This reduction varies across the two vehicle classes and vehicle base weight. For cars below 2,950 pounds curb weight, the average reduction is 2.8 percent (75 pounds), while the average was 4.3 percent (153 pounds) for cars above 2,950 curb weight. For trucks below 3,850 pounds curb weight, the average reduction is 4.7 percent (163 pounds), while it was 5.1 percent (240 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 4.4 percent (186 pounds), while it was 7.0 percent (376 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 final 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 technologies. 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 does not 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 final 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 final 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.

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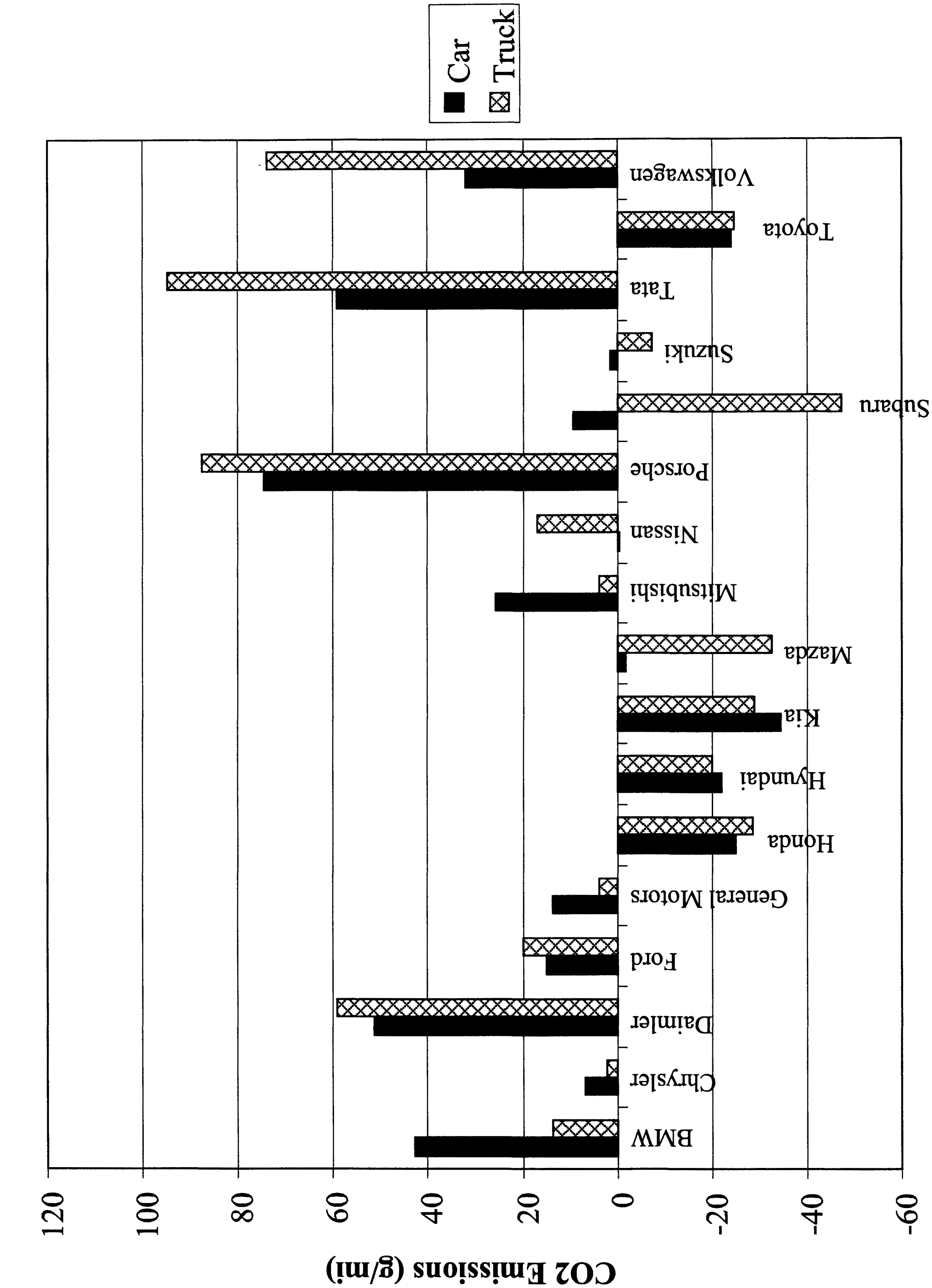

Figure III.D.6-1 CO_2 Emission Reduction Required in 2016 from 2008 Vehicles After Removing the Benefit of Technology Already Present, Relative to That for the Fleet as a Whole

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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 acceleration performance (henceforth referred to as "performance"). The footprint-based form of the final 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 fuel economy test procedure. So manufacturers with higher average performance levels will tend to have higher average CO_2 emissions for any given footprint. This variability at any given footprint contributes to much of the scatter in the data (shown for example on plots like Figures II.C.1–3 through II.C.1–6).

We developed a methodology to assess the impact of these two factors on each manufacturer's projected compliance with the 2016 standards. First, we had to remove (or isolate) the effect of CO_2 control technology already being employed on 2008 vehicles. As described above, 2008 vehicles exhibit a wide range of control technology and leaving these impacts in place would confound the assessment of performance and weight on CO_2 emissions. Thus, the first step was to estimate each vehicle's "no technology" CO_2 emissions. To do this, we used the EPA lumped parameter model (described in the TSD) to estimate the overall percentage reduction in CO_2 emissions associated with technology already on the vehicle and then backed out this effect mathematically. Second, we performed a least-square linear regression of these no technology CO_2 levels against curb weight and the ratio of rated engine horsepower to curb weight simultaneously. The ratio of rated engine horsepower to curb weight is a good surrogate for acceleration performance and the data is available for all vehicles, whereas the zero to sixty time is not. Both factors were found to be statistically significant at the 95% confidence level. Together, they explained over 80% of the variability in vehicles' CO_2 emissions for cars and over 70% for trucks. Third, we determined the sales-weighted average curb weight per footprint for cars and trucks, respectively, for the fleet as a whole. We also determined the sales-weighted average of the ratio of rated engine horsepower to curb weight for cars and trucks, respectively, for the fleet as a whole. Fourth, we adjusted each vehicle's "no technology" CO_2 emissions to eliminate the degree to which the vehicle had higher or lower acceleration performance or curb weight per footprint relative to the car or truck fleet as a whole. For example, if a car's ratio of horsepower to weight was 0.007 and the average ratio for all cars was 0.006, then the vehicle's "no technology" CO_2 emission level was reduced by the difference between these two values (0.001) times the impact of the ratio of horsepower to weight on car CO_2 emissions from the above linear regression. Finally, we substituted these performance and weight adjusted CO_2 emission levels for the original, "no technology" CO_2 emission levels shown in Figure III.D.6–1. The results are shown in Figure III.D.6–2.

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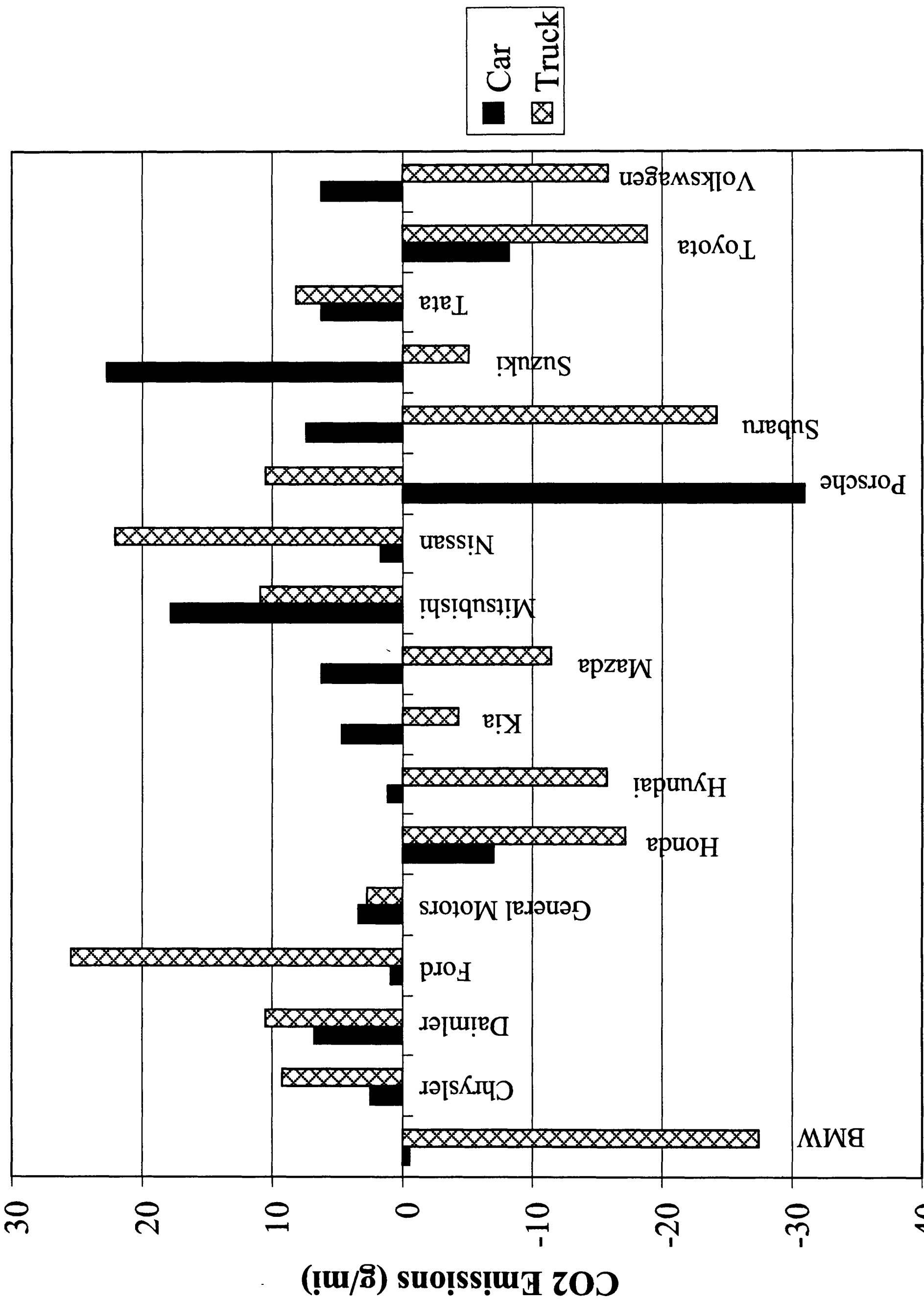

Figure III.D.6-2 CO_2 Emission Reduction Required in 2016 From 2008 Vehicles After 1) Removing the Benefit of Technology Already Present, and 2) Adjusting for Differences in Weight per Footprint. and Performance. Relative to That for the Fleet as a as a Whole

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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 variability among the manufacturers' CO_2 emissions. Most of the manufacturers with high positive 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 acceleration 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-acceleration performance and some manufacturers orient their sales towards these consumers. However, the cost in terms of CO_2 emissions is clear. Manufacturers producing relatively heavy or high performance vehicles presently (with concomitant increased CO_2 emissions) will require greater levels of technology in order to meet the final CO_2 standards in 2016.

As can be seen from Table III.D.6–3 above, widespread use of several technologies is projected due to the final 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 6+ 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.

In their comments, Porsche stated that their vehicles have twice the power-to-weight ratio as the fleet average and that their vehicles presently have a high degree of technology penetration, which allows them to meet the 2009 CAFE standards. Porsche also commented that the 2016 standards are not feasible for their firm, in part due to the high level of technologies already present in their vehicles and due to their "very long production life cycles". BMW in their comments stated that their vehicles are "feature-dense" thus "requiring additional efforts to comply" with future standards.[258] Ferrari, in their comments, states that the standards are not feasible for high-performance sports cars without compromising on their "distinctiveness". They also state that because they already have many technologies on the vehicles, "there are limited possibilities for further improvements." Finally Ferrari states that smaller volume manufacturers have higher costs "because they can be distributed over very limited production volumes", and they have longer product lifecycles. The latter view was also shared by Lotus. These comments will be addressed below, but are cited here as supporting the conclusions from the above analysis that high-performance and feature-dense vehicles have a greater challenge meeting the 2016 standards. In general, other manufacturers covering the rest of the fleet and other commenters agreed with EPA's analysis in the proposal of projected technology usage, and supported the view that the 2016 model year standards were feasible in the lead-time provided.

In response to the comments above, EPA foresees no significant technical or engineering issues with the projected deployment of these technologies across the fleet by MY 2016, with their incorporation being folded into the vehicle redesign process (with the exception of some of the small volume manufacturers). 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 based on a 42-volt architecture also represent a 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 EPA estimated 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% of sales, with some manufacturers projected to use higher levels.

Most manufacturers are not projected to hybridize any vehicles to comply with the final standards. The hybrids shown for Toyota are projected to be sold even in the absence of the final standards. However the relatively high hybrid penetrations (14–15%) 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 timeframe, which is 15 percent.

As discussed in the EPA RIA, a maximum 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. Hybrids are a relatively costly technology option which requires significant changes to a vehicle's powertrain design, and EPA estimates that manufacturers will require a significant amount of lead time and capital investment to introduce this technology into the market in very large numbers. Thus the EPA captures this significant change in production facilities with a lower penetration cap. A more thorough discussion of lead time limitations can be found below and in Section III.B.5.

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 4 percent, compared with 3 percent in the reference case. This 4 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 final TLAAS provisions will provide significant needed lead time to these manufacturers for pre-2016 compliance, since all qualified companies are able to take advantage of these provisions.

By 2016, it is likely that these manufacturers would also be able to

[258] As a side note, one of the benefits for the off-cycle technology credits allowed in this final rule is the opportunity this flexibility provides for some of these 'feature-dense' vehicles to generate such credits to assist, to some extent, in the companies' ability to comply.

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 mass reduction, electric and/or plug-in hybrid vehicles 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 (while the 15% cap on the application of hybrid technology is reasonable for the industry as a whole, higher percentages are certainly possible for individual manufacturers, particularly those with small volumes). 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.

EPA believes it is likely that there will be certain high volume manufacturers that will earn a significant amount of early GHG credits starting in 2010 that would expire 5 years later, by 2015, unused. It is possible that these manufacturers may be willing to sell these credits to manufacturers with whom there is little or no direct competition.[259] Furthermore, a large number of manufacturers have also stated publicly that they support the 2016 standards. 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, Nissan, 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 model year 2016 non-compliance for BMW, Daimler, and Volkswagen is based on an inability of our model at this time 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 manufacturers 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 (feature dense) 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 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 final standards. Comments from the manufacturers provided broad support for this conclusion. A limited number of commenters presented specific concerns about their technology opportunities, and EPA has described above (and elsewhere in the rule) the paths available for them to comply.

In sum, EPA believes that the emissions reductions called for by the final 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 final 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.[260]

TABLE III.D.6–4—COST OF TECHNOLOGY PER VEHICLE IN 2016 ($2007)

	2011 MY CAFE standards, relative to 2008 MY			Final 2016 CO_2 standards, relative to 2011 MY CAFE standards		
	Cars	Trucks	All	Cars	Trucks	All
BMW	$346	$423	$368	$1,558	$1,195	$1,453
Chrysler	33	116	77	1,129	1,501	1,329
Daimler	468	683	536	1,536	931	1,343
Ford	73	161	106	1,108	1,442	1,231
General Motors	31	181	102	899	1,581	1,219
Honda	0	0	0	635	473	575
Hyundai	0	69	10	802	425	745
Kia	0	42	7	667	247	594
Mazda	0	0	0	855	537	808
Mitsubishi	328	246	295	817	1,218	978
Nissan	0	61	18	686	1,119	810
Porsche	473	706	550	1,506	759	1,257
Subaru	68	62	66	962	790	899
Suzuki	49	232	79	1,015	537	937
Tata	611	1,205	845	1,181	680	984
Toyota	0	0	0	381	609	455
Volkswagen	228	482	272	1,848	972	1,694

[259] For example, a manufacturer that only sells electric vehicles may very well sell the credits they earn to another manufacturer that does not sell any electric vehicles.

[260] Note that the actual cost of the A/C technology is estimated at $71 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 $60 per vehicle ($71 × 85% = $60).

TABLE III.D.6–4—COST OF TECHNOLOGY PER VEHICLE IN 2016 ($2007)—Continued

	2011 MY CAFE standards, relative to 2008 MY			Final 2016 CO_2 standards, relative to 2011 MY CAFE standards		
	Cars	Trucks	All	Cars	Trucks	All
Overall	63	138	89	870	1,099	948

As can be seen, the industry average cost of complying with the 2011 MY CAFE standards is quite low, $89 per vehicle. This cost is $11 per vehicle higher than that projected in the NPRM. This change is very small and is due to several factors, mainly changes in the projected sales of each manufacturer's specific vehicles, and changes in estimated technology costs. Similar to the costs projected in the NPRM, the range of costs across manufacturers is quite large. Honda, Mazda and Toyota are projected to face no cost. In contrast, Mitsubishi, Porsche, Tata and Volkswagen face costs of at least $272 per vehicle. As described above, three of these last four manufacturers (all but Mitsubishi) face high costs to meet even the 2011 MY CAFE standards due to either their vehicles' weight per unit footprint or performance. Porsche would have been projected to face lower costs in 2016 if they were not expected to pay CAFE fines in 2011.

As shown in the last row of Table III.D.6–4, the average cost of technology to meet the final 2016 standards for cars and trucks combined relative to the 2011 MY CAFE standards is $948 per vehicle. This is $103 lower than that projected in the NPRM, due primarily to lower technology cost projections for the final rule compared to the NPRM for certain technologies. (See Chapter 1 of the Joint TSD for a detailed description of how our technology costs for the final rule differ from those used in the NPRM). As was the case in the NPRM, Table III.D.6–4 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 $948 per vehicle cost is significant, representing 3.4 percent of the total cost of a new vehicle. However, as discussed below, the fuel savings associated with the final standards exceed this cost significantly. In general, commenters supported EPA's cost projections, as discussed in Section II.

While the CO_2 emission compliance modeling using the OMEGA model focused on the final 2016 MY standards, the final standards for 2012–2015 are also feasible. As discussed above, manufacturers develop their future 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 final 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 final 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 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 manufacture could take advantage of the many optional credit generation provisions contained in this final rule, including early-credit generation for model years 2009–2011, credits for advanced technology vehicles, and credits for the application of technology which result in off-cycle GHG reductions. Finally, 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 final standards for 2012–2016 would be feasible. Further discussion of the technical feasibility of the interim year standards, including for smaller volume manufacturers can be found in Section III.B, in the discussion on the Temporary Leadtime Allowance Alternative Standards.

7. What other fleet-wide CO_2 levels were considered?

Two alternative sets of CO_2 standards were considered. One set would reduce 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 final 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 projected CO_2 standards in 2016 for each manufacturer under these two alternative scenarios and under the final rule 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	Final Rule	6% per year
BMW	248	244	224
Chrysler	270	266	245
Daimler	260	256	236
Ford	261	257	237
General Motors	275	271	250
Honda	248	244	224

TABLE III.D.7–1—OVERALL AVERAGE CO_2 EMISSION STANDARDS BY MANUFACTURER IN 2016—Continued

	4% per year	Final Rule	6% per year
Hyundai	234	231	212
Kia	239	236	217
Mazda	232	228	210
Mitsubishi	244	239	219
Nissan	250	245	226
Porsche	237	233	213
Subaru	238	234	214
Suzuki	222	218	199
Tata	263	259	239
Toyota	249	245	225
Volkswagen	236	232	213
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

[In percent]

	GDI	OHC–DEAC	Turbo	Diesel	6 Speed auto trans	Dual clutch trans	Start-stop	Hybrid	Mass reduction (%)
BMW	80	21	61	6	13	63	65	14	5
Chrysler	67	13	17	0	26	52	54	0	6
Daimler *	76	30	53	5	12	72	67	14	5
Ford	77	18	16	0	25	58	59	0	5
General Motors	62	24	11	0	7	57	57	0	5
Honda	44	6	2	0	0	49	15	2	2
Hyundai	52	0	1	0	3	52	28	0	3
Kia	37	0	1	0	0	57	0	0	2
Mazda	79	0	14	1	17	66	60	0	5
Mitsubishi	85	0	31	0	16	72	72	0	6
Nissan	69	7	11	0	2	64	61	1	6
Porsche *	83	15	62	8	5	45	62	15	4
Subaru	72	0	9	0	0	70	37	0	3
Suzuki	70	0	0	0	3	67	67	0	3
Tata *	85	55	27	0	14	70	70	15	5
Toyota	15	7	0	0	13	30	7	12	1
Volkswagen *	82	18	71	11	10	68	60	15	4
Overall	56	13	14	1	11	53	41	4	4
Increase over 2011 CAFE	46	11	7	1	−5	46	38	2	4

* These manufacturers were unable to meet the final 2016 standards with the imposed caps on technology.

TABLE III.D.7–3—TECHNOLOGY PENETRATION—6% PER YEAR ALTERNATIVE STANDARDS IN 2016: CARS AND TRUCKS COMBINED

[In percent]

	GDI	OHC–DEAC	Turbo	Diesel	6 Speed auto trans	Dual clutch trans	Start-stop	Hybrid	Mass reduction (%)
BMW *	80	21	61	6	13	63	65	14	5
Chrysler	85	13	50	0	3	82	83	2	8
Daimler *	76	30	53	5	12	72	67	14	5
Ford*	85	13	57	0	4	74	75	10	7
General Motors	85	25	43	0	2	83	83	2	8
Honda	68	6	10	0	1	65	65	2	6
Hyundai	73	1	12	0	9	64	64	0	5
Kia	62	0	1	0	0	62	61	0	5
Mazda	85	0	19	1	4	80	82	0	7
Mitsubishi *	85	4	42	0	4	75	75	10	7
Nissan	85	8	38	0	0	78	81	4	8
Porsche *	83	15	62	8	5	45	62	15	4
Subaru	84	0	18	1	3	79	80	0	6
Suzuki	85	0	85	0	0	85	85	0	8
Tata *	85	55	27	0	14	70	70	15	5
Toyota	71	7	5	0	20	49	47	12	4

TABLE III.D.7–3—TECHNOLOGY PENETRATION—6% PER YEAR ALTERNATIVE STANDARDS IN 2016: CARS AND TRUCKS COMBINED—Continued

[In percent]

	GDI	OHC–DEAC	Turbo	Diesel	6 Speed auto trans	Dual clutch trans	Start-stop	Hybrid	Mass reduction (%)
Volkswagen *	82	18	71	11	10	68	60	15	4
Overall	79	12	33	1	7	69	69	6	6
Increase over 2011 CAFE	69	10	26	1	−9	62	66	4	6

* These manufacturers were unable to meet the final 2016 standards with the imposed caps on technology.

With respect to the 4 percent per year standards, the levels of requisite control technology are lower than those under the final standards, as would be expected. Industry-wide, the largest decreases were a 7 percent decrease in use of gasoline direct injection engines, a 4 percent decrease in the use of dual clutch transmissions, and a 2 percent decrease in the application of start-stop technology. On a manufacturer specific basis, the most significant decreases were a 10 percent or larger decrease in the use of stop-start technology for Honda, Kia, Mitsubishi and Suzuki and a 12 percent drop in turbocharger use for Mitsubishi. 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 final standards in 2016. Porsche, Tata and Volkswagen continue to be unable to comply with the CO_2 standards in 2016, even under the 4 percent per year standard scenario. BMW just complied under this scenario, so its costs and technology penetrations are the same as under the final standards.

With respect to the 6 percent per year standards, the levels of requisite control technology increased substantially relative to those under the final standards, as again would be expected. Industry-wide, the largest increase was a 25 percent increase in the application of start-stop technology and 13–17 percent increases in the use of gasoline direct injection engines, turbocharging and dual clutch transmissions. On a manufacturer specific basis, the most significant increases were a 10 percent increase in hybrid penetration for Ford and Mitsubishi. 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 final standards in 2016. Our projections for BMW, Porsche, Tata and Volkswagen continue to show they are unable to comply with the CO_2 standards in 2016, so our projections for these manufacturers do not differ relative to the final standards, though the amount of short-fall for each firm increases significantly, by an additional 20 g/mi CO_2 per firm. However, Ford and Mitsubishi join this list as can be seen from Figure III.D.6–2. The CO_2 emissions from Ford's cars are very similar to those of the industry when adjusted for technology, weight and performance. However, their trucks emit more than 25% more CO_2 per mile than the industry average. It is possible that addressing this issue would resolve their difficulty in complying with the 6 percent per year scenario. Both Mitsubishi's cars and truck emit roughly 10% more than the industry average vehicles after adjusting for technology, weight and performance. Again, addressing this issue could resolve their difficulty in complying with the 6 percent per year scenario. Five manufacturers are projected to need to increase their use of start-stop technology by at least 30 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, relative to 2011 MY CAFE standards			6 Percent per year standards, relative to 2011 MY CAFE standards		
	Cars	Trucks	All	Cars	Trucks	All
BMW	$1,558	$1,195	$1,453	$1,558	$1,195	$1,453
Chrysler	1,111	1,236	1,178	1,447	2,156	1,827
Daimler	1,536	931	1,343	1,536	931	1,343
Ford	1,013	1,358	1,140	1,839	2,090	1,932
General Motors	834	1,501	1,148	1,728	2,030	1,870
Honda	598	411	529	894	891	893
Hyundai	769	202	684	1,052	1,251	1,082
Kia	588	238	527	1,132	247	979
Mazda	766	537	733	1,093	1,083	1,092
Mitsubishi	733	1,164	906	1,224	1,840	1,471
Nissan	572	1,119	729	1,151	1,693	1,306
Porsche	1,506	759	1,257	1,506	759	1,257
Subaru	962	616	836	1,173	1,316	1,225
Suzuki	1,015	179	879	1,426	1,352	1,414
Tata	1,181	680	984	1,181	680	984
Toyota	323	560	400	747	906	799
Volkswagen	1,848	972	1,694	1,848	972	1,694
Overall	811	1,020	883	1,296	1,538	1,379

As can be seen, the average cost of the 4 percent per year standards is only $65 per vehicle less than that for the final standards. This incremental cost is very similar to that projected in the NPRM. In contrast, the average cost of the 6 percent per year standards is over $430 per vehicle more than that for the final standards, which is $80 less than that projected in the NPRM (again due to lower technology costs). Compliance costs are entering the region of non-linearity. The $65 cost savings of the 4 percent per year standards relative to the final rule represents $19 per g/mi CO_2 increase. The $430 cost increase of the 6 percent per year standards relative to the final rule represents a 25 per g/mi CO_2 increase. More importantly, two additional manufacturers, Ford and Mitsubishi, are projected to be unable to comply with the 6% per year standards. In addition, under the 6% per year standards, four manufacturers (Chrysler, General Motors, Suzuki and Nissan) are within 2 g/mi CO_2 of the minimum achievable levels projected by EPA's OMEGA model analysis for 2016.

EPA does not believe the 4% per year alternative is an appropriate standard for the MY 2012–2016 time frame. As discussed above, the 250 g/mi final rule 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 final standards. In absolute percent increases in the technology penetration, compared to the final 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 final standards. At the same time, CO_2 emissions would be reduced by about 8%, compared to the 250 g/mi target level.

As noted above, EPA's OMEGA model predicts that for model year 2016, Ford, Mitsubishi, Mercedes, BMW, Volkswagen, Jaguar-Land Rover, and Porsche do not meet their target under the 6 percent per year scenario. In addition, Chrysler, General Motors, Suzuki and Nissan all are within 2 grams/mi CO_2 of maximizing the applicable technology allowed under EPA's OMEGA model—that is, these companies have almost no head-room for compliance. In total, these 11 companies represent more than 58 percent of total 2016 projected U.S. light-duty vehicle sales. This provides a strong indication that the 6 percent per year standard is much more stringent than the final standards, and presents a significant risk of non-compliance for many firms, including four of the seven largest firms by U.S. sales.

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 final 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 years 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 now and over the next few years, under the final standards. EPA believes that the final rule (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 Joint Technical Support Document and the 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 reduction 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. The 6% per year alternative standard would impose significantly increased pressure on capital and other resources, indicating it is 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.

Jaguar/Land Rover, in their comments, agreed that the more stringent standards would not be economically practicable, and several automotive firms indicated that the proposed standards, while feasible, would be overly challenging.[261] On the other hand, the Center for Biological Diversity (henceforth referred to here as CBD), strongly urged EPA to adopt more

[261] *See* comments from Toyota, General Motors.

stringent standards. CBD gives examples of higher standards in other nations to support their contention that the standards should be more stringent. CBD also claims that the agencies are "setting standards that deliberately delay implementation of technology that is available now" by setting lead time for the rule greater than 18 months. CBD also accuses the agencies of arbitrarily "adhering to strict five-year manufacturer 'redesign cycles.'" CBD notes that the agencies have stated that all of the "technologies are already available today," and EPA 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." Based on the agencies' previous statements, CBD concludes that the fleet can meet the 250 g/mi target in 2010. EPA believes that in all cases, CBD's analysis for feasibility and necessary lead time is flawed.

Other countries' absolute fleetwide standards are not a reliable or directly relevant comparison. The fleet make-up in other nations is quite different than that of the United States. CBD primarily cites the European Union and Japan as examples. Both of these regions have a large fraction of small vehicles (with lower average weight, and footprint size) when compared to vehicles in the U.S. Also the U.S. has a much greater fraction of light-duty trucks. In particular in Europe, there is a much higher fraction of diesel vehicles in the existing fleet, which leads to lower CO_2 emissions in the baseline fleet as compared to the U.S. This is in large part due to the significantly different fuel prices seen in Europe as compared to the U.S. The European fleet also has a much higher penetration of manual transmission than the U.S., which also results in lower CO_2 emissions. Moreover, these countries use different test cycles, which bias CO_2 emissions relative to the EPA 2 cycle test cycles. When looked at from a technology-basis, with the exception of the existing large penetration of diesels and manual transmissions in the European fleet—there is no "magic" in the European and Japanese markets which leads to lower fleet-wide CO_2 emissions. In fact, from a technology perspective, the standards contained in this final rule are premised to a large degree on the same technologies which the European and Japanese governments have relied upon to establish their CO_2 and fuel economy limits for this same time frame and for the fleet mixes in their countries. That is for example, large increases in the use of 6+ speed transmissions, automated manual transmissions, gasoline direct injection, engine downsizing and turbocharging, and start-stop systems. CBD has not provided any detailed analysis of what technologies are available in Europe which EPA is not considering—and there are no such "magic" technologies. The vast majority of the differences between the current and future CO_2 performance of the Japanese and European light-duty vehicle fleets are due to differences in the size and current composition of the vehicle fleets in those two regions—not because EPA has ignored technologies which are available for application to the U.S. market in the 2012–2016 time frame.

If CBD is advocating a radical reshifting of domestic fleet composition, (such as requiring U.S. consumers to purchase much smaller vehicles and requiring U.S. consumers to purchase vehicles with manual transmissions), it is sufficient to say that standards forcing such a result are not compelled under section 202(a), where reasonable preservation of consumer choice remains a pertinent factor for EPA to consider in balancing the relevant statutory factors. *See* also *International Harvester* (478 F. 2d at 640 (Administrator required to consider issues of basic demand for new passenger vehicles in making technical feasibility and lead time determinations). Thus EPA believes that the standard is at the proper level of stringency for the projected domestic fleet in the 2012–2016 model years taking into account the wide variety of consumer choice that is reflected in this projection of the domestic fleet.

As mentioned earlier (in III.D.4), CBD's comments on available lead time also are inaccurate. Under section 202(a), standards 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." Having sufficient lead time includes among other things, the time required to certify vehicles. For example, model year 2012 vehicles will be tested and certified for the EPA within a short time after the rule is finalized, and this can start as early as calendar year 2010, for MY 2012 vehicles that can be produced in calendar year 2011. In addition, these 2012 MY vehicles have already been fully designed, with prototypes built several years earlier. It takes several years to redesign a vehicle, and several more to design an entirely new vehicle not based on an existing platform. Thus, redesign cycles are an inextricable component of adequate lead time under the Act. A full line manufacturer only has limited staffing and financial resources to redesign vehicles, therefore the redesigns are staggered throughout a multi-year period to optimize human capital.[262] Furthermore, redesigns require a significant outlay of capital from the manufacturer. This includes research and development, material and equipment purchasing, overhead, benefits, etc. These costs are significant and are included in the cost estimates for the technologies in this rule. Because of the manpower and financial capital constraints, it would only be possible to redesign all the vehicles across a manufacturer's line simultaneously if the manufacturer has access to tremendous amounts of ready capital and an unrealistically large engineering staff. However no major automotive firm in the world has the capability to undertake such an effort, and it is unlikely that the supplier basis could support such an effort if it was required by all major automotive firms. Even if this unlikely condition were possible, the large engineering staff would then have to be downsized or work on the next redesign of the entire line another few years later. This would have the effect of increasing the cost of the vehicles.

There is much evidence to indicate that the average redesign cycle in the industry is about 5 years.[263] There are some manufacturers who have longer cycles (such as smaller manufacturers described above), and there are others who have shorter cycles for some of their products. EPA believes that there are no full line manufacturers who can maintain significant redesigns of vehicles (with relative large sales) in 1 or 2 years, and CBD has provided no evidence indicating this is technically feasible. A complete redesign of the entire U.S. light-duty fleet by model year 2012 is clearly infeasible, and EPA believes that several model years additional lead time is necessary in order for the manufacturers to meet the standards. The graduated increase in the stringency of the standards from MYs 2012 through 2016 accounts for this needed lead time.

There are other reasons that the fleet cannot meet the 250g/mi CO_2 target in 2012 (much less in 2010). The commenter reasons that if technology is in use now—even if limited use—it can

[262] *See* for example "How Automakers Plan Their Products", Center for Automotive Research, July 2007.

[263] *See* for example "Car Wars 2010–2013, The U.S. automotive product pipeline", John Murphy, Research Analyst, Bank of America/Merrill Lynch research paper, July 15, 2009.

be utilized across the fleet nearly immediately. This is not the case. An immediate demand from original equipment manufacturers (OEMs) to supply 100% of the fleet with these technologies in 2012 would cause their suppliers to encounter the same lead time issues discussed above. Suppliers have limited capacity to change their current production over to the newer technologies quickly. Part of this reason is due to engineering, cost and manpower constraints as described above, but additionally, the suppliers face an issue of "stranded capital". This is when the basic tooling and machines that produce the technologies in question need to be replaced. If these tools and machines are replaced before they near the end of their useful life, the suppliers are left with "stranded capital" *i.e.,* a significant financial loss because they are replacing perfectly good equipment with newer equipment. This situation can also occur for the OEMs. In an extreme example, a plant that switches over from building port fuel injected gasoline engines to building batteries and motors, will require a nearly complete retooling of the plant. In a less extreme example, a plant that builds that same engine and switches over to suddenly building smaller turbocharged direct injection engines with starter alternators might have significant retooling costs as well as stranded capital. Finally, it takes a significant amount of time to retool a factory and smoothly validate the tooling and processes to mass produce a replacement technology. This is why most manufacturers do this process over time, replacing equipment as they wear out. CBD has not accounted for any of these considerations. EPA believes that attempting to force the types of massive technology penetration needed in the early model years of the standard to achieve the 2016 standards would be physically and cost prohibitive.

A number of automotive firms and associations (including the Alliance of Automobile Manufacturers, Mercedes, and Toyota) commented that the standards during the early model years, in particular MY 2012, are too stringent, and that a more linear phase-in of the standards beginning with the MY 2011 CAFE standards and ending with the 250 gram/mi proposed EPA projected fleet-wide level in MY 2016 is more appropriate. In the May 19, 2009 Joint Notice of Intent, EPA and NHTSA stated that the standards would have "* * * *a generally linear phase-in from MY 2012 through to model year 2016*." (74 FR 24008). The Alliance of Automobile Manufacturers stated that the phase-in of the standards is not linear, and they proposed a methodology for the CAFE standards to be a linear progression from MY 2011 to MY 2016. The California Air Resources Board commented that the proposed level of stringency, including the EPA proposed standards for MY 2012–2015, were appropriate and urged EPA to finalize the standards as proposed and not reduce the stringency in the early model years as this would result in a large loss of the GHG reductions from the National Program. EPA agrees with the comments from CARB, and we have not reduced the stringency of the program for the early model years. While some automotive firms indicated a desire to see a linear transition from the Model Year 2011 CAFE standards, our technology and cost analysis indicates that our standards are appropriate for these interim years. As shown in Section III.H of this final rule, the final standards result in significant GHG reductions, including the reductions from MY 2012–2015, and at reasonable costs, providing appropriate lead time. The automotive industry commenters did not point to a specific technical issue with the standards, but rather their desire for a linear phase-in from the existing 2011 CAFE standards.

In summary, the EPA believes that the MY 2012–2016 standards finalized are feasible and that there are compelling reasons not to adopt more stringent standards, based on a reasonable weighing of the statutory factors, including available technology, its cost, and the lead time necessary to permit its development and application. For further discussion of these issues, see Chapter 4 of the RIA as well as the response to comments.

E. Certification, Compliance, and Enforcement

1. Compliance Program Overview

This section describes EPA's comprehensive program to ensure compliance with 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 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 EPA and NHTSA programs recognize, and replicate 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 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. Today's rule establishes fleet average greenhouse gas 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 establishing in-use standards that apply throughout a vehicle's useful life, with the in-use standard determined by adding an adjustment factor to the emission results used to calculate the fleet average. EPA's program will thus not only assess compliance with the fleet average standards described in Section III.B, but will also assess compliance with the in-use standards. As it does now, EPA will 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 establishing 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 an assessment of compliance with the in-use standards concurrent with existing EPA and manufacturer Tier 2 emission compliance testing programs. Under this compliance program manufacturers will 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 received broad comment from regulated industry and from the public interest community supporting this overall compliance program structure.

The compliance program is outlined in further detail below.

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 will 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 will 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 will 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's proposal to extend this approach to the GHG program received overwhelming support from vehicle manufacturers. EPA is finalizing GHG requirements under which manufacturers will 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.[264] Manufacturers will submit one data set in satisfaction of both CAFE and GHG requirements such that EPA's program will 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. Now manufacturers will 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 will be determined on a manufacturer by manufacturer basis, separately for cars and trucks, using the footprint attribute curves. EPA will 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 will then compare the actual fleet average to the manufacturer's footprint standard to determine compliance, taking into consideration use of averaging and 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 received considerable comment about the need for transparency in its implementation of the greenhouse gas program and specifically about the need for public access to information about Agency compliance determinations. Many comments emphasized the importance of making greenhouse gas compliance information publicly available to ensure such transparency. EPA also received comment from industry about the need to protect confidential business information. Both transparency and protection of confidential information are longstanding EPA practices, and both will remain priorities in EPA's implementation of the greenhouse gas program. EPA periodically provides mobile source emissions and fuel economy information to the public, for example through the annual Compliance Report[265] and Fuel Economy Trends Report.[266] As proposed, 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 fleet average emission levels compared with standards, and final compliance status for a model year after credit reconciliation occurs. EPA intends to regularly disseminate non-confidential, model-level and fleet information for each manufacturer after the close of the model year. EPA will reassess data release needs and opportunities once the program is underway.

Beyond transparency in reporting emissions data and compliance status, EPA is concerned, as a matter of principle moving into a new era of greenhouse gas control, that greenhouse gas reductions reported for purposes of compliance with the standards adopted in this rule will be reflected in the real world and not just as calculated fleet average emission levels or measured certification test results. Therefore EPA will pay close attention to technical details behind manufacturer reports. For example, EPA intends to look closely at each manufacturer's certification testing procedures, GHG calculation procedures, and laboratory correlation with EPA's laboratory, and to carefully review manufacturer pre-production, production, and in-use testing programs. In addition, EPA plans to monitor GHG performance through its own in-use surveillance program in the coming years. This will ensure that the environmental benefits of the rule are achieved as well as ensure a level playing field for all.

b. Required Minimum Testing for Fleet Average CO_2

EPA received no public comment on provisions that would extend current CAFE testing requirements and flexibilities to the GHG program, and is finalizing as proposed minimum testing requirements for fleet average CO_2 determination. EPA will require and use the same test data to determine a manufacturer's compliance with both the CAFE standard and 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.[267] 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

[264] As discussed in Section III.B.1, vehicle and fleet average compliance will be based on a combination of CO_2, HC, and CO emissions. This is consistent with the carbon balance methodology used to determine fuel consumption for the labeling and CAFE programs. The final regulations account for these total carbon emissions appropriately and refer to the sum of these emissions as the "carbon-related exhaust emissions" (CREE). Although regulatory text uses the more accurate term "CREE" to represent the CO_2-equivalent sum of carbon emissions, the term CO_2 is used as shorthand throughout Section III.E as a more familiar term for most readers.

[265] 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.*

[266] 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.*

[267] *See* 40 CFR 600.010–08(d).

vehicles, at their option. As described above, EPA will 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 fleet average standard.

EPA will 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. EPA will continue to accept use of substituted data in the GHG program, but only when the substituted data are also used for CAFE purposes.

EPA regulations for CAFE testing permit the use of analytically derived fuel economy data in lieu of conducting actual fuel economy tests in certain situations.[268] Analytically derived data are generated mathematically using expressions determined by EPA and are allowed on a limited basis when a manufacturer has not tested a specific vehicle configuration. This has been done as a way 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 derived data and that specifies the conditions when analytically derived fuel economy data may be used. EPA will apply the same guidance to the GHG program and will allow any analytically derived data used for CAFE to also satisfy the GHG data reporting requirements. EPA will 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 will 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.

[268] 40 CFR 600.006–08(e).

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.[269]

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.[270] 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.[271]

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 with the fleet average 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 fleet-wide 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.

[269] CAA section 206(a)(1).

[270] 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.

[271] 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.

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 will similarly condition each certificate of conformity for the GHG program upon a manufacturer's demonstration of compliance with the manufacturer's fleet-wide average CO_2 standard. The following discussion explains how EPA will integrate the new GHG vehicle certification program into the existing certification program.

a. Compliance Plans

In an effort to expedite the Tier 2 program certification process and facilitate early resolution of any compliance related concerns, EPA conducts annual reviews of each manufacturer's certification, in-use compliance and fuel economy plans for upcoming model year vehicles. EPA meets with each manufacturer individually, typically before the manufacturer begins to submit applications for certification for the new model year. Discussion topics include compliance plans for the upcoming model year, any new product offerings/ new technologies, certification and/or testing issues, phase-in and/or ABT plans, and a projection of potential EPA confirmatory test vehicles. EPA has been conducting these compliance preview meetings for more than 10 years and has found them to be very useful for both EPA and manufacturers. Besides helping to expedite the certification process, certification preview meetings provide an opportunity to resolve potential issues before the process begins. The meetings give EPA an early opportunity to assess a manufacturer's compliance strategy, which in turn enables EPA to address any potential concerns before plans are finalized. The early interaction reduces the likelihood of unforeseen issues occurring during the actual certification of a test group which can result in the delay or even termination of the certification process.

For the reasons discussed above, along with additional factors, EPA believes it is appropriate for manufacturers to include their GHG compliance plan information as part of the new model year compliance preview process. This requirement is both consistent with existing practice under Tier 2 and very similar to the pre-model year report required under existing and new CAFE regulation. Furthermore, in light of the production weighted fleet average program design in which the final compliance determination cannot be made until after the end of the model year, EPA believes it is especially important for manufacturers to demonstrate that they have a credible compliance plan prior to the beginning of certification.

Several commenters raised concerns about EPA's proposal for requiring manufacturers to submit GHG compliance plans. AIAM stated that EPA did not identify a clear purpose for the review of the plans, criteria for evaluating the plans, or consequences if EPA found the plans to be unacceptable. AIAM also expressed concern over the appropriateness of requiring manufacturers to prepare regulatory compliance plans in advance, since vicissitudes of the market and other factors beyond a manufacturer's direct control may change over the course of the year and affect the model year outcome. Finally, AIAM commented that EPA should not attempt to take any enforcement action based on an asserted inadequacy of a plan. The comments stated that compliance should be determined only after the end of a model year and the subsequent credit earning period. The Alliance commented that there was an inconsistency between the proposed preamble language and the regulatory language in 600.514–12(a)(2)(i). The preamble language indicated that the compliance report should be submitted prior to the beginning of the model year and prior to the certification of any test group, while the regulatory language stated that the pre-model year report must be submitted during the month of December. The Alliance pointed out that if EPA wanted GHG compliance plan information before the certification of any test groups, the regulatory language would need to be corrected.

EPA understands that a manufacturer's plan may change over the course of a model year and that compliance information manufacturers present prior to the beginning of a new model year may not represent the final compliance outcome. Rather, EPA views the compliance plan as a manufacturer's good-faith projection of strategy for achieving compliance with the greenhouse gas standard. It is not EPA's intent to base compliance action solely on differences between projections in the compliance plan and end of year results. EPA understands that compliance with the GHG program will be determined at the end of the model year after all appropriate credits have been taken into consideration.

As stated earlier, a requirement to include GHG compliance information in the new model year compliance preview meetings is consistent with long standing EPA policy. The information will provide EPA with an early overview of the manufacturer's GHG compliance plan and allow EPA to make an early assessment as to possible issues, questions, or concerns with the program in order to expedite the certification process and help manufacturers better understand overall compliance provisions of the GHG program. Therefore, EPA is finalizing revisions to 40 CFR 600.514–12 which will require manufacturers to submit a compliance plan to EPA prior to the beginning of the model year and prior to the certification of any test group. The compliance plan must, at a minimum, include a manufacturer's projected footprint profile, projected total and model-level production volumes, projected fleet average and model-level CO_2 emission values, projected fleet average CO_2 standards and projected fleet average CO_2 credit status. In addition, EPA will expect the compliance plan to explain the various credit, transfer and trading options that will be used to comply with the standard, including the amount of credit the manufacturer intends to generate for air conditioning leakage, air conditioning efficiency, off-cycle technology, and various early credit programs. The compliance plan should also indicate how and when any deficits will be paid off through accrual of future credits.

EPA has corrected the inconsistency between the proposed preamble and regulatory language with respect to when the compliance report must be submitted and what level of information detail it must contain. EPA is finalizing revisions to 40 CFR 600.514–12 which require the compliance plan to be submitted to EPA prior to the beginning of the model year and prior to the certification of any test group. Today's action will also finalize simplified reporting requirements as discussed above.

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.[272] 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.[273] 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 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 affect CO_2 generation and emissions but are not included in EPA's test group criteria.[274] Most important among these may be vehicle weight, horsepower, aerodynamics, vehicle size, and performance features.

As described in the proposal, EPA considered but did not propose 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

[272] 40 CFR 86.1827–01.

[273] 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).

[274] 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).

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.

For these reasons, EPA will retain the current Tier 2 test group structure for cars and light trucks in the certification requirements for CO_2. EPA believes that the current test group concept is also appropriate for N_20 and CH_4 because the technologies that are employed to control N_2O and CH_4 emissions will generally be the same as those used to control the criteria pollutants. Vehicle manufacturers agreed with this assessment and universally supported the use of current Tier 2 test groups in lieu of developing separate CO_2 test groups.

At the time of certification, manufacturers may 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 further testing will generally be required for compliance with the fleet average CO_2 standard as described below. EPA's issuance of a certificate will 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.

As just discussed, the "worst case" Emissions Data Vehicle selected 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 emits 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. Vehicle manufacturers expressed concern with this approach as well, and EPA ultimately rejected this approach because it could have required manufacturers 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 proposed and will adopt provisions that allow a single Emission Data Vehicle to represent the test group for both Tier 2 and CO_2 certification. The manufacturer will 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 will 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 will become the official certification test results (as per the conditioned certificate) and will 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.

Manufacturers will be subject to two standards, 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 applied to each model. For each model, the in-use standard will generally be set at 10% higher than the level used for that model in calculating the fleet average (*see* Section III.E.4).[275] The certificate will cover both of these standards, and the manufacturer will 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 will 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 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.7 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, and any other carbon-containing exhaust components such as aldehyde emissions from alcohol-fueled vehicles. 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 hydrocarbon compounds being accounted for). Thus, EPA will calculate the carbon-related exhaust emissions, also known as "CREE," of each test vehicle according to the following formula, where HC, CO, and CO_2 are in units of grams per mile:

[275] In cases where configuration or sub-configuration level data exist, the in-use standard will be set at 10% higher than those emissions test results. See Section III.E.4.

carbon-related exhaust emissions (grams/mile) = CWF*HC + 1.571*CO + CO_2

Where:

CWF = the carbon weight fraction of the test fuel.

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 rule, EPA will add CO_2, N_2O, and CH_4 to the emissions measured in the course of Tier 2 and CAFE confirmatory testing. The N_2O and methane measurement requirements will begin for model year 2015, when requirements for manufacturer measurement to comply with the standard also take effect. The emission values measured at the EPA laboratory will continue to stand as official, as under existing regulatory programs.

Under current practice, if during EPA's confirmatory fuel economy testing, the EPA fuel economy value differs from the manufacturer's value by more than 3%, manufacturers can request a re-test. The re-test results stand as official, even if they differ by more than 3% from the manufacturer's value. EPA proposed extending this practice to CO_2 results, but manufacturers commented that this could lead to duplicative testing and increased test burden. EPA agrees that the close relationship between CO_2 and fuel economy precludes the need to conduct additional confirmatory tests for both fuel economy and CO_2 to resolve potential discrepancies. Therefore EPA will continue to allow a re-test request based on a 3% or greater disparity in manufacturer and EPA confirmatory fuel economy test values, 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).

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 NO_X fleet average standards and the new 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 [276] or 120,000 miles with an optional 15 year or 150,000 mile provision. A similar approach is used for heavy-duty engines, however a specific Family Emissions Level is assigned to the engine family at certification, as compared to a pre-defined bin emissions level as in Tier 2.

As noted above, the in-use CO_2 standard under the greenhouse gas program, like Tier 2, will apply to individual vehicles and is separate from the fleet-average standard. However, unlike the Tier 2 program and other EPA fleet average standards, the model-level CO_2 test results are themselves used to calculate the fleet average standard for compliance purposes. This is consistent with the current CAFE practice, but it means the fleet average standard and the emission test results used to calculate compliance with the fleet average standard do not take into account test-to-test variability and production variability that can affect in-use levels. Since the CO_2 fleet average uses the model level emissions test results themselves for purposes of calculating the fleet average, EPA proposed an adjustment factor for the in-use standard to provide some margin for production and test-to-test variability that could result in differences between the initial emission test results used to calculate the fleet average and emission results obtained during subsequent in-use testing. EPA proposed that each model's in-use CO_2 standard would be the model specific level used in calculating the fleet average, adjusted to be 10% higher.

EPA received significant comment from industry expressing concern with the in-use standard. The comments focused on concerns about manufacturer liability for in-use CO_2 performance and for the most part did not address the proposed 10% adjustment level or even the need for an adjustment to account for variability. Some comments suggested that an in-use standard is not necessary because in-use testing is not mandated in the CAA. Others stated that since there is no evidence that CO_2 emission levels increase over time, there is no need for an in-use standard. Finally, there was a general concern that failure to meet the in-use standard would result in recall liability and that recall can only be used in cases where it can be demonstrated that a "repair" can remedy the nonconformity. One manufacturer provided comments supporting the use of a 10% adjustment factor for the in-use standard. These comments also recommended that the 10% adjustment factor be applied to configuration or subconfiguration data rather than to model-level data unless the lower-level data were not available. Finally, the manufacturer expressed concern that a straight 10% adjustment would result in inequity between high- and low-emitting vehicles.

Section 202(a)(1) specifies that emissions standards are to be applicable for the useful life of the vehicle. The in-use emissions standard for CO_2 implements this provision. While EPA agrees that the CAA does not require the Agency to perform in-use testing to monitor compliance with in-use standards, the Act clearly authorizes in-use testing. EPA has a long tradition of performing in-use testing and has found it to be an effective tool in the overall light-duty vehicle compliance program. EPA continues to believe that it is appropriate to perform in-use testing and that the evaluation of individual vehicle performance for all regulated emission constituents, including CO_2, N_2O and CH_4, is necessary to ensure compliance with all light-duty requirements. EPA also believes that the CAA clearly mandates that all emission standards apply for a vehicle's useful life and that an in-use standard is therefore necessary.

EPA agrees with industry commenters that there is little evidence to indicate that CO_2 emission levels from current-technology vehicles increase over time. However, as stated above, the CAA mandates that all emission standards apply for a vehicle's useful life regardless of whether the emissions increase over time. In addition, there are factors other than emission deterioration over time that can cause in-use emissions to be greater than emission standards. The most obvious are component defects, production mistakes, and the stacking of component production and design tolerances. Any one of these can cause an exceedance of emission standards for individual vehicles or whole model lines. Finally EPA believes that it is essential to monitor in-use GHG emissions performance of new technologies, for which there is currently no in-use experience, as they enter the market. Thus EPA believes that the value in establishing an in-use standard extends beyond just addressing emission deterioration over time from current technology vehicles.

The concern over recall liability in cases where there is no effective repair remedy has some legitimate basis. For

[276] 11 years for heavy-light-duty trucks, ref. 40 CFR 86.1805–12.

example, EPA agrees there would be a concern if a number of vehicles for a particular model were to have in-use emissions that exceed the in-use standard, with no effective repair available to remedy the noncompliance. However, EPA does not anticipate a scenario involving exceedance of the in-use standard that would cause the Agency to pursue a recall unless there is a repairable cause of the exceedance. At the same time, failures to emission-related components, systems, software, and calibrations do occur that could result in a failure of the in-use CO_2 standard. For example, a defective oxygen sensor that causes a vehicle to burn excessive fuel could result in higher CO_2 levels that would exceed the in-use standard. While it is likely that such a problem would affect other emissions as well, there would still be a demonstratable, repairable problem such that a recall might be valid. Therefore, EPA believes that a CO_2 in-use standard is statutorily required and can serve as a useful tool for determining compliance with the GHG program.

EPA agrees with the industry comment that it is appropriate where possible to apply the 10% adjustment factor to the vehicle-level emission test results, rather than to a model-type value that includes production weighting factors. If no subconfiguration test data are available, then the adjustment factor will be applied to the model-type value. Therefore, EPA is finalizing an in-use standard based on a 10% multiplicative adjustment factor but the adjustment will be applied to emissions test results for the vehicle subconfiguration if such data exist, or to the model-type emissions level used to calculate the fleet average if subconfiguration test data are not available.

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 will 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 has therefore determined that an assigned deterioration factor be applied at the time of certification. At this time EPA will use an additive assigned deterioration factor of zero, or a multiplicative factor of one. EPA anticipates that the deterioration factor will 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 will explore with each manufacturer any new technologies that could warrant use of a different deterioration factor. For any vehicle model determined likely to experience increases in CO_2 emissions over the vehicle's useful life, manufacturers will not be allowed to use the assigned deterioration factor but rather will be required to establish an appropriate factor. If such an instance were to occur, EPA would allow manufacturers to use the whole-vehicle mileage accumulation method currently offered in EPA's regulations.[277]

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. EPA recognizes that manufacturers have not been required to account for durability effects of N_2O and CH_4 prior to now. EPA also realizes that industry will need sufficient time to explore durability options and become familiar with procedures for determining deterioration of N_2O and CH_4. Therefore, until the 2015 model year, rather than requiring manufacturers to establish a durability program for N_2O and CH_4, EPA will allow manufacturers to attest that vehicles meet the deteriorated, full useful life standard. If manufacturers choose to comply with the optional CO_2 equivalent standard, EPA will allow the use of the manufacturer's existing NO_X deterioration factor for N_2O and the existing NMOG deterioration factor for CH_4.

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 adjusting a manufacturer's credit balance to the voluntary or mandatory recall of noncompliant vehicles. These potential remedies provide 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 fourth 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.[278] The emissions data collected from IUVP serve several purposes. IUVP results provide 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 manufacturer 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, onboard refueling vapory recovery (ORVR) emissions and on-board diagnostics (OBD) data.

Manufacturers are required to provide data for all regulated criteria pollutants. Some manufacturers have voluntarily submitted CO_2 data as part of IUVP. EPA proposed that manufacturers provide CO_2, N_2O, and CH_4 data as part of the IUVP. EPA also proposed that in order to adequately analyze and assess

[277] 40 CFR 86.1823–08.

[278] 64 FR 23906, May 4, 1999.

in-use CO_2 results, which are based on the combination of FTP and highway cycle test results, the highway fuel economy test would also need to be part of IUVP. The University of California, Santa Barbara expressed support for including N_2O and CH_4 emissions as part of the IUVP. Manufacturer comments were almost unanimously opposed to including any GHG as part of the IUVP. Specifically, industry commented that CO_2 emissions do not deteriorate over time and in some cases actually improve. Ford provided data for several 2004 through 2007 model year vehicles that indicate CO_2 emissions improved an average of 1.42% when vehicles were tested over 5,000 miles. Manufacturers commented that the inclusion of a greenhouse gas emissions requirement and the highway test cycle as part of the IUVP would unnecessarily increase burden on manufacturers and provide no benefit, since CO_2 emissions do not deteriorate over time. Manufacturers also commented that N_2O and CH_4 emissions are very low and by EPA's own account only represent about 1% of total light-duty vehicle GHG emissions. They also expressed concern over the cost and burden of measuring N_2O for IUVP, since many manufacturers use contractor laboratories to assist in their IUVP testing and many of these facilities do not have the necessary equipment to measure N_2O. They stated that since it was unnecessary to include CO_2 emissions as part of IUVP and since N_2O and CH_4 were such small contributors to GHG emissions, it did not make sense to include N_2O and CH_4 as part of the IUVP either. They felt that N_2O and CH_4 could be more appropriately handled through attestation or an annual unregulated emissions report.

As discussed above, although EPA shares the view expressed in manufacturer comments that historical data demonstrate little CO_2 deterioration, in-use emissions can increase for a number of reasons other than deterioration over time. For example, production or design errors can result in increased GHG emissions. Components that aren't built as they were designed or vehicles inadvertently assembled improperly or with the wrong parts or with parts improperly designed can result in GHG emissions greater than those demonstrated to EPA during the certification process and used in calculating the manufacturer's fleet average. The "stacking" of component design and production tolerances can also result in in-use emissions that are greater than those used in calculating a manufacturer's fleet average.

EPA believes IUVP testing is also important to monitor in-use versus certification emission levels. Because the emphasis of the GHG program is on a manufacturer's fleet average standard, it is difficult for EPA to make an assessment as to whether manufacturer's vehicles are actually producing the GHG levels claimed in their fleet average without some in-use data for comparison. For example, EPA has expressed concern that with the in-use standard based on a 10% adjustment factor, there would be an incentive for manufacturers to develop their fleet average utilizing the full range of the 10% in-use standard. The only way for EPA to assess whether manufacturers are designing and producing vehicles that meet their respective fleet average standards is for EPA to be able to review in-use GHG emissions from the IUVP.

Finally EPA does have some concern about potential CO_2 emissions deterioration in advanced technologies for which we currently have no in-use experience or data. Since CAFE has never had an in-use requirement and today's final regulations are the first ever GHG standards, there has been no need to focus on GHG emissions in-use as there will be with the new GHG standards. Many of the advanced technologies that EPA expects manufacturers to use to meet the GHG standards have been introduced in production vehicles, but until now not for the purpose of controlling greenhouse gas emissions. For example, advanced dual-clutch or seven-speed automatic transmissions, and start-stop technologies have not been broadly tested in the field for their long-term CO_2 performance. In-use GHG performance information for vehicles using these technologies is needed for many reasons, including evaluation of whether allowing use of assigned deterioration factors for CO_2 in lieu of actual deterioration factors will continue to be appropriate.

Therefore, EPA is finalizing the requirement that all manufacturers must provide IUVP emissions data for CO_2. EPA will also require manufacturers to perform the highway test cycle as part of IUVP. Since the 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 understands that requiring manufacturers to also measure N_2O and CH_4 will be initially challenging, since many manufacturer facilities do not currently have the proper analytical equipment. To be consistent with timing of the N_2O and CH_4 emissions standards for this rule, N_2O and CH_4 will not be required for IUVP until the 2015 model year.

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 for vehicles tested in the IUVP 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 substance. EPA proposed to exclude IUVP data for CO_2, N_2O, and CH_4 emissions from the IUCP thresholds. EPA felt that there was not sufficient data to determine if the existing IUCP thresholds were appropriate or even applicable to those emissions. The University of California, Santa Barbara disagreed with EPA's concerns and recommended that CO_2, N_2O, and CH_4 emissions all be subject to the IUVP threshold criteria. Manufacturers commented that since CO_2 performance is a function of vehicle design and cannot be remedied in the field with the addition or replacement of emissions control devices like traditional criteria pollutants, it would not be appropriate or necessary to include IUCP threshold criteria for GHG emissions.

EPA continues to believe that the IUCP is an important part of EPA's in-use compliance program for traditional criteria pollutants. For GHG emissions, EPA believes the IUCP will also be a valuable future tool for achieving compliance. However, there are insufficient data today to determine whether the current IUCP threshold criteria are appropriate for GHG 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. Therefore, for today's final action, EPA will exclude IUVP data for CO_2, N_2O, and CH_4 emissions from the IUCP thresholds.

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 will 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 standard used for fleet average calculation 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, it would be inappropriate to compare an individual vehicle to the fleet average, since that vehicle could have been certified to an emission level that is different than the fleet average level.

This will also be true for the CO_2 fleet average standard. Therefore, to ensure that an individual vehicle complies with the 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 CO_2 standards and Tier 2 standards. For Tier 2, the standard level used for the fleet average calculation is one of eight different emission levels, or "bins," whereas for the CO_2 fleet average standard, the standard level used for the fleet average calculation 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.[279] In contrast, the CO_2 fleet average standard will be calculated using the actual vehicle model-level CO_2 values from the certification test vehicles. With a specified 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 CO_2 standards, the emission level used to calculate the fleet average 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 value used for calculating the fleet average.

The CO_2 fleet average standard is based on the performance of pre-production technology that is 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 proposed an in-use standard that was 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 certification 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 levels used to calculate the fleet average. 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 a reasonable cushion for in-use variability that is beyond a manufacturer's control. EPA proposed a factor of 10% that would 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.

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%.[280] However, there are some fundamental differences between CO_2 emissions and other criteria pollutants in the magnitude of the compounds. 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.

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

[279] In a similar fashion, the fleet average for heavy-duty engines is calculated using a Family Emission Level, determined by the manufacturer, which is different from the emission level of the test engine.

[280] *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.*

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 calculation of the fleet average, EPA will discuss the matter with the manufacturer and consider possible resolutions such as changes to ensure that the emissions test data more accurately reflect the emissions level of vehicles at the time of production, increased EPA confirmatory testing, and other similar measures.

Commenters generally did not comment on whether 10% was the appropriate level for the adjustment factor. Honda did support use of the proposed 10% adjustment factor for the in-use standard. But Honda also recommended that the 10% adjustment factor be applied to subconfiguration data rather than the model-level data unless there was no subconfiguration data available. Honda also expressed some concern over the inequity a straight 10% adjustment would incur between high- and low-emitting vehicles. They suggested that rather than using an across-the-board 10% multiplicative adjustment factor applied to the model-level CO_2 value for all vehicles, it would be more equitable to take the sum of a 5% multiplicative factor applied to the model-level CO_2 value and a 5% factor applied to the manufacturer's fleet CO_2 target.

EPA understands that use of a multiplicative adjustment factor would result in a higher absolute in-use value for a vehicle that has higher CO_2 than for a vehicle with a lower CO_2. However, this difference is not relevant to the purpose of the adjustment factor, which is to provide some cushion for test and production variability. EPA does not believe the difference would be great enough to confer the higher-emitting vehicles with an unfair advantage with respect to emissions variability.

Given that the purpose of the in-use standard is to enable a fair comparison between certification and in-use emission levels, EPA agrees that it is appropriate to apply the 10% adjustment factor to actual emission test results rather than to model-type emission levels which are production weighted. Therefore, EPA is finalizing an in-use standard that applies a multiplicative 10% adjustment factor to the subconfiguration emissions values, if such are available. (For flexible-fuel and dual-fuel vehicles the multiplicative factor will be applied to the test results on each fuel. In other words, these vehicles will have two applicable in-use emission standards; one for operation on the conventional fuel and one for operation on the alternative fuel.) If no emissions data exist at the subconfiguration level the adjustment will be applied to the model-type value as originally proposed. If the in-use emission result for a vehicle exceeds the emissions level, as applicable, adjusted as just described by 10%, then the vehicle will have exceeded the in-use emission standard. The in-use standard will apply to all in-use compliance testing including IUVP, selective enforcement audits, and EPA's internal test program.

5. Credit Program Implementation

As described in Section III.E.2 above, for each manufacturer's model year production, the manufacturer will average the CO_2 emissions within each of the two averaging sets (passenger cars and trucks) and compare that with its respective fleet average standards (which in turn will have been determined from the appropriate footprint curve applicable to that model year). In addition to this within-company averaging, when a manufacturer's fleet average CO_2 values 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 sell or otherwise distribute to another manufacturer (trading). Section III.C discusses opportunities for manufacturers to improve their fleet average, beyond the credits that are simply calculated by over-achieving their applicable fleet average 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.

EPA is promulgating two broad types of credit programs under this rulemaking. One type of credit directly lowers a manufacturer's actual fleet average by virtue of being applied within the methodology for calculating the fleet average emissions. Examples of this type of credit include the credits available for alternative fuel vehicles and the advanced technology vehicle provisions. 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 reviews the different types of credits and shows where and how they are calculated and how they impact a manufacturer's available credits.

a. Basic Credits: Fleet Average Emissions Are Below the Standard

As just noted, basic credits are earned by a manufacturer's fleet that performs better than the applicable fleet average standard. Manufacturers will calculate their fleet average 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 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. As part of this rulemaking, EPA has amended key subparts and sections of Part 600 to require that fleet average CO_2 emissions be calculated in a manner parallel to the way CAFE values are calculated. First, manufacturers will 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 on a CO_2-equivalent basis. For gasoline and diesel vehicles this simply involves measurement of total hydrocarbons and carbon monoxide in addition to CO_2. The calculation 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 currently necessary to determine fuel economy for the labeling and CAFE programs, and thus no new testing or data collection will be required.[281] Second, manufacturers will calculate a fleet average by weighting the CO_2 value for each model type by the production of that model type, as they currently do for the CAFE program. Again, this will be done separately for cars and trucks. Finally, the manufacturer will compare the calculated standard with the fleet average that is actually achieved to determine the credits (or debits) that are generated. Both the determination of the applicable standard and the actual fleet average will be done after the model

[281] Note that the final rule also provides an option for manufacturers to incorporate N_2O and CH_4 in this calculation at their CO_2-equivalent values.

year is complete and using final model year vehicle production data.

Consider a basic hypothetical example where Manufacturer "A" has calculated a car fleet average standard of 300 grams/mile and a car fleet average of 290 grams/mile (Table 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 manufacturer's production of 500,000. This result is then multiplied by the assigned lifetime vehicle miles travelled (for cars this is 195,264 miles, as discussed in Joint TSD Chapter 4), then finally divided by 1,000,000 to convert from grams to total megagrams. The result is the total number of megagrams of credit generated by the manufacturer's car fleet. The same methodology is used to calculate the total number of megagrams of deficit, if the manufacturer was not able to comply with the fleet average standard. In this example, the result is 976,320 megagrams of credits, as shown in Table III.E.5–1.

TABLE III.E.5–1—SUMMARY FOR MANUFACTURER A: EARNING BASIC CREDITS

		CO_2	Totals
Total production	Conventional: 500,000	290 g/mi	500,000
Fleet average standard		300 g/mi	
Fleet average		290 g/mi	
Credits	[(300 − 290) × 500,000 × 195,264] ÷ 1,000,000		= 954,855 Mg

b. Interim Advanced Technology Vehicle Provisions

The lower exhaust greenhouse gas emissions of some advanced technology vehicles can directly benefit a manufacturer's fleet average, thus increasing the amount of fleet average-based credits they earn (or reducing the amount of debits that would otherwise accrue). Manufacturers that produce electric vehicles, plug-in hybrid electric vehicles, or fuel cell electric vehicles will include these vehicles in the fleet average calculation with their model type emission values. As described in detail in Section III.C.3, the emissions from electric vehicles and plug-in hybrid electric vehicles when operating on electricity will be accounted for by assuming zero emissions (0 g/mi CO_2) for a limited number of vehicles through the 2016 model year. This interim limited use of 0 g/mi will be allowed for the technologies specifically noted above and as defined in the regulations, with the limitation that the vehicles must be certified to Tier 2 Bin 5 emission standards or cleaner (*i.e.,* advanced technology vehicles must contribute to criteria pollutant reductions as well as to greenhouse gas emission reductions).

EPA proposed specific definitions for the vehicle technologies eligible for these provisions. One manufacturer suggested the following changes in their comments:

- Insert an additional criterion for electric vehicles that specifically states that an electric vehicle may not have an onboard combustion engine/generator system.
- A minor deletion of text from the definition for "Fuel cell."
- The deletion of the requirement that a PHEV have an equivalent all-electric range of more than 10 miles.

EPA agrees with the first comment. As written in the proposal, a vehicle with an onboard combustion engine that serves as a generator would not have been excluded from the definition of electric vehicle. However, EPA believes it should be. Although such a vehicle might be propelled by an electric motor directly, if the indirect source of electricity is an onboard combustion engine then the vehicle is fundamentally not an electric vehicle. EPA is also adopting the commenter's proposed rephrasing of the definition for "Fuel cell," which is simpler and clearer. Finally, in the context of the advanced technology incentive provisions in this final rule, EPA concurs with the commenter that the requirement that a PHEV have an equivalent all-electric range of at least ten miles is unnecessary. In the context of the proposed credit multiplier EPA was concerned that some vehicles could install a charging system on a limited battery and gain credit beyond what the limited technology would deserve simply by virtue of being defined as a PHEV. However, because EPA is not finalizing the proposed multiplier provisions (*see* Section III.C.3) and is instead using as the sole incentive the zero emission tailpipe level as the compliance value for a manufacturer's fleetwide average, this concern is no longer valid. Since EPA is not promulgating multipliers, the concern expressed at proposal no longer applies, and each PHEV will get a benefit from electricity commensurate with its measured use of grid electricity, thus EPA is no longer concerned about the multiplier effect. Thus, EPA is finalizing the following definitions in the regulations:

- *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:
  - Recharge energy must be drawn from a source off the vehicle, such as residential electric service;
  - The vehicle must be certified to the emission standards of Bin #1 of Table S04–1 in paragraph (c)(6) of § 86.1811; and
  - The vehicle does not have an onboard combustion engine/generator system as a means of providing electrical energy.
- *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 non-combustion reaction of a consumable fuel, typically hydrogen.
- *Plug-in hybrid electric vehicle (PHEV)* means a hybrid electric vehicle that 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.

With some simplifying assumptions, assume that 25,000 of Manufacturer A's fleet are now plug-in hybrid electric vehicles with a calculated CO_2 value of 80 g/mi, and the remaining 475,000 are conventional technology vehicles with an average CO_2 value of 290 grams/mile. By including the advanced technology PHEVs in their fleet, Manufacturer A now has more than 2.9 million credits (Table III.E.5–2).

TABLE III.E.5–2—SUMMARY FOR MANUFACTURER A: EARNING BASIC AND INTERIM ADVANCED TECHNOLOGY CREDITS

		CO_2	Totals
Total production	Conventional: 475,000	290 g/mi	500,000
	PHEV: 25,000	80 g/mi	
Fleet average standard		300 g/mi	
Fleet average	[(475,000 × 290) + (25,000 × 80)] ÷ [500,000]	280 g/mi	
Credits	[(300 − 280) × 500,000 × 195,264] ÷ 1,000,000		= 1,952,640 Mg

c. Flexible-Fuel Vehicle Credits

As noted in Section III.C, treatment of flexible-fuel vehicle (FFV) credits differs between model years 2012–2015 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 final regulations have been modified as needed to do the calculations in terms of grams per mile of CO_2 values rather than miles per gallon. These credits are integral to the fleet average calculation and allow the vehicles to be represented by artificially reduced emissions. To use this credit program, the CO_2 values of FFVs will be represented by the average of two things: the CO_2 value while operating on gasoline and the CO_2 value while operating on the alternative fuel multiplied by 0.15.

For MY 2012 to 2015 for example, Manufacturer A makes 30,000 FFVs with CO_2 values of 280 g/mi using gasoline and 260 g/mi using E85. The CO_2 value 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 Table 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.

TABLE III.E.5–3 SUMMARY FOR MANUFACTURER A: EARNING BASIC, INTERIM ADVANCED TECHNOLOGY, AND FLEXIBLE FUEL VEHICLE CREDITS

		CO_2	Totals
Total production	Conventional: 445,000	290 g/mi	500,000
	PHEV: 25,000	80 g/mi	
	FFV: 30,000	160 g/mi	
Fleet average standard		300 g/mi	
Fleet average	[(445,000 × 290) + (25,000 × 80) + 30,000 × 160] ÷ [500,000]	272 g/mi	
Credits	[(300 − 272) × 500,000 × 195,264] ÷ 1,000,000		= 2,733,696 Mg

In the 2016 and later model years, the calculation of FFV emissions differ substantially from prior years in that the determination of the CO_2 value to represent an FFV model type will be based upon the actual use of the alternative fuel and on actual 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 will 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 has two options. First, the regulations 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 will be published by EPA, and that weighting value would be available for all manufacturers to use for that fuel. The second option allows 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 must be approved by EPA before their use is allowed. In either case, whether EPA supplies the weighting factors or EPA approves a manufacturer's alternative fuel weighting factors, the CO_2 emissions of an FFV in 2016 and later would be as follows (assuming non-zero use of the alternative fuel):

(W1 × CO2conv) + (W2 × CO2alt),

Where W1 and W2 are the proportion of miles driven using conventional fuel and alternative fuel, respectively, CO2conv is the CO_2 value while using conventional fuel, and CO2alt is the CO_2 value while using the alternative fuel. In the example above, for instance, the default CO_2 value for the fictional FFV described above would be the gasoline value of 280 g/mi, and the resulting fleet average and total credits would be 279 g/mi and 2,050,272 megagrams, respectively. However, if the EPA determines that real-world ethanol use amounts to 40 percent of driving, then using the equation above the FFV would be included in the fleet average calculation with a CO_2 value of 272 g/mi, resulting in an overall fleet average of 278 g/mi and total credit accumulation of 2,147,904 megagrams.

d. Dedicated Alternative Fuel Vehicle Credits

Like the FFV credit program described above, these credits will 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 (Table III.E.5–4). Prior to the 2016 model year the CO_2 emissions representing these CNG vehicles will be 33 grams/mile (220×0.15).

TABLE III.E.5–4—SUMMARY FOR MANUFACTURER A: EARNING BASIC, ADVANCED TECHNOLOGY, FLEXIBLE FUEL VEHICLE, AND DEDICATED ALTERNATIVE FUEL VEHICLE CREDITS

		CO_2	Totals
Total production	Conventional: 425,000	290 g/mi	500,000
	PHEV: 25,000	80 g/mi	
	FFV: 30,000	160 g/mi	
	CNG: 20,000	33 g/mi	
Fleet average standard		300 g/mi	
Fleet average	$[(425{,}000 \times 290) + (25{,}000 \times 80) + (30{,}000 \times 160) + (20{,}000 \times 33)] \div [500{,}000]$.	261 g/mi	
Credits	$[(300 - 261) \times 500{,}000 \times 195{,}264] \div 1{,}000{,}000$		= 3,807,648 Mg

The calculation for 2016 and later will be the same except the 0.15 credit adjustment factor is removed from the equation, and the CNG vehicles in this example 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 or fleet average standard. 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 calculations shown above. 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 can generate credits for reducing the leakage of refrigerant from their air conditioning systems. To do this the manufacturer will 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 regulations. Air conditioning credits will 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 described above, the air conditioning leakage credits will need to be calculated separately for cars and trucks. Thus, the resulting grams per mile credit determined from the appropriate car or truck equation will be multiplied by the lifetime VMT assigned by EPA (195,264 for cars; 225,865 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 will 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:

$$[13.8 \times [1 - (12/16.6 \times 850/1{,}430)] = 7.9 \text{ g/mi}.$$

Total megagrams of credits would then be:

$$[7.9 \times 250{,}000 \times 195{,}264] \div 1{,}000{,}000 = 385{,}646 \text{ Mg}.$$

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 4,193,294 megagrams of credits.

f. Air Conditioning Efficiency Credits

As noted in Section III.C.1.b, manufacturers may 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 efficiency credits are calculated separately for cars and trucks. Thus, the resulting grams per mile credit determined in the above equation is multiplied by the lifetime VMT, and then divided by 1,000,000 to get the total megagrams of efficiency 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 will determine their credit based on selections from a menu of technologies, each of which provides a gram per mile credit amount. The credits will be summed for all the technologies implemented by the manufacturer, but cannot 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:

$$[5.7 \times 250{,}000 \times 195{,}264] \div 1{,}000{,}000 = 278{,}251 \text{ Mg}.$$

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 4,471,545 megagrams of credits.

g. Off-Cycle Technology Credits

As described in Section III.C, these credits will be available for certain new or innovative 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 will 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 is 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 GHG regulations contain provisions that describe how to calculate 5-cycle CO_2 values (see 40 CFR 600.114–08). The manufacturer will have to design a test program that accounts for vehicle differences if the technology is installed in different vehicle types, and enough data will have to be collected to address data uncertainty issues. Manufacturers seeking to generate off-cycle credits based on a 5-cycle analysis will be required to submit a description of their test program and the results to EPA for approval.

As noted in Section III.C.4, a manufacturer-developed testing, data collection, and analysis program will require additional EPA approval and oversight. EPA received considerable comment from environmental and public interest organizations suggesting that EPA's decisions about which technologies merit off-cycle credit should be open and public. EPA agrees that a public process will help ensure a fair review and alleviate concerns about potential misuse of the off-cycle credit flexibility. Therefore EPA intends to seek public comment on manufacturer proposals for off-cycle credit that do not use the 5-cycle approach to quantify emission reductions. EPA will consider any comments it receives in determining whether and how much credit is appropriate. Manufacturers should submit proposals well in advance of their desired decision date to allow time for these public and EPA reviews.

Once the demonstration of the CO_2 reduction of an off-cycle technology is complete, 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 will determine the total credit value by multiplying the gram per mile per vehicle credit by the production 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 4.4 grams/mile and that is installed in 175,000 cars would generate credits as follows:

$$[4.4 \times 175{,}000 \times 195{,}264] \div 1{,}000{,}000 = 150{,}353 \text{ Mg.}$$

h. End-of-Year Reporting

In general, implementation of the averaging, banking, and trading (ABT) program, including the calculation of credits and deficits, will be accomplished via existing reporting mechanisms. EPA's existing regulations define how manufacturers calculate fleet average miles per gallon for CAFE compliance purposes. Today's action modifies 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 will now require a similar report that includes fleet average CO_2 levels and related information. That can be integrated with the CAFE report at the manufacturer's option. In addition to requiring reporting of the actual fleet average achieved, this end-of-year report will 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 will 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, the number of credits bought or sold, and the resulting balance of credits or debits.

Because of the multitude of credit programs that are available under the greenhouse gas program, 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 report will 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 will be required to identify the number and type of these vehicles and the effect of these credits on their fleet average. The same will be true for credits due to flexible-fuel and alternative-fuel vehicles, although for 2016 and later flexible-fuel credits manufacturers may 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 will have to include a summary of their use of such credits that will 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 procedure, and reporting will have to detail compliance with the phase-in as well as the test results and the resulting efficiency credits generated. Similar reporting requirements will also apply to the variety of possible off-cycle credit options, where manufacturers will 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 will expect manufacturers to 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 will be required to submit projections of all of the elements described above, plus any projected credit trading transactions (described below).

Finally, to the extent that there are any credit transactions, the manufacturer will have to detail in the end-of-year report documentation on all credit transactions that the manufacturer has engaged in. Information for each transaction will 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. The final report is due to EPA within 90 days of the end of the model year, or no later than March 31 in the calendar year after the calendar year named for the model year. For example, the final GHG report for the 2012 model year is due no later than March 31, 2013. Failure by the manufacturer to submit the annual report in the specified time period will 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, manufacturers will report to EPA their fleet average and 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 will review the annual reports, figures, and calculations submitted by the manufacturer to determine any nonconformance.

Each certificate, required prior to introduction into commerce, will be conditioned upon the manufacturer attaining the CO_2 fleet average standard. If a manufacturer fails to meet this condition and has 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 will review the manufacturer's production for the model year in which the deficit originated and designate which vehicles caused the fleet average standard to be exceeded.

EPA proposed that the vehicles that would be identified as nonconforming would come from the most recent model year, and some comments pointed out that this was inconsistent with how the NLEV and Tier 2 programs were structured. EPA agrees with these comments and is finalizing an enforcement structure that is essentially identical to the one in place for existing programs. 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. 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 produced 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.

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 rule.[282] This section of the 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.

Manufacturer comments expressed concern about potential enforcement action for violations of the greenhouse gas standards, and the circumstances under which EPA would impose penalties. Manufacturers also suggested that EPA should adopt a penalty structure similar to the one in place under CAFE.

The CAA specifies different civil penalty provisions for noncompliance than EPCA does, and EPA cannot therefore adopt the CAFE penalty structure. However, 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 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.[283] The underlying principle of this penalty factor is to operate as a safety mechanism when necessary to prevent injustice.[284]

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 gas standards as to any other regulated emission. Acts that are prohibited by section 203 of the Clean Air Act include the introduction into commerce or the sale of a vehicle without a certificate of conformity, removing or otherwise defeating emission control equipment, the sale or installation of devices designed to defeat emission controls, and other actions. EPA proposed to include in the

[282] 42 U.S.C. 7524(a), Civil Monetary Penalty Inflation Adjustment, 69 FR 7121 (Feb. 13, 2004) and Civil Monetary Penalty Inflation Adjustment Rule, 73 FR 75340 (Dec. 11, 2008).

[283] *In re Spang & Co.,* 6 E.A.D. 226, 249 (EAB 1995).

[284] *B.J. Carney Industries,* 7 E.A.D. 171, 232, n. 82 (EAB 1997).

regulations a new section that details these prohibited acts. Prior regulations, such as the NLEV program, had included such a section, and although there is no burden associated with the regulations or any specific need to repeat what is in the Clean Air Act, EPA believes that including this language in the regulations provides clarity and improves the ease of use and completeness of the regulations. No comments were received on the proposal, and EPA is finalizing the section on prohibited acts (see 40 CFR 86.1854–12).

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 will also apply this policy 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 have 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 rule. 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 rule is not known. EPA will assess its compliance testing and other activities associated with the rule and may amend its fees regulations in the future to include any warranted new costs.

c. Small Entity Exemption

EPA is exempting small entities, and these entities (necessarily) would not be subject to the certification requirements of this rule.

As discussed in Section III.B.8, 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 GHG requirements, pending future regulatory action. EPA proposed that such entities instead be required to 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. EPA has reconsidered the need for this additional submission under the regulations and is deleting it as not necessary. We already have information on the limited number of small entities that we expect would receive the benefits of the exemption, and do not need the proposed regulatory requirement to be able to effectively implement this exemption for those parties who in fact meet its terms. 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.

As discussed in detail in Section III.B.6, small volume manufacturers with annual sales volumes of less than 5,000 vehicles will also be deferred from the CO_2 standards, pending future regulatory action. These manufacturers would still be required to meet N_2O and CH_4 standards, however. To qualify for CO_2 standard deferral, manufacturers would need to submit a declaration to EPA, and would also be required to demonstrate due diligence in having attempted to first secure credits from other manufacturers. 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 volume manufacturer 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 volume manufacturer declaration would be due in September, 2011. If 2012 model year vehicles are not planned for introduction until March, 2012, then the declaration would have to be submitted in December, 2011. Such manufacturers 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 manufacturer was not deferred from compliance with the 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.[285] 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 did not propose that CO_2 emissions would become one of the applicable standards required to be monitored by the OBD system. EPA did not propose CO_2 become an applicable standard for OBD because it was 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 did not have data on the feasibility or effectiveness of monitoring various emission systems and components for CO_2 emissions and did not believe that it would be prudent to include CO_2 emissions without such information.

EPA did not address whether N_2O or CH_4 emissions should become applicable standards for OBD monitoring in the proposal. Several manufacturers felt that EPA's silence on this issue implied that EPA was proposing that N_2O and CH_4 emissions become applicable OBD standards. They commented that EPA should not include them as part of OBD. They felt that adding N_2O and CH_4 would significantly increase OBD development burden, without significant benefit, since any malfunctions that increase N_2O and CH_4 would likely be caught by current OBD system designs. EPA agrees with the manufacturer's comments on including N_2O and CH_4 as applicable standards. Therefore, at this time, EPA is not requiring CO_2, N_2O, and CH_4 emissions as one of the applicable standards required for the OBD monitoring threshold. EPA plans to evaluate OBD monitoring technology, with regard to monitoring these GHG emissions-related systems and components, and may choose to propose to include CO_2, N_2O, and CH_4 emissions as part of the OBD requirements in a future regulatory action.

[285] 40 CFR 86.1806–04.

e. Applicability of Current High Altitude Provisions to Greenhouse Gases

Vehicles covered by this rule must meet the CO_2, N_2O and CH_4 standard at altitude. The CAA requires emission standards under section 202 for light-duty vehicles and trucks to apply at all altitudes.[286] 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 will retain its current high altitude regulations so manufacturers will not normally be required to submit vehicle CO_2 test data for high altitude. Instead, they must submit an engineering evaluation indicating that common calibration approaches will be utilized at high altitude. Any deviation in emission control practices employed only at altitude will need to be included in the auxiliary emission control device (AECD) descriptions submitted by manufacturers at certification. In addition, any AECD specific to high altitude will be required to include emissions data to allow EPA evaluate and quantify any emission impact and validity of the AECD.

f. Applicability of Standards to Aftermarket Conversions

With the exception of the small entity and small volume exemptions, EPA's emission standards, including greenhouse gas standards, will continue to apply as stated in the applicability sections of the relevant regulations. The greenhouse gas standards are being incorporated into 40 CFR part 86, subpart S, which includes 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 will qualify for and seek the small entity and/or small volume exemption, but those that do not qualify will be required to meet the applicable emission standards, including the greenhouse gas standards.

[286] *See* CAA 206(f).

g. Geographical Location of Greenhouse Gas Fleet Vehicles

One manufacturer commented that the CAFE sales area location defined by Department of Transportation regulations is different than the EPA sales area location defined by the CAA. DOT regulations require CAFE compliance[287] in the 50 states, the District of Columbia, and Puerto Rico. However, EPA emission certification regulations require emission compliance[288] in the 50 states, the District of Columbia, the Puerto Rico, the Virgin Islands, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands.

The comment stated that EPA has the discretion under the CAA to align the sales area location of production vehicles for the greenhouse gas fleet with the sales area location for the CAFE fleet and recommended that EPA amend the definitions in 40 CFR 86.1803 accordingly. This would exclude from greenhouse gas requirements production vehicles that are introduced into commerce in the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana.

Although EPA has tried to harmonize greenhouse gas and CAFE requirements in this rule to the extent possible, EPA believes that the approach suggested in comment would be contrary to the requirements of the Act. EPA does not believe that the Agency has discretion under the CAA to exclude from greenhouse gas requirements production vehicles introduced into commerce in the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands. In addition, this change would introduce an undesirable level of complexity into the certification process and result in confusion due to vehicles intended for commerce in separate geographical locations being covered under a single certificate. For these reasons, EPA will retain the proposed greenhouse gas production vehicle sales area location as defined in the CAA.

[287] DOT regulations at 49 CFR 525.4(a)(5) read "The term *customs territory of the United States* is used as defined in 19 U.S.C. 1202." Section 19 U.S.C. 1202 has been replaced by the Harmonized Tariff Schedule of the United States. The Harmonized Tariff Schedule reads in part that "The term 'customs territory of the United States' * * * includes only the States, the District of Columbia, and Puerto Rico."

[288] Section 216 of the Clean Air Act defines the term commerce to mean "(A) commerce between any place in any State and any place outside thereof; and (B) commerce wholly within the District of Columbia."

Section 302(d) of the Clean Air Act reads "The term 'State' means a State, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, and American Samoa and includes the Commonwealth of the Northern Mariana Islands." In addition, 40 CFR 85.1502(14) regarding the importation of motor vehicles and motor vehicle engines defines the United States to include "the States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, and the U.S. Virgin Islands."

9. Miscellaneous Revisions to Existing Regulations

a. Revisions and Additions to Definitions

EPA has amended its definitions of "engine code," "transmission class," and "transmission configuration" in its vehicle certification regulations (part 86) to conform to 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 will not determine which vehicle is 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). Since the same vehicles tested to determine corporate average fuel economy will also be tested to determine fleet average CO_2, the same definitions will apply. Thus EPA has amended its part 86 definitions of the above terms to conform to the definitions in part 600.

Two provisions have been amended to bring EPA's fuel economy regulations in Part 600 into conformity with the fleet average CO_2 requirement contained in this rulemaking and with NHTSA's reform truck regulations. First, the definition of "footprint" in this rule is also being added 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 amending 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 included in this rule for fleet average CO_2 and fuel economy compliance.

b. Addition of Ethanol Fuel Economy Calculation Procedures

EPA has amended part 600 to add calculation procedures 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 updated to specify procedures for vehicles operating on ethanol. Under today's rule EPA is requiring use of a carbon balance approach for ethanol-fueled vehicles that is similar to the way carbon-related exhaust emissions are calculated for vehicles operating on other fuels for the purpose of determining fuel economy and for compliance with the fleet average CO_2 standards. The carbon balance formula is similar to the one in place for methanol, except that ethanol and acetaldehyde emissions must also be measured for ethanol-fueled vehicles. The 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 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:

$$CO_2\text{-eq} = (CWF_{exHC} \times HC) + (0.429 \times CO) + (0.375 \times CH_3OH) + (0.400 \times HCHO) + (0.521 \times C_2H_5OH) + (0.545 \times C_2H_4O) + CO_2.$$

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.[289] 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 1980 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 produces fewer than 10,000 vehicles of all kinds worldwide. EPA believes that this exemption language is no longer appropriate and is deleting 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 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 has revised 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

EPA has made a number of minor amendments to update the regulations as needed or to ensure that the regulations are consistent with changes 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 applicable 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 regulatory text to ensure a complete understanding of the regulatory changes being promulgated by EPA.

In the process of amending regulations that vary in applicability by model year, EPA has several approaches that can be taken. The first option is to amend an existing section of the regulations. For example, EPA did this in the final regulations with § 86.111–94. In this case EPA chose to directly amend this section—which applies to 1994 and later model years as indicated by the suffix after the hyphen—but ensure that the model year of applicability of the amendments (2015 and later for N_2O measurement) is stated clearly in the regulatory text. A second option is to create a new section with specific applicability to the 2012 and later model years; *i.e.,* a section number with a "12" following the hyphen. This approach typically involves pulling forward all the language from an earlier model year section, then amending as needed (but it could also involve a wholesale revision and replacement with entirely new language). For example, EPA took this approach with § 86.1809–12. Although only paragraphs (d) and (e) contain revisions pertaining to this greenhouse gas rule, the remainder of the section is "pulled forward" from a prior model year section (in this case, § 86.1809–10) for completeness. Thus paragraphs (a) through (c) are unchanged relative to the prior model year section. Readers should therefore be aware that sections that are indicated as taking effect in the 2012 model year may differ in only subtle ways from the prior model year section being superseded. A third approach (not used in this regulation) is to use the "Reserved. For guidance see * * *" technique. For example, in the § 86.1809–12, rather than bring forward the existing language from paragraphs (a) through (c), EPA could have simply put a statement in the regulations

[289] 45 FR 49256, July 24, 1980.

directing the reader to refer back to § 86.1809–10 for those requirements. This method has been used in the past, but is not being used in this regulation.

10. Warranty, Defect Reporting, and Other Emission-Related Components Provisions

As outlined in the proposal, Section 207(a) of the Clean Air Act (CAA) requires manufacturers to provide a defect warranty that warrants a vehicle is designed to comply with emission standards and will be free from defects that may cause noncompliance over the specified warranty period which is 2 years/24,000 miles (whichever is first) or, for major emission control components, 8 years/80,000 miles. The warranty covers parts which must function properly to assure continued compliance with emission standards. The proposal explained that under the greenhouse gas rule, this coverage would include compliance with the proposed CO_2, CH_4, and N_2O standards. The proposal did not discuss the CAA Section 207(b) performance warranty.

EPA proposed to include air conditioning system components under the CAA section 207(a) emission warranty in cases where manufacturers use air conditioning leakage and efficiency credits to comply with the proposed fleet average CO_2 standards. The warranty period of 2 years/24,000 miles would apply. EPA requested comments as to whether any other parts or components should be designated as “emission related parts” and thus subject to warranty and defect reporting provisions under this rule.

The Alliance of Automobile Manufacturers (Alliance), Toyota and the State of New Jersey provided comments. The State of New Jersey supported EPA's proposal to include motor vehicle air conditioning system components under the emission warranty provisions. Both the Alliance and Toyota commented that emission warranty requirements are not appropriate for mobile air conditioners because (1) in-use performance of the air conditioning system at levels comparable to a new vehicle is not needed to achieve the emission levels targeted by EPA and (2) manufacturer general warranties already cover air conditioning systems and are typically longer than the two-year/24,000 mile proposed emissions warranty period.

Regarding direct emissions (refrigerant leakage), the Alliance and Toyota commented that warranty requirements are unnecessary for refrigerants with a global warming potential (GWP) below 150 because the environmental impact is negligible even if refrigerants are released from the system. Regarding indirect emissions (fuel consumed to power the air conditioning system), the Alliance commented that EPA should not require warranty coverage of the air conditioning system because in the vast majority of air conditioning failure modes, the system stops cooling and ceases operation—either because the critical moving parts stop moving or because the system is switched off—thereby actually reducing the indirect CO_2 emissions.

EPA received no comments regarding (1) other parts or components which should be designated as “emission related parts” subject to warranty requirements, (2) defect reporting requirements, or (3) other requirements associated with warranty and defect reporting requirements (*e.g.,* voluntary emission-related recall reporting requirements, performance warranty requirements, voluntary aftermarket parts certification requirements or tampering requirements.

Defect Warranty. EPA's current policy for defect warranty requirements is provided in Section 207 of the Act. There are currently no defect warranty regulations. Congress provided under Section 207(a) and (b) of the CAA that emission-related components shall be covered under the 207(a) defect warranty and the 207(b) performance warranty for the warranty period outlined in section 207(i) of the CAA. For example, section 207(a) reads in part:

“* * * the manufacturer of each new motor vehicle and new motor vehicle engine shall warrant to the ultimate purchaser and each subsequent purchaser that such vehicle or engine is (A) designed, built and equipped so as to conform at the time of sale with applicable regulations under section 202, and (B) free from defects in materials and workmanship which cause such vehicle or engine to fail to conform with applicable regulations for its useful life (as determined under sec. 202(d)). In the case of vehicles and engines manufactured in the model year 1995 and thereafter such warranty shall require that the vehicle or engine is free from any such defects for the warranty period provided under subsection (i).”

Section 207(i) reads in part:

“(i) Warranty Period.—

(1) In General.—For purposes of subsection (a)(1) and subsection (b), the warranty period, effective with respect to new light-duty trucks and new light-duty vehicles and engines, manufactured in model year 1995 and thereafter, shall be the first 2 years or 24,000 miles of use (whichever first occurs), except as provided in paragraph (2). For the purposes of subsection (a)(1) and subsection (b), for other vehicles and engines the warranty period shall be the period established by the Administrator by regulation (promulgated prior to the enactment of the Clean Air Act Amendments of 1990) for such purposes unless the Administrator subsequently modifies such regulation.

(2) In the case of a specified major emission control component, the warranty period for new light-duty trucks and new light-duty vehicles manufactured in the model year 1995 and thereafter for purposes of subsection (a)(1) and subsection (b) shall be 8 years or 80,000 miles of use (whichever first occurs). As used in this paragraph, the term ‘specified major emission control component’ means only a catalytic converter, an electronic emissions control unit, and an onboard emissions diagnostic device, except that the Administrator may designate any other pollution control device or component as a specified major emission control component if—(A) the device or component was not in general use on vehicles and engines manufactured prior to the model year 1990; and (B) the Administrator determines that the retail cost (exclusive of installation costs) of such device or component exceeds $200 (in 1989 dollars, adjusted for inflation or deflation) as calculated by the Administrator at the time of such determination * * *”

Thus, the CAA provides the basis of the warranty requirements contained in today's final rule, which will cover “emission related parts” necessary to provide compliance with CO_2, CH_4, and N_2O standards. Emission related parts would include those parts, systems, components and software installed for the specific purpose of controlling emissions or those components, systems, or elements of design which must function properly to assure continued vehicle emission compliance, including compliance with CO_2, CH_4, and N_2O standards; (similar to the current definition of “emission related parts” provided in 40 CFR 85.2102(14) for performance warranty requirements). For example, today's action will extend defect warranty requirements to emission-related components on advanced technology vehicles such as cylinder deactivation components or batteries used in hybrid-electric vehicles.

Under today's rule, EPA will extend the defect warranty requirement to emission-related components necessary to meet CO_2, CH_4, and N_2O standards, including emission-related components which are used to obtain optional credits for (1) certification of advanced technology vehicles, (2) credits for reduction of air conditioning refrigerant leakage, (3) credits for improving air conditioning system efficiency, (4) credits for off-cycle CO_2 reducing technologies, and (5) optional early credits for 2009–2011 model year vehicles outlined in the provisions of 40

CFR 86.1867–12 (which are required to be reported to EPA after the 2011 model year).

Regarding the comments received by the Alliance and Toyota, that warranty coverage is not needed for air conditioning components, EPA believes that the Clean Air Act requires warranty coverage on components used to demonstrate compliance with the emission standards, including components used in the optional credit programs for reduction of air conditioning refrigerant leakage and air conditioning efficiency improvements. EPA does not have the discretion to forgo warranty requirements by regulation in today's final rule. Thus, the Agency is adopting defect warranty requirements for air conditioning components as proposed.

Effective date of Warranty for Components used to Obtain Early Credits. Regarding the defect warranty for emission-related components used to obtain optional early credits for 2009–2011 vehicles, the defect warranty should provide coverage for these components at the time the early credits report is submitted to EPA (*e.g.,* no later than 90 days after the end of the 2011 model year). For example, the defect warranty for early credit components does not have to apply retroactively (before the manufacturer declares the credits to EPA). The Agency believes this approach is reasonable, because (1) manufacturer's early credit plans may not be finalized until after vehicles have been produced; (2) manufacturers will be provided satisfactory lead time to provide warranty requirements to customers; and (3) the manufacturer's basic (bumper-to-bumper) warranty for air conditioning and other early credit components are typically longer than the two-year/24,000 mile proposed warranty period which will be applicable to most early credit components.

Performance Warranty. EPA did not propose any changes to the current performance warranty requirements, because the performance warranty preconditions outlined in section 207(b) of the CAA have not been satisfied. For example, section 207(b) of the CAA comes into play if EPA issues performance warranty short test regulations and determines that there are inspection facilities available in the field to determine when vehicles do not comply with greenhouse gas emission standards. Once EPA issues performance warranty short test regulations, then the CAA performance warranty provisions require the manufacturer to pay for emission-related repairs if a vehicle is properly maintained and used, and fails the short test and is required to repair the vehicle. Currently the provisions of 85.2207 and 85.2222 provide performance warranty short test (commonly called an inspection and maintenance or I/M test). The provisions of 85.2207 and 85.2222 provide an I/M test procedure and failure criteria based on an inspection of the onboard diagnostic (OBD) system of the vehicle. The OBD inspection procedure in 85.2222 is currently used in most areas of the country where I/M tests are required. For example, a vehicle fails the OBD test procedure outlined in 85.2222 if the vehicle's MIL is commanded to be "on" during the I/M test procedure.

Although most areas of the country which require I/M testing use the OBD test procedure outlined in 40 CFR 85.2207 and 85.2222, the NPRM did not propose that the OBD system would be required to monitor CO_2, CH_4 or N_2O emission performance, ref 74 FR 49574 and 74 FR 49755. Therefore, the performance warranty preconditions in 201(b) of the CAA are not currently in effect for greenhouse gas CO_2 emissions. The performance warranty continues to apply for criteria pollutants but not for greenhouse emissions.

Defect Reporting and Voluntary Emission-related Recall Reporting Requirements. EPA did not propose any changes to the current defect reporting and voluntary emission-related recall reporting requirements outlined in the provisions of 40 CFR 85.1901–1909. Although EPA requested comments, we did not receive any comments on defect reporting and voluntary emission-related recall reporting requirements. Current regulations require manufacturers to submit a defect report to EPA whenever an emission-related defect exists in 25 or more in-use vehicles or engines of the same model year. The defect report is required to be submitted to EPA within 15 working days of the time the manufacturer becomes aware of a defect that affects 25 or more vehicles. Current regulations require manufacturers to submit to EPA voluntary emission-related recall reports within 15 working days of the date when owner notification begins.

Similar to the performance warranty requirements outlined above, the Agency believes that as proposed, defect reporting and voluntary emission-related recall reporting requirements would apply to emission-related components necessary to meet CO_2, CH_4, and N_2O standards for the useful life of the vehicle, including emission-related components that are used to obtain optional credits for (1) certification of advanced technology vehicles, (2) credits for reduction of air conditioning refrigerant leakage, (3) credits for improving air conditioning system efficiency, and (4) credits for off-cycle CO_2 reducing technologies, and (5) optional early credits for 2009–2011 model year vehicles outlined in the provisions of 40 CFR 86.1867–12 (which are required to be reported to EPA after the 2011 model year). For early credit components, defect reporting requirements and voluntary emission-related recall reporting requirements become effective at the time the early credits report is submitted to EPA (*e.g.,* no later than 90 days after the end of the 2011 model year).

The final rule includes a minor clarification to the provisions of 40 CFR 85.1902 (b) and (d) to clarify that beginning with the 2012 model year, manufacturers are required to report emission-related defects and voluntary emission recalls to EPA, including emission-related defects and voluntary emission recalls related to greenhouse gas emissions (CH_4, N_2O and CO_2).

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 duty 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, especially 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.

Therefore, in proposing this greenhouse gas action, EPA sought comment on issues surrounding consumer vehicle labeling in general, and labeling of advanced technology vehicles in particular. EPA specifically asked for input as to whether today's miles per gallon fuel economy metric provides adequate information to consumers.

EPA received considerable public input in response to the request for comment in the proposal. Since the greenhouse gas rule was proposed in September, 2009, EPA has initiated a separate rulemaking to explore in detail the information displayed on the fuel economy label and the methodology for deriving that information. The purpose of the vehicle labeling rulemaking is 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.

EPA will consider all vehicle labeling comments received in response to the greenhouse gas proposal in its development of the new labeling rule in coming months. We encourage the interested public to stay engaged and continue to provide input on this issue in the context of the vehicle labeling rulemaking.

F. How will this final rule 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. As shown below, U.S. GHGs are estimated to make up roughly 17 percent of total worldwide emissions in 2010, and the contribution of direct emissions from cars and light-trucks to this U.S. share is growing over time, reaching an estimated 19 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

[$MMTCO_2eq$]

	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]	1,243	1,293	1,449	1,769	2,219

[a] ADAGE model projections, U.S. EPA.[290]
[b] MOVES2010 (2010), OMEGA Model (2020–50) U.S. EPA. See RIA Chapter 5.3 for modeling details.

EPA's GHG rule 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 rule is part of a joint National Program such that a large majority of the projected benefits would be achieved jointly with NHTSA's CAFE standards, which are described in detail in Section IV. EPA estimates the reductions attributable to the GHG program over time assuming the model year 2016 standards continue indefinitely post-2016,[291] compared to a reference 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-eq emissions by 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 "upstream" emission reductions from gasoline extraction, production and distribution processes as a result of reduced gasoline demand associated with this rule. 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 program would be 307 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 approximately 50 million cars and light trucks from the road in this timeframe.[292]

EPA projects the total reduction of the program over the full life of model year 2012–2016 vehicles to be about 960 $MMTCO_2eq$, with fuel savings of 78 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 standards.

The impacts on global mean temperature and global mean sea level rise resulting from these emission reductions are discussed in Section III.F.3.

1. Impact on GHG Emissions

This action 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 subject to 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 the emission caps set forth in this rule, which are meant to prevent emission backsliding and to bring diesel vehicles equipped with advanced technology aftertreatment, and other advanced technology vehicles such as lean-burn gasoline vehicles, into

[290] 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 (*http://www.epa.gov/climatechange/economics/economicanalyses.html*). ADAGE model projections of worldwide and U.S. totals include EISA, and are provided for context.

[291] This analysis does not include the EISA requirement for 35 MPG through 2020 or California's Pavley 1 GHG standards. The standards are intended to supersede these requirements, and the baseline case for comparison are the emissions that would result without further action above the currently promulgated fuel economy standards.

[292] Estimated using MOVES2010, the average vehicle in the light duty fleet emitted 5.1 tons of CO_2 during calendar year 2008.

alignment with current gasoline vehicle emissions.[293]

No substantive comments were received on the emissions modeling methods or on the greenhouse gas inventories presented in the proposal. These analyses are updated here to include model revisions and more recent economic analysis, including revised estimates of future vehicle sales, fuel prices, and vehicle miles traveled. The primary source for these data is the AEO 2010 preliminary release.[294] For more details, please see the TSD and RIA Chapter 5.

As detailed in the RIA, 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 derived from AEO 2010 Early Release. 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, the TLAAS program and FFV credits. EPA also estimated full lifetime reductions for model years 2012–2016 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 rule allows 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 50 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 Chapter 5 of the RIA. These estimates include both international and domestic emission reductions, since reductions in foreign exports of finished gasoline and/or crude would make up a significant share of the fuel savings resulting from the GHG standards. Thus, significant portions of the upstream GHG emission reductions will occur outside of the U.S.; a breakdown of projected international versus domestic reductions is included in the RIA.

a. Calendar Year Reductions for Future Years

Table III.F.1–1 shows reductions estimated from these GHG standards assuming a pre-control case of 2011 MY standards continuing indefinitely beyond 2011, and a post-control case in which 2016 MY GHG standards continue indefinitely beyond 2016.[295] 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 307 $MMTCO_2eq$ 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 GHG REDUCTIONS

[$MMTCO_2eq$ per year]

	Calendar year			
	2020	2030	2040	2050
Net Reduction *	156.4	307.0	401.5	505.9
Net CO_2	*139.1*	*273.3*	*360.4*	*458.7*
Net other GHG	*17.3*	*33.7*	*41.1*	*47.2*
Downstream Reduction	125.2	245.7	320.7	403.0
CO_2 (excluding A/C)	*101.2*	*199.5*	*263.2*	*335.1*
A/C—indirect CO_2	*10.6*	*20.2*	*26.5*	*33.8*
A/C—direct HFCs	*13.3*	*26.0*	*30.9*	*34.2*
CH_4 (rebound effect)	*0.0*	*0.0*	*0.0*	*0.0*
N_2O (rebound effect)	*0.0*	*−0.1*	*−0.1*	*−0.1*
Upstream Reduction	31.2	61.3	80.8	102.9
CO_2	*27.2*	*53.5*	*70.6*	*89.9*
CH_4	*3.9*	*7.6*	*10.0*	*12.7*
N_4O	*0.1*	*0.3*	*0.3*	*0.4*
Percent reduction relative to U.S. reference (cars + light trucks)	12.1%	21.2%	22.7%	22.8%
Percent reduction relative to U.S. reference (all sectors)	2.1%	4.0%	5.0%	6.0%
Percent reduction relative to worldwide reference	0.3%	0.6%	0.7%	0.8%

* Includes impacts of 10% VMT rebound rate presented in Table III.F.1–3.

[293] EPA is adopting a compliance option whereby manufacturers can comply with a CO_2 equivalent standard in lieu of meeting the CH_4 and N_2O standards. This should have no effect on the estimated GHG reductions attributable to the rule since a condition of meeting that alternative standard is that the fleetwide CO_2 target remains in place.

[294] Energy Information Administration. Annual Energy Outlook 2010 Early Release. *http://www.eia.doe.gov/oiaf/aeo/.*

[295] Legally, the 2011 CAFE standards only apply to the 2011 model year and no standards apply to future model years. However, we do not believe that it would be appropriate to assume that no CAFE standards would apply beyond the 2011 model year when projecting the impacts of this rule.

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 program.[296] These results, including both upstream and downstream GHG contributions, are presented in Table III.F.1–2, showing lifetime reductions of about 960 $MMTCO_2eq$, with fuel savings of 78 billion gallons (1.8 billion barrels) of gasoline.

TABLE III.F.1–2—PROJECTED NET GHG REDUCTIONS

[$MMTCO_2eq$ per year]

Model year	Lifetime GHG reduction ($MMT\ CO_2$ EQ)	Lifetime Fuel savings (billion gallons)
2012	88.9	7.3
2013	130.2	10.5
2014	174.2	13.9
2015	244.2	19.5
2016	324.6	26.5
Total Program Benefit	962.0	77.7

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 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 25.0 $MMTCO_2eq$ 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 vehicle GHG standards are attributed solely to this rebound effect.

TABLE III.F.1–3—GHG IMPACT OF 10% VMT REBOUND [a]

[$MMTCO_2eq$ per year]

	2020	2030	2040	2050
Total GHG Increase	13.0	25.0	32.9	41.9
Tailpipe & Indirect A/C CO_2	*10.2*	*19.6*	*25.8*	*32.8*
Upstream GHGs [b]	*2.8*	*5.4*	*7.1*	*9.1*
Tailpipe CH_4	*0.0*	*0.0*	*0.0*	*0.0*
Tailpipe N_2O	*0.0*	*0.1*	*0.1*	*0.1*

[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 GHG emission standards. 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 253 g/mile CO_2eq (4%), and 230 g/mile CO_2eq (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 RIA Chapter 5. EPA's assessment of these alternative standards, including our response to public comments, is discussed in Section III.D.

TABLE III.F.1–4—CALENDAR YEAR IMPACTS OF ALTERNATIVE SCENARIOS

	Scenario	Calendar year			
		CY 2020	CY 2030	CY 2040	CY 2050
Total GHG Reductions ($MMT\ CO_2$ eq)	Primary	−156.4	−307.0	−401.5	−505.8
	4%	−141.9	−286.2	−375.4	−472.9
	6%	−202.6	−403.4	−529.3	−668.7
Fuel Savings (Billion Gallons Gasoline Equivalent)	Primary	−12.6	−24.7	−32.6	−41.5
	4%	−11.3	−22.9	−30.3	−38.6
	6%	−16.7	−33.2	−43.9	−55.9

[296] As detailed in the RIA Chapter 5 and TSD Chapter 4, for this analysis the full life of the vehicle is represented by average lifetime mileages for cars (195,000 miles) and trucks (226,000 miles) averaged over calendar years 2012 through 2030, a function of how far vehicles drive per year and scrappage rates.

TABLE III.F.1–5—MODEL YEAR IMPACTS OF ALTERNATIVE SCENARIOS

	Scenario	Model year lifetime					
		MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
Total GHG Reductions (MMT CO_2 eq)	Primary	−88.8	−130.2	−174.2	−244.2	−324.6	−962.0
	4%	−39.9	−96.6	−155.4	−226.5	−303.6	−822.0
	6%	−61.7	−146.5	−237.0	−332.2	−427.6	−1,204.9
Fuel Savings (Billion Gallons Gasoline Equivalent).	Primary	−7.3	−10.5	−13.9	−19.5	−26.5	−77.7
	4%	−2.9	−7.1	−12.2	−18.0	−24.6	−64.8
	6%	−4.9	−12.0	−19.4	−27.3	−35.6	−99.1

2. Overview of Climate Change Impacts From GHG Emissions

Once emitted, GHGs that are the subject of this regulation can remain in the atmosphere for decades to centuries, meaning that (1) their concentrations become well-mixed throughout the global atmosphere regardless of emission origin, and (2) their effects on climate are long lasting. GHG emissions come mainly from the combustion of fossil fuels (coal, oil, and gas), with additional contributions from the clearing of forests and agricultural activities. The transportation sector represents a significant portion, 28%, of U.S. GHG emissions.[297]

This section provides a summary of observed and projected changes in GHG emissions and associated climate change impacts. The source document for the section below is the Technical Support Document (TSD)[298] for EPA's Endangerment and Cause or Contribute Findings Under the Clean Air Act.[299] Below is the Executive Summary of the TSD which provides technical support for the endangerment and cause or contribute analyses concerning GHG emissions under section 202(a) of the Clean Air Act. The TSD reviews observed and projected changes in climate based on current and projected atmospheric GHG concentrations and emissions, as well as the related impacts and risks from climate change that are projected in the absence of GHG mitigation actions, including this action and other U.S. and global actions. The TSD was updated and revised based on expert technical review and public comment as part of EPA's rulemaking process for the final Endangerment Findings. The key findings synthesized here and the information throughout the TSD are primarily drawn from the assessment reports of the Intergovernmental Panel on Climate Change (IPCC), the U.S. Climate Change Science Program (CCSP), the U.S. Global Change Research Program (USGCRP), and the National Research Council (NRC).[300]

a. Observed Trends in Greenhouse Gas Emissions and Concentrations

The primary long-lived GHGs directly emitted by human activities include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Greenhouse gases have a warming effect by trapping heat in the atmosphere that would otherwise escape to space. In 2007, U.S. GHG emissions were 7,150 teragrams[301] of CO_2 equivalent[302] ($TgCO_2eq$). The dominant gas emitted is CO_2, mostly from fossil fuel combustion. Methane is the second largest component of U.S. emissions, followed by N_2O and the fluorinated gases (HFCs, PFCs, and SF_6). Electricity generation is the largest emitting sector (34% of total U.S. GHG emissions), followed by transportation (28%) and industry (19%).

Transportation sources under Section 202(a)[303] of the Clean Air Act (passenger cars, light duty trucks, other trucks and buses, motorcycles, and passenger cooling) emitted 1,649 $TgCO_2eq$ in 2007, representing 23% of total U.S. GHG emissions. U.S. transportation sources under Section 202(a) made up 4.3% of total global GHG emissions in 2005,[304] which, in addition to the United States as a whole, ranked only behind total GHG emissions from China, Russia, and India but ahead of Japan, Brazil, Germany, and the rest of the world's countries. In 2005, total U.S. GHG emissions were responsible for 18% of global emissions, ranking only behind China, which was responsible for 19% of global GHG emissions. The scope of this action focuses on GHG emissions under Section 202(a) from passenger cars and light duty trucks source categories (see Section III.F.1).

The global atmospheric CO_2 concentration has increased about 38% from pre-industrial levels to 2009, and almost all of the increase is due to anthropogenic emissions. The global atmospheric concentration of CH_4 has increased by 149% since pre-industrial levels (through 2007); and the N_2O concentration has increased by 23% (through 2007). The observed concentration increase in these gases can also be attributed primarily to anthropogenic emissions. The industrial fluorinated gases, HFCs, PFCs, and SF_6, have relatively low atmospheric concentrations but the total radiative forcing due to these gases is increasing rapidly; these gases are almost entirely anthropogenic in origin.

Historic data show that current atmospheric concentrations of the two most important directly emitted, long-lived GHGs (CO_2 and CH_4) are well above the natural range of atmospheric concentrations compared to at least the last 650,000 years. Atmospheric GHG concentrations have been increasing because anthropogenic emissions have been outpacing the rate at which GHGs are removed from the atmosphere by

[297] U.S. EPA (2009) *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007.* EPA–430–R–09–004, Washington, DC.

[298] "Technical Support Document for Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act." Docket: EPA–HQ–OAR–2009–0472–11292.

[299] *See* 74 FR 66496 (Dec. 15, 2009).

[300] For a complete list of core references from IPCC, USGCRP/CCSP, NRC and others relied upon for development of the TSD for EPA's Endangerment and Cause or Contribute Findings *see* section 1(b), specifically, Table 1.1 of the TSD.

[301] One teragram (Tg) = 1 million metric tons. 1 metric ton = 1,000 kilograms = 1.102 short tons = 2,205 pounds.

[302] Long-lived GHGs are compared and summed together on a CO_2-equivalent basis by multiplying each gas by its global warming potential (GWP), as estimated by IPCC. In accordance with United Nations Framework Convention on Climate Change (UNFCCC) reporting procedures, the U.S. quantifies GHG emissions using the 100-year timeframe values for GWPs established in the IPCC Second Assessment Report.

[303] Source categories under Section 202(a) of the Clean Air Act are a subset of source categories considered in the transportation sector and do not include emissions from non-highway sources such as boats, rail, aircraft, agricultural equipment, construction/mining equipment, and other off-road equipment.

[304] More recent emission data are available for the United States and other individual countries, but 2005 is the most recent year for which data for all countries and all gases are available.

natural processes over timescales of decades to centuries.

b. Observed Effects Associated With Global Elevated Concentrations of GHGs

Current ambient air concentrations of CO_2 and other GHGs remain well below published exposure thresholds for any direct adverse health effects, such as respiratory or toxic effects.

The global average net effect of the increase in atmospheric GHG concentrations, plus other human activities (*e.g.,* land-use change and aerosol emissions), on the global energy balance since 1750 has been one of warming. This total net heating effect, referred to as forcing, is estimated to be +1.6 (+0.6 to +2.4) watts per square meter (W/m^2), with much of the range surrounding this estimate due to uncertainties about the cooling and warming effects of aerosols. However, as aerosol forcing has more regional variability than the well-mixed, long-lived GHGs, the global average might not capture some regional effects. The combined radiative forcing due to the cumulative (*i.e.,* 1750 to 2005) increase in atmospheric concentrations of CO_2, CH_4, and N_2O is estimated to be +2.30 (+2.07 to +2.53) W/m^2. The rate of increase in positive radiative forcing due to these three GHGs during the industrial era is very likely to have been unprecedented in more than 10,000 years.

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Global mean surface temperatures have risen by 1.3 ± 0.32 °F (0.74 °C ± 0.18 °C) over the last 100 years. Eight of the 10 warmest years on record have occurred since 2001. Global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries.

Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations. Climate model simulations suggest natural forcing alone (*i.e.,* changes in solar irradiance) cannot explain the observed warming.

U.S. temperatures also warmed during the 20th and into the 21st century; temperatures are now approximately 1.3 °F (0.7 °C) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. Both the IPCC [305] and the CCSP reports attributed recent North American warming to elevated GHG concentrations. In the CCSP (2008) report,[306] the authors find that for North America, "more than half of this warming [for the period 1951–2006] is likely the result of human-caused greenhouse gas forcing of climate change."

Observations show that changes are occurring in the amount, intensity, frequency and type of precipitation. Over the contiguous United States, total annual precipitation increased by 6.1% from 1901 to 2008. It is likely that there have been increases in the number of heavy precipitation events within many land regions, even in those where there has been a reduction in total precipitation amount, consistent with a warming climate.

There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate. It is not clear whether the increasing rate of sea level rise is a reflection of short-term variability or an increase in the longer-term trend. Nearly all of the Atlantic Ocean shows sea level rise during the last 50 years with the rate of rise reaching a maximum (over 2 millimeters [mm] per year) in a band along the U.S. east coast running east-northeast.

Satellite data since 1979 show that annual average Arctic sea ice extent has shrunk by 4.1% per decade. The size and speed of recent Arctic summer sea ice loss is highly anomalous relative to the previous few thousands of years.

Widespread changes in extreme temperatures have been observed in the last 50 years across all world regions, including the United States. Cold days, cold nights, and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent.

Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. However, directly attributing specific regional changes in climate to emissions of GHGs from human activities is difficult, especially for precipitation.

Ocean CO_2 uptake has lowered the average ocean pH (increased acidity) level by approximately 0.1 since 1750. Consequences for marine ecosystems can include reduced calcification by shell-forming organisms, and in the longer term, the dissolution of carbonate sediments.

Observations show that climate change is currently affecting U.S. physical and biological systems in significant ways. The consistency of these observed changes in physical and biological systems and the observed significant warming likely cannot be explained entirely due to natural variability or other confounding non-climate factors.

c. Projections of Future Climate Change With Continued Increases in Elevated GHG Concentrations

Most future scenarios that assume no explicit GHG mitigation actions (beyond those already enacted) project increasing global GHG emissions over the century, with climbing GHG concentrations. Carbon dioxide is expected to remain the dominant anthropogenic GHG over the course of the 21st century. The radiative forcing associated with the non-CO_2 GHGs is still significant and increasing over time.

Future warming over the course of the 21st century, even under scenarios of low-emission growth, is very likely to be greater than observed warming over the past century. According to climate model simulations summarized by the IPCC,[307] through about 2030, the global warming rate is affected little by the choice of different future emissions scenarios. By the end of the 21st century, projected average global warming (compared to average temperature around 1990) varies significantly depending on the emission scenario and climate sensitivity assumptions, ranging from 3.2 to 7.2 °F (1.8 to 4.0 °C), with an uncertainty range of 2.0 to 11.5 °F (1.1 to 6.4 °C).

All of the United States is very likely to warm during this century, and most areas of the United States are expected to warm by more than the global

[305] Hegerl, G.C. et al. (2007) Understanding and Attributing Climate Change. In: *Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[306] CCSP (2008) *Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Randall Dole, Martin Hoerling, and Siegfried Schubert (eds.)]. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC, 156 pp.

[307] Meehl, G.A. *et al.* (2007) Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

average. The largest warming is projected to occur in winter over northern parts of Alaska. In western, central and eastern regions of North America, the projected warming has less seasonal variation and is not as large, especially near the coast, consistent with less warming over the oceans.

It is very likely that heat waves will become more intense, more frequent, and longer lasting in a future warm climate, whereas cold episodes are projected to decrease significantly.

Increases in the amount of precipitation are very likely in higher latitudes, while decreases are likely in most subtropical latitudes and the southwestern United States, continuing observed patterns. The mid-continental area is expected to experience drying during summer, indicating a greater risk of drought.

Intensity of precipitation events is projected to increase in the United States and other regions of the world. More intense precipitation is expected to increase the risk of flooding and result in greater runoff and erosion that has the potential for adverse water quality effects.

It is likely that hurricanes will become more intense, with stronger peak winds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures. Frequency changes in hurricanes are currently too uncertain for confident projections.

By the end of the century, global average sea level is projected by IPCC [308] to rise between 7.1 and 23 inches (18 and 59 centimeter [cm]), relative to around 1990, in the absence of increased dynamic ice sheet loss. Recent rapid changes at the edges of the Greenland and West Antarctic ice sheets show acceleration of flow and thinning. While an understanding of these ice sheet processes is incomplete, their inclusion in models would likely lead to increased sea level projections for the end of the 21st century.

Sea ice extent is projected to shrink in the Arctic under all IPCC emissions scenarios.

d. Projected Risks and Impacts Associated With Future Climate Change

Risk to society, ecosystems, and many natural Earth processes increase with increases in both the rate and magnitude of climate change. Climate warming may increase the possibility of large, abrupt regional or global climatic events (*e.g.,* disintegration of the Greenland Ice Sheet or collapse of the West Antarctic Ice Sheet). The partial deglaciation of Greenland (and possibly West Antarctica) could be triggered by a sustained temperature increase of 2 to 7 °F (1 to 4 °C) above 1990 levels. Such warming would cause a 13 to 20 feet (4 to 6 meter) rise in sea level, which would occur over a time period of centuries to millennia.

The CCSP [309] reports that climate change has the potential to accentuate the disparities already evident in the American health care system, as many of the expected health effects are likely to fall disproportionately on the poor, the elderly, the disabled, and the uninsured. The IPCC [310] states with very high confidence that climate change impacts on human health in U.S. cities will be compounded by population growth and an aging population.

Severe heat waves are projected to intensify in magnitude and duration over the portions of the United States where these events already occur, with potential increases in mortality and morbidity, especially among the elderly, young, and frail.

Some reduction in the risk of death related to extreme cold is expected. It is not clear whether reduced mortality from cold will be greater or less than increased heat-related mortality in the United States due to climate change.

Increases in regional ozone pollution relative to ozone levels without climate change are expected due to higher temperatures and weaker circulation in the United States and other world cities relative to air quality levels without climate change. Climate change is expected to increase regional ozone pollution, with associated risks in respiratory illnesses and premature death. In addition to human health effects, tropospheric ozone has significant adverse effects on crop yields, pasture and forest growth, and species composition. The directional effect of climate change on ambient particulate matter levels remains uncertain.

Within settlements experiencing climate change, certain parts of the population may be especially vulnerable; these include the poor, the elderly, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources. Thus, the potential impacts of climate change raise environmental justice issues.

The CCSP [311] concludes that, with increased CO_2 and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable. Furthermore, the marketable yield of many horticultural crops (*e.g.,* tomatoes, onions, fruits) is very likely to be more sensitive to climate change than grain and oilseed crops.

Higher temperatures will very likely reduce livestock production during the summer season in some areas, but these losses will very likely be partially offset by warmer temperatures during the winter season.

Cold-water fisheries will likely be negatively affected; warm-water fisheries will generally benefit; and the results for cool-water fisheries will be mixed, with gains in the northern and losses in the southern portions of ranges.

Climate change has very likely increased the size and number of forest fires, insect outbreaks, and tree mortality in the interior West, the Southwest, and Alaska, and will continue to do so. Over North America, forest growth and productivity have been observed to increase since the middle of the 20th century, in part due to observed climate change. Rising CO_2 will very likely increase photosynthesis for forests, but the increased photosynthesis will likely only increase wood production in young forests on fertile soils. The combined effects of expected increased temperature, CO_2, nitrogen deposition, ozone, and forest

[308] IPCC (2007) Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[309] Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson (2008) Effects of Global Change on Human Health. In: *Analyses of the effects of global change on human health and welfare and human systems.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, pp. 2–1 to 2–78.

[310] Field, C.B. et al. (2007) North America. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[311] Backlund, P., A. Janetos, D.S. Schimel, J. Hatfield, M.G. Ryan, S.R. Archer, and D. Lettenmaier (2008) Executive Summary. In: *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC., USA, 362 pp.

disturbance on soil processes and soil carbon storage remain unclear.

Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution. Sea level is rising along much of the U.S. coast, and the rate of change will very likely increase in the future, exacerbating the impacts of progressive inundation, storm-surge flooding, and shoreline erosion. Storm impacts are likely to be more severe, especially along the Gulf and Atlantic coasts. Salt marshes, other coastal habitats, and dependent species are threatened by sea level rise, fixed structures blocking landward migration, and changes in vegetation. Population growth and rising value of infrastructure in coastal areas increases vulnerability to climate variability and future climate change.

Climate change will likely further constrain already overallocated water resources in some regions of the United States, increasing competition among agricultural, municipal, industrial, and ecological uses. Although water management practices in the United States are generally advanced, particularly in the West, the reliance on past conditions as the basis for current and future planning may no longer be appropriate, as climate change increasingly creates conditions well outside of historical observations. Rising temperatures will diminish snowpack and increase evaporation, affecting seasonal availability of water. In the Great Lakes and major river systems, lower water levels are likely to exacerbate challenges relating to water quality, navigation, recreation, hydropower generation, water transfers, and binational relationships. Decreased water supply and lower water levels are likely to exacerbate challenges relating to aquatic navigation in the United States.

Higher water temperatures, increased precipitation intensity, and longer periods of low flows will exacerbate many forms of water pollution, potentially making attainment of water quality goals more difficult. As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to warmer water. In the long term, warmer water and changing flow may result in deterioration of aquatic ecosystems.

Ocean acidification is projected to continue, resulting in the reduced biological production of marine calcifiers, including corals.

Climate change is likely to affect U.S. energy use and energy production and physical and institutional infrastructures. It will also likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements, particularly in Alaska where indigenous communities are facing major environmental and cultural impacts. The U.S. energy sector, which relies heavily on water for hydropower and cooling capacity, may be adversely impacted by changes to water supply and quality in reservoirs and other water bodies. Water infrastructure, including drinking water and wastewater treatment plants, and sewer and stormwater management systems, will be at greater risk of flooding, sea level rise and storm surge, low flows, and other factors that could impair performance.

Disturbances such as wildfires and insect outbreaks are increasing in the United States and are likely to intensify in a warmer future with warmer winters, drier soils, and longer growing seasons. Although recent climate trends have increased vegetation growth, continuing increases in disturbances are likely to limit carbon storage, facilitate invasive species, and disrupt ecosystem services.

Over the 21st century, changes in climate will cause species to shift north and to higher elevations and fundamentally rearrange U.S. ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will alter ecosystem structure, function, and services.

Climate change impacts will vary in nature and magnitude across different regions of the United States.

- Sustained high summer temperatures, heat waves, and declining air quality are projected in the Northeast,[312] Southeast,[313] Southwest,[314] and Midwest.[315] Projected climate change would continue to cause loss of sea ice, glacier retreat, permafrost thawing, and coastal erosion in Alaska.
- Reduced snowpack, earlier spring snowmelt, and increased likelihood of seasonal summer droughts are projected in the Northeast, Northwest,[316] and Alaska. More severe, sustained droughts and water scarcity are projected in the Southeast, Great Plains,[317] and Southwest.
- The Southeast, Midwest, and Northwest in particular are expected to be impacted by an increased frequency of heavy downpours and greater flood risk.
- Ecosystems of the Southeast, Midwest, Great Plains, Southwest, Northwest, and Alaska are expected to experience altered distribution of native species (including local extinctions), more frequent and intense wildfires, and an increase in insect pest outbreaks and invasive species.
- Sea level rise is expected to increase storm surge height and strength, flooding, erosion, and wetland loss along the coasts, particularly in the Northeast, Southeast, and islands.
- Warmer water temperatures and ocean acidification are expected to degrade important aquatic resources of islands and coasts such as coral reefs and fisheries.
- A longer growing season, low levels of warming, and fertilization effects of carbon dioxide may benefit certain crop species and forests, particularly in the Northeast and Alaska. Projected summer rainfall increases in the Pacific islands may augment limited freshwater supplies. Cold-related mortality is projected to decrease, especially in the Southeast. In the Midwest in particular, heating oil demand and snow-related traffic accidents are expected to decrease.

Climate change impacts in certain regions of the world may exacerbate problems that raise humanitarian, trade, and national security issues for the United States. The IPCC[318] identifies the most vulnerable world regions as the Arctic, because of the effects of high rates of projected warming on natural systems; Africa, especially the sub-Saharan region, because of current low adaptive capacity as well as climate change; small islands, due to high exposure of population and infrastructure to risk of sea level rise

[312] Northeast includes West Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine.

[313] Southeast includes Kentucky, Virginia, Arkansas, Tennessee, North Carolina, South Carolina, southeast Texas, Louisiana, Mississippi, Alabama, Georgia, and Florida.

[314] Southwest includes California, Nevada, Utah, western Colorado, Arizona, New Mexico (except the extreme eastern section), and southwest Texas.

[315] The Midwest includes Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio, and Missouri.

[316] The Northwest includes Washington, Idaho, western Montana, and Oregon.

[317] The Great Plains includes central and eastern Montana, North Dakota, South Dakota, Wyoming, Nebraska, eastern Colorado, Nebraska, Kansas, extreme eastern New Mexico, central Texas, and Oklahoma.

[318] Parry, M.L. *et al.* (2007) Technical Summary. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)], Cambridge University Press, Cambridge, United Kingdom, pp. 23–78.

and increased storm surge; and Asian mega-deltas, such as the Ganges-Brahmaputra and the Zhujiang, due to large populations and high exposure to sea level rise, storm surge and river flooding. Climate change has been described as a potential threat multiplier with regard to national security issues.

3. Changes in Global Climate Indicators Associated With the Rule's GHG Emissions Reductions

EPA examined [319] the reductions in CO_2 and other GHGs associated with this action and analyzed the projected effects on global mean surface temperature and sea level, two common indicators of climate change. The analysis projects that this action 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 commenter agreed that the modeling results showed small, but quantifiable, reductions in the global atmospheric CO_2 concentration, as well as a reduction in projected global mean surface temperature and sea level rise, from implementation of this action, across all climate sensitivities. As such, the commenter encourages the agencies to move forward with this action while continuing to develop additional, more stringent vehicle standards beyond 2016.

Another commenter indicated that the projected changes in climate impacts resulting from this action are small and therefore not meaningful. EPA disagrees with this view as the reductions may be small in overall magnitude, but in the global climate change context, they are quantifiable showing a clear directional signal across a range of climate sensitivities.[320] [321] EPA therefore determines that the projected reductions in atmospheric CO_2, global mean temperature and sea level rise are meaningful in the context of this rule. EPA addresses this point further in the Response to Comments document. For the final rule, EPA provides an additional climate change impact analysis for projected changes in ocean pH in the context of this action. In addition, EPA updated the modeling analysis based on the revised GHG emission reductions provided in Section III.F.1; however, the change in modeling results was very small in magnitude. Based on the reanalysis the results for projected atmospheric CO_2 concentrations are estimated to be reduced by an average of 2.9 ppm (previously 3.0 ppm), global mean temperature is estimated to be reduced by 0.006 to 0.015 °C by 2100 (previously 0.007 to 0.016 °C) and sea-level rise is projected to be reduced by approximately 0.06–0.14cm by 2100 (previously 0.06–0.15cm).

a. Estimated Projected Reductions in Atmospheric CO_2 Concentration, Global Mean Surface Temperatures Sea Level Rise and Ocean pH

EPA estimated changes in the atmospheric CO_2 concentration, global mean surface temperature and sea level to 2100 resulting from the emissions reductions in this action 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.1 were applied as net reductions to a peer reviewed global reference case (or baseline) emissions scenario to generate an emissions scenario specific to this action. For the scenario related to this action, 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 for 2020 and then continuing to 2100. Details about the reference case scenario and how the emissions reductions were applied to generate the scenario can be found in the RIA Chapter 7.

Changes in atmospheric CO_2 concentration, temperature, and sea-level for both the reference case and the emissions scenarios associated with this action were computed using MAGICC. To compute the reductions in the atmospheric CO_2 concentrations as well as in temperature and sea level resulting from this action, the output from the scenario associated with this final rule was subtracted from an existing Global Change Assessment Model (GCAM, formerly MiniCAM) reference emission scenario. To capture some key uncertainties in the climate system with the MAGICC model, changes in 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).[322] 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 RIA Chapter 7.4.

The results of this modeling, summarized in Table III.F.3–1, show small, but quantifiable, reductions in atmospheric CO_2 concentrations, projected global mean surface temperature and sea level resulting from this action, across all climate sensitivities. As a result of the emission reductions from this action, the atmospheric CO_2 concentration is projected to be reduced by an average of 2.9 parts per million (ppm), the global mean temperature is projected to be reduced by approximately 0.006–0.015°C by 2100, and global mean sea level rise is projected to be reduced by approximately 0.06–0.14cm 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 this rule and therefore does not come from previously published work. Further discussion of EPA's modeling analysis is found in the final RIA.

[319] 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 RIA for additional information.

[320] The National Research Council (NRC) 2001 study, *Climate Change Science: An Analysis of Some Key Questions,* defines climate sensitivity as the sensitivity of the climate system to a forcing is commonly expressed in terms of the global mean temperature change that would be expected after a time sufficiently long enough for both the atmosphere and ocean to come to equilibrium with the change in climate forcing.

[321] To capture some of the uncertainty in the climate system, the changes in atmospheric CO_2, projected temperatures and sea level were estimated across the most current Intergovernmental Panel on Climate Change (IPCC) range of climate sensitivities, 1.5 °C to 6.0 °C.

[322] 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/.*

TABLE III.F.3–1—EFFECT OF GHG EMISSIONS REDUCTIONS ON PROJECTED CHANGES IN GLOBAL CLIMATE FOR THE FINAL VEHICLES RULEMAKING

[For climate sensitivities ranging from 1.5–6 °C]

Measure	Units	Year	Projected change
Atmospheric CO_2 Concentration	ppm	2100	−2.7–3.1
Global Mean Surface Temperature	°C	2100	−0.006–0.015
Sea Level Rise	Cm	2100	−0.06–0.14
Ocean pH	pH units	2100	0.0014

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 action) across all climate sensitivities.

The IPCC [323] has noted that ocean acidification due to the direct effects of elevated CO_2 concentrations will impair a wide range of planktonic and other marine organisms that use aragonite to make their shells or skeletons. EPA used the Program CO2SYS,[324] version 1.05 to estimate projected changes in tropical ocean pH based on the atmospheric CO_2 concentration reductions resulting from this action and other specified input conditions (*e.g.,* sea surface temperature characteristic of tropical waters). The program performs calculations relating parameters of the carbon dioxide (CO_2) system in seawater. EPA used the program to calculate ocean pH as a function of atmospheric CO_2, among other specified input conditions. Based on the projected atmospheric CO_2 concentration reductions (average of 2.9 ppm by 2100) that would result from this rule, the program calculates an increase in ocean pH of about 0.0014 pH units in 2100. Thus, this analysis indicates the projected decrease in atmospheric CO_2 concentrations from today's rule would result in an increase in ocean pH.

[323] Fischlin, A. *et al.* (2007) Ecosystems, their Properties, Goods, and Services. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[324] Lewis, E., and D. W. R. Wallace. 1998. Program Developed for CO_2 System Calculations. ORNL/CDIAC–105. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee.

EPA's analysis of the rule's effect on global climate conditions is intended to quantify these potential reductions using the best available science. While EPA's modeling results of the effect of this rule alone show small differences in climate effects (CO_2 concentration, temperature, sea-level rise, ocean pH), when expressed in terms of global climate endpoints and global GHG emissions, they yield results that are repeatable and consistent within the modeling frameworks used.

G. How will the standards impact non-GHG emissions and their associated effects?

In addition to reducing the emissions of greenhouse gases, this rule will 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 (PM2.5), 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 GHG 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) and the effects of our assumptions about ethanol-blended fuel (E10), as discussed below. 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 in the proposal, for this analysis we attribute decreased fuel consumption from this program to gasoline only, while assuming no effect on volumes of ethanol and other renewable fuels because they are mandated under the Renewable Fuel Standard (RFS2). However, because this rule does not assume RFS2 volumes of ethanol in the baseline, the result is a greater projected market share of E10 in the control case.[325] In fact, the GHG standards will not be affecting the market share of E10, because EPA's analysis for the RFS2 rule predicts 100% E10 penetration by 2014.[326]

The amount of E10 affects downstream non-GHG emissions. In the proposal, EPA stated these same fuel assumptions and qualitatively noted that there were likely unquantified impacts on non-GHG emissions between the two cases. In DRIA Chapter 5, EPA indicated its plans to quantify these impacts in the air quality modeling and in the final rule inventories. Upstream emission impacts depend only on fuel volumes, so the impacts presented here reflect only the reduced gasoline consumption.

The inventories presented in this rulemaking include an analysis of these fuel effects which was conducted using EPA's Motor Vehicle Emission Simulator (MOVES2010). The most notable impact, although still relatively slight, is a 2.2 percent increase in 2030 in national acetaldehyde emissions over the baseline scenario. It should be noted that these emission impacts are not due to the new GHG vehicle standards. These impacts are instead a consequence of the assumed ethanol volumes. This program does not mandate an increase in E10, nor any particular fuel blend. The emission impact of this shift was also modeled in the RFS2 rule.

As shown in Table III.G–1, EPA estimates that this program would result in reductions of NO_X, VOC, PM and

[325] When this rule's analysis was initiated, the RFS2 rule was not yet final. Therefore, it assumes the ethanol volumes in Annual Energy Outlook 2007 (U.S. Energy Information Administration, Annual Energy Outlook 2007, Transportation Demand Sector Supplemental Table. *http://www.eia.doe.gov/oiaf/archive/aeo07/supplement/index.html*)

[326] EPA 2010, Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis. EPA–420–R–10–006. February 2010. Docket EPA–HQ–OAR–2009–0472–11332. *See* also 75 FR 14670, March 26, 2010.

SO_X, but would increase CO emissions. For NO_X, VOC, and PM we estimate net reductions because the emissions reductions from upstream sources are larger than the emission increases due to downstream sources. In the case of CO, we estimate slight emission increases, because there are relatively small reductions in upstream emissions, and thus the projected downstream emission increases are greater than the projected emission decreases due to reduced fuel production. For SO_X, downstream emissions are roughly proportional to fuel consumption, therefore a decrease is seen in both upstream and downstream sources.

For all criteria 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 program would reduce total NO_X, PM and SO_X inventories by 0.1 to 0.8 percent and reduce the VOC inventory by 1.0 percent, while increasing the total national CO inventory by 0.6 percent.

As shown in Table III.G–2, EPA estimates that the GHG program would result in small changes for air toxic emissions compared to total U.S. inventories across all sectors. In 2030, EPA estimates the program would reduce total benzene and 1,3 butadiene emissions by 0.1 to 0.3 percent. Total acrolein and formaldehyde emissions would increase by 0.1 percent. Acetaldehyde emissions would increase by 2.2 percent.

One commenter requested that EPA present emission inventories for additional air toxics. EPA is presenting inventories for certain air toxic emissions which were identified as key national and regional-scale cancer and noncancer risk drivers in past National Air Toxics Assessments (NATA). For additional details, please refer to the Response to Comments document.[327]

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. EPA does not project increased penetration of diesels as necessary to meet the GHG standards.
- Early introduction of electric vehicles and plug-in hybrid electric vehicles, which would reduce criteria emissions in cases where those vehicles are able to be certified to lower certification standards. This 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 rule.

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	−60,187	−115,542	*−64,506*	*−126,749*	*4,318*	*11,207*
% of total inventory	−0.51%	−1.01%	*−0.55%*	*−1.11%*	*0.04%*	*0.01%*
CO	3,992	170,675	*−6,165*	*−12,113*	*10,156*	*182,788*
% of total inventory	0.01%	0.56%	*−0.02%*	*−0.04%*	*0.01%*	*0.6%*
NO_X	−5,881	−21,763	*−19,291*	*−37,905*	*13,410*	*16,143*
% of total inventory	−0.02	−0.07%	*−0.06%*	*−0.12%*	*0.04%*	*0.05%*
$PM_{2.5}$	−2,398	−4,564	*−2,629*	*−5,165*	*231.0*	*602.3*
% of total inventory	−0.03%	−0.05%	*−0.03%*	*−0.06%*	*0.00%*	*0.01%*
SO_X	−13,832	−27,443	*−11,804*	*−23,194*	*−2,027*	*−4,249*
% of total inventory	−0.41%	−0.82%	*−0.35%*	*−0.69%*	*−0.06%*	*−0.13%*

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	−95	−21	−1.5	−3.0	−93.6	−18.1
% of total inventory	−0.38%	−0.10%	−0.01%	−0.01%	−0.37%	−0.09%
Acetaldehyde	760	668	−6.8	−13.4	766.9	681.5
% of total inventory	2.26%	2.18%	−0.02%	−0.04%	2.28%	2.22%
Acrolein	1	5	−0.9	−1.8	1.7	6.5
% of total inventory	0.01%	0.07%	−0.01%	−0.03%	0.03%	0.10%
Benzene	−890	−523	−139.6	−274.3	−750.0	−248.3
% of total inventory	−0.48%	−0.29%	−0.08%	−0.15%	−0.40%	−0.14%
Formaldehyde	−49	15	−51.4	−101.0	2.1	116.3
% of total inventory	−0.06%	0.02%	−0.06%	−0.12%	0.00%	0.14%

[327] U.S. EPA. National Air Toxics Assessment. 2002, 1999, and 1996. Available at: *http://www.epa.gov/nata/*.

1. Upstream Impacts of Program

No substantive comments were received on the upstream inventory modeling used in the proposal. The rulemaking inventories were updated with the revised estimates of fuel savings as detailed in Section III.F.

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 127,000 tons, NO_X by 38,000 tons, and $PM_{2.5}$ by 5,000 tons. Table III.G–2 shows the corresponding impacts on upstream air toxic emissions in 2030. Formaldehyde decreases by 101 tons, benzene by 274 tons, acetaldehyde by 13 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,[328] but in some cases the GREET values were modified or updated by EPA to be consistent with the National Emission Inventory (NEI).[329] 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 formaldehyde. The development of these emission factors is detailed in RIA Chapter 5.

2. Downstream Impacts of Program

No substantive comments were received on the emission modeling or emission inventories presented in this section. However, two changes in modeling differentiate the analysis presented here from that presented in the proposal. Economic inputs such as fuel prices and vehicle sales were updated from AEO 2009 to AEO 2010 Early Release, and as described above, the effects of ethanol volume assumptions were explicitly modeled. Thus, the primary differences in non-GHG emissions between the proposed rule and final rule are attributed more to these changes in analytic inputs, and less to changes in the GHG standards program.

Downstream emission impacts attributable to this program are due to the VMT rebound effect and the ethanol volume assumptions. 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 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 approximately a 1 percent increase in VMT.

As detailed in the introduction to this section, fuel composition also has effects on vehicle emissions and particularly air toxics. The relationship between fuel composition and emission impacts used in MOVES2010 and applied in this analysis match those developed for the recent Renewable Fuels Standard (RFS2) requirement, and are extensively documented in the RFS2 RIA and supporting documents.[330]

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 impacts from the rebound effect and the change in fuel supply grow over time as the fleet turns over to cleaner CO_2 vehicles, so that by 2030 VOC would increase by 11,000 tons, NO_X by 16,000 tons, and $PM_{2.5}$ by 600 tons. Table III.G–2 shows the corresponding impacts on air toxic emissions. These impacts in 2030 include 18 fewer tons of 1,3-butadiene, 668 additional tons of acetaldehyde, 248 fewer tons of benzene, 116 additional tons of formaldehyde, and 6.5 additional tons of acrolein.

For this analysis, MOVES2010 was used to estimate base VOC, CO, NO_X, PM and air toxics emissions for both control and reference cases. Rebound emissions from light duty cars and trucks were then calculated using the OMEGA model post-processor and added to the control case. A more complete discussion of the inputs, methodology, and results is contained in RIA Chapter 5.

3. Health Effects of Non-GHG Pollutants

In this section we discuss health effects associated with exposure to some of the criteria and air toxics impacted by the vehicle standards; PM, ozone, NO_X and SO_X, CO and air toxics. No substantive comments were received on the 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 $PM_{10\text{-}2.5}$). 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

[328] 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/.*

[329] U.S. EPA. 2002 National Emissions Inventory (NEI) Data and Documentation, *http://www.epa.gov/ttn/chief/net/2002inventory.html.*

[330] EPA 2010, Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis. EPA–420–R–10–006. February 2010. Docket EPA–HQ–OAR–2009–0472–11332. *See* also 75 FR 14670, March 26, 2010.

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 Integrated Science Assessment for Particulate Matter (ISA).[331] Further discussion of health effects associated with PM can also be found in the RIA for this rule. The ISA summarizes evidence associated with $PM_{2.5}$, $PM_{10\text{-}2.5}$, and ultrafine particles (UFPs).

The ISA concludes that health effects associated with short-term exposures (hours to days) to ambient $PM_{2.5}$ include non-fatal cardiovascular effects, mortality, and respiratory effects, such as exacerbation of asthma symptoms in children and hospital admissions and emergency department visits for chronic obstructive pulmonary disease (COPD) and respiratory infections.[332] The ISA notes that long-term exposure to $PM_{2.5}$ (months to years) is associated with the development/progression of cardiovascular disease, premature mortality, and respiratory effects, including reduced lung function growth, increased respiratory symptoms, and asthma development.[333] The ISA concludes that that the currently available scientific evidence from epidemiologic, controlled human exposure studies, and toxicological studies supports that a causal association exists between short- and long-term exposures to $PM_{2.5}$ and cardiovascular effects and mortality. Furthermore, the ISA concludes that the collective evidence supports likely causal associations between short- and long-term $PM_{2.5}$ exposures and respiratory effects. The ISA also concludes that the evidence is suggestive of a causal association for reproductive and developmental effects and cancer, mutagenicity, and genotoxicity and long-term exposure to $PM_{2.5}$.[334]

For $PM_{10\text{-}2.5}$, the ISA concludes that the current evidence is suggestive of a causal relationship between short-term exposures and cardiovascular effects, such as hospitalization for ischemic heart disease. There is also suggestive evidence of a causal relationship between short-term $PM_{10\text{-}2.5}$ exposure and mortality and respiratory effects. Data are inadequate to draw conclusions regarding the health effects associated with long-term exposure to $PM_{10\text{-}2.5}$.[335]

For UFPs, the ISA concludes that there is suggestive evidence of a causal relationship between short-term exposures and cardiovascular effects, such as changes in heart rhythm and blood vessel function. It also concludes that there is suggestive evidence of association between short-term exposure to UFPs and respiratory effects. Data are inadequate to draw conclusions regarding the health effects associated with long-term exposure to UFP's.[336]

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.[337] Ground-level ozone is produced and destroyed in a cyclical set of chemical reactions, many of which are sensitive to temperature and sunlight. When ambient temperatures and sunlight levels remain high for several days and the air is relatively stagnant, ozone and its precursors can build up and result in more ozone than typically occurs on a single high-temperature day. Ozone can be transported hundreds of miles downwind from precursor emissions, resulting in elevated ozone levels even in areas with low local VOC or NO_X emissions.

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.[338] [339] 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.[340] 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

[331] U.S. EPA (2009) Integrated Science Assessment for Particulate Matter. EPA 600/R–08/139F, Docket EPA–HQ–OAR–2009–0472–11295.

[332] U.S. EPA (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, 2009. Section 2.3.1.1.

[333] U.S. EPA (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, 2009. page 2–12, Sections 7.3.1.1 and 7.3.2.1.

[334] U.S. EPA (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, 2009. Section 2.3.2.

[335] U.S. EPA (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, 2009. Section 2.3.4, Table 2–6.

[336] U.S. EPA (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, 2009. Section 2.3.5, Table 2–6.

[337] U.S. EPA (2006). Air Quality Criteria for Ozone and Related Photochemical Oxidants (Final). EPA/600/R–05/004aF–cF. Washington, DC: U.S. EPA. Docket EPA–HQ–OAR–2009–0472–0099 through –0101.

[338] 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.

[339] U.S. EPA (2007). Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper. EPA–452/R–07–003. Washington, DC, U.S. EPA. Docket EPA–HQ–OAR–2009–0472–0105 through –0106.

[340] National Research Council (NRC), 2008. *Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution.* The National Academies Press: Washington, DC Docket EPA–HQ–OAR–2009–0472–0322.

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 EPA Integrated Science Assessment (ISA) for Nitrogen Oxides.[341] The EPA has concluded that the findings of epidemiologic, controlled human exposure, and animal toxicological studies provide evidence that is sufficient to infer a likely causal relationship between respiratory effects and short-term NO_2 exposure. The ISA concludes that the strongest evidence for such a relationship comes from epidemiologic studies of respiratory effects including symptoms, emergency department visits, and hospital admissions. The ISA also draws two broad conclusions regarding airway responsiveness following NO_2 exposure. First, the ISA concludes that NO_2 exposure may enhance the sensitivity to allergen-induced decrements in lung function and increase the allergen-induced airway inflammatory response following 30-minute exposures of asthmatics to NO_2 concentrations as low as 0.26 ppm. In addition, small but significant increases in non-specific airway hyperresponsiveness were reported following 1-hour exposures of asthmatics to 0.1 ppm NO_2. Second, exposure to NO_2 has been found to enhance the inherent responsiveness of the airway to subsequent nonspecific challenges in controlled human exposure studies of asthmatic subjects. Enhanced airway responsiveness could have important clinical implications for asthmatics since transient increases in airway responsiveness following NO_2 exposure have the potential to increase symptoms and worsen asthma control. Together, the epidemiologic and experimental data sets form a plausible, consistent, and coherent description of a relationship between NO_2 exposures and an array of adverse health effects that range from the onset of respiratory symptoms to hospital admission.

Although the weight of evidence supporting a causal relationship is somewhat less certain than that associated with respiratory morbidity, NO_2 has also been linked to other health endpoints. These include all-cause (nonaccidental) mortality, hospital admissions or emergency department visits for cardiovascular disease, and decrements in lung function growth associated with chronic exposure.

iii. Health Effects of SO_2

Information on the health effects of SO_2 can be found in the EPA Integrated Science Assessment for Sulfur Oxides.[342] 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

Information on the health effects of carbon monoxide (CO) can be found in the EPA Integrated Science Assessment (ISA) for Carbon Monoxide.[343] The ISA concludes that ambient concentrations of CO are associated with a number of adverse health effects.[344] This section provides a summary of the health effects associated with exposure to ambient concentrations of CO.[345]

Human clinical studies of subjects with coronary artery disease show a decrease in the time to onset of exercise-induced angina (chest pain) and electrocardiogram changes following CO exposure. In addition, epidemiologic studies show associations between short-term CO exposure and cardiovascular morbidity, particularly increased emergency room visits and hospital admissions for coronary heart disease (including ischemic heart disease, myocardial infarction, and angina). Some epidemiologic evidence is also available for increased hospital admissions and emergency room visits for congestive heart failure and cardiovascular disease as a whole. The ISA concludes that a causal relationship is likely between short-term exposures to CO and cardiovascular morbidity. It also concludes that available data are inadequate to conclude that a causal

[341] U.S. EPA (2008). *Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (Final Report).* EPA/600/R–08/071. Washington, DC: U.S.EPA. Docket EPA–HQ–OAR–2009–0472–0350.

[342] U.S. EPA. (2008). *Integrated Science Assessment (ISA) for Sulfur Oxides—Health Criteria (Final Report).* EPA/600/R–08/047F. Washington, DC: U.S. Environmental Protection Agency. Docket EPA–HQ–OAR–2009–0472–0335.

[343] U.S. EPA, 2010. Integrated Science Assessment for Carbon Monoxide (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–09/019F, 2010. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=218686.*

[344] The ISA evaluates the health evidence associated with different health effects, assigning one of five "weight of evidence" determination: causal relationship, likely to be a causal relationship, suggestive of a causal relationship, inadequate to infer a causal relationship, and not likely to be a causal relationship. For definitions of these levels of evidence, please refer to Section 1.6 of the ISA.

[345] Personal exposure includes contributions from many sources, and in many different environments. Total personal exposure to CO includes both ambient and nonambient components; and both components may contribute to adverse health effects.

relationship exists between long-term exposures to CO and cardiovascular morbidity.

Animal studies show various neurological effects with in-utero CO exposure. Controlled human exposure studies report inconsistent neural and behavioral effects following low-level CO exposures. The ISA concludes the evidence is suggestive of a causal relationship with both short- and long-term exposure to CO and central nervous system effects.

A number of epidemiologic and animal toxicological studies cited in the ISA have evaluated associations between preterm birth and cardiac birth defects and CO exposure. The epidemiologic studies provide limited evidence of a CO-induced effect on pre-term births and birth defects, with weak evidence for a decrease in birth weight. Animal toxicological studies have found associations between perinatal CO exposure and decrements in birth weight, as well as other developmental outcomes. The ISA concludes these studies are suggestive of a causal relationship between long-term exposures to CO and developmental effects and birth outcomes.

Epidemiologic studies provide evidence of effects on respiratory morbidity such as changes in pulmonary function, respiratory symptoms, and hospital admissions associated with ambient CO concentrations. A limited number of epidemiologic studies considered copollutants such as ozone, SO_2, and PM in two-pollutant models and found that CO risk estimates were generally robust, although this limited evidence makes it difficult to disentangle effects attributed to CO itself from those of the larger complex air pollution mixture. Controlled human exposure studies have not extensively evaluated the effect of CO on respiratory morbidity. Animal studies at levels of 50–100 ppm CO show preliminary evidence of altered pulmonary vascular remodeling and oxidative injury. The ISA concludes that the evidence is suggestive of a causal relationship between short-term CO exposure and respiratory morbidity, and inadequate to conclude that a causal relationship exists between long-term exposure and respiratory morbidity.

Finally, the ISA concludes that the epidemiologic evidence is suggestive of a causal relationship between short-term exposures to CO and mortality. Epidemiologic studies provide evidence of an association between short-term exposure to CO and mortality, but limited evidence is available to evaluate cause-specific mortality outcomes associated with CO exposure. In addition, the attenuation of CO risk estimates which was often observed in copollutant models contributes to the uncertainty as to whether CO is acting alone or as an indicator for other combustion-related pollutants. The ISA also concludes that there is not likely to be a causal relationship between relevant long-term exposures to CO and mortality.

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 the class of pollutants known collectively as "air toxics".[346] 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.[347] Emissions and ambient concentrations of compounds are discussed in the RIA chapters 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.[348] [349] [350] 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.[351] [352]

A number of adverse noncancer health effects including blood disorders, such as preleukemia and aplastic anemia, have also been associated with long-term exposure to benzene.[353] [354] The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.[355] [356] In addition, recent work, including studies sponsored by the Health Effects Institute (HEI), provides evidence that biochemical responses are occurring at lower levels of benzene exposure than previously known.[357] [358] [359] [360] EPA's

[346] U.S. EPA. 2002 National-Scale Air Toxics Assessment. *http://www.epa.gov/ttn/atw/nata12002/risksum.html.* Docket EPA–HQ–OAR–2009–0472–11322.

[347] U.S. EPA. 2009. National-Scale Air Toxics Assessment for 2002. *http://www.epa.gov/ttn/atw/nata2002/.* Docket EPA–HQ–OAR–2009–0472–11321.

[348] 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.* Docket EPA–HQ–OAR–2009–0472–1659.

[349] 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. Docket EPA–HQ–OAR–2009–0472–0366.

[350] Irons, R.D.; Stillman, W.S.; Colagiovanni, D.B.; Henry, V.A. 1992. Synergistic action of the benzene metabolite hydroquinone on myelopoietic stimulating activity of granulocyte/macrophage colony-stimulating factor in vitro, Proc. Natl. Acad. Sci. 89:3691–3695. Docket EPA–HQ–OAR–2009–0472–0370.

[351] 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. Docket EPA–HQ–OAR–2009–0472–0366.

[352] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at: *http://ntp.niehs.nih.gov/go/16183.*

[353] Aksoy, M. (1989). Hematotoxicity and carcinogenicity of benzene. Environ. Health Perspect. 82: 193–197. Docket EPA–HQ–OAR–2009–0472–0368.

[354] Goldstein, B.D. (1988). Benzene toxicity. Occupational medicine. State of the Art Reviews. 3: 541–554. Docket EPA–HQ–OAR–2009–0472–0325.

[355] Rothman, N., G.L. Li, M. Dosemeci, W.E. Bechtold, G.E. Marti, Y.Z. Wang, M. Linet, L.Q. Xi, W. Lu, M.T. Smith, N. Titenko-Holland, L.P. Zhang, W. Blot, S.N. Yin, and R.B. Hayes (1996) Hematotoxicity among Chinese workers heavily exposed to benzene. Am. J. Ind. Med. 29: 236–246. Docket EPA–HQ–OAR–2009–0472–0326.

[356] 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.* Docket EPA–HQ–OAR–2009–0472–0327.

[357] Qu, O.; Shore, R.; Li, G.; Jin, X.; Chen, C.L.; Cohen, B.; Melikian, A.; Eastmond, D.; Rappaport, S.; Li, H.; Rupa, D.; Suramaya, R.; Songnian, W.; Huifant, Y.; Meng, M.; Winnik, M.; Kwok, E.; Li, Y.; Mu, R.; Xu, B.; Zhang, X.; Li, K. (2003) HEI Report 115, Validation & Evaluation of Biomarkers in Workers Exposed to Benzene in China. Docket EPA–HQ–OAR–2009–0472–0328.

[358] Qu, Q., R. Shore, G. Li, X. Jin, L.C. Chen, B. Cohen, *et al.* (2002) Hematological changes among Chinese workers with a broad range of benzene exposures. Am. J. Industr. Med. 42: 275–285. Docket EPA–HQ–OAR–2009–0472–0329.

[359] Lan, Qing, Zhang, L., Li, G., Vermeulen, R., et al. (2004) Hematotoxically in Workers Exposed to

Continued

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.[361] [362] 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.[363] [364] 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.[365]

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.[366] 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.[367] [368] 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.[369] 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.[370] 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.[371] Recently, the IARC re-classified formaldehyde as a human carcinogen (Group 1).[372]

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.[373] [374]

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.[375] Acetaldehyde is reasonably anticipated to be a human carcinogen by the U.S. DHHS in the 11th Report on Carcinogens and is classified as possibly carcinogenic to humans (Group 2B) by the IARC.[376] [377] 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.[378] In short-term (4 week) rat studies, degeneration of olfactory epithelium was observed at various concentration levels of

Low Levels of Benzene. Science 306: 1774–1776. Docket EPA–HQ–OAR–2009–0472–0330.

[360] Turtletaub, K.W. and Mani, C. (2003) Benzene metabolism in rodents at doses relevant to human exposure from Urban Air. Research Reports Health Effect Inst. Report No.113. Docket EPA–HQ–OAR–2009–0472–0385.

[361] U.S. EPA (2002) Health Assessment of 1,3-Butadiene. Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC. Report No. EPA600–P–98–001F. This document is available electronically at *http://www.epa.gov/iris/supdocs/buta-sup.pdf*. Docket EPA–HQ–OAR–2009–0472–0386.

[362] U.S. EPA (2002) Full IRIS Summary for 1,3-butadiene (CASRN 106–99–0). Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington, DC. *http://www.epa.gov/iris/subst/0139.htm*. Docket EPA–HQ–OAR–2009–0472–1660

[363] 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. Docket EPA–HQ–OAR–2009–0472–0387.

[364] 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*.

[365] Bevan, C.; Stadler, J.C.; Elliot, G.S.; *et al.* (1996) Subchronic toxicity of 4-vinylcyclohexene in rats and mice by inhalation. Fundam. Appl. Toxicol. 32:1–10. Docket EPA–HQ–OAR–2009–0472–0388.

[366] U.S. EPA (1987) Assessment of Health Risks to Garment Workers and Certain Home Residents from Exposure to Formaldehyde, Office of Pesticides and Toxic Substances, April 1987. Docket EPA–HQ–OAR–2009–0472–0389.

[367] Hauptmann, M.; Lubin, J.H.; Stewart, P.A.; Hayes, R.B.; Blair, A. 2003. Mortality from lymphohematopoetic malignancies among workers in formaldehyde industries. Journal of the National Cancer Institute 95: 1615–1623. Docket EPA–HQ–OAR–2009–0472–0336.

[368] Hauptmann, M..; Lubin, J.H.; Stewart, P.A.; Hayes, R.B.; Blair, A. 2004. Mortality from solid cancers among workers in formaldehyde industries. American Journal of Epidemiology 159: 1117–1130. Docket EPA–HQ–OAR–2009–0472–0337.

[369] Beane Freeman, L.E.; Blair, A.; Lubin, J.H.; Stewart, P.A.; Hayes, R.B.; Hoover, R.N.; Hauptmann, M. 2009. Mortality from lymphohematopoietic malignancies among workers in formaldehyde industries: The National Cancer Institute cohort. J. National Cancer Inst. 101: 751–761. Docket EPA–HQ–OAR–2009–0472–0338.

[370] Pinkerton, L.E. 2004. Mortality among a cohort of garment workers exposed to formaldehyde: an update. Occup. Environ. Med. 61: 193–200. Docket EPA–HQ–OAR–2009–0472–0339.

[371] Coggon, D, EC Harris, J Poole, KT Palmer. 2003. Extended follow-up of a cohort of British chemical workers exposed to formaldehyde. J National Cancer Inst. 95:1608–1615. Docket EPA–HQ–OAR–2009–0472–0340.

[372] 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. Docket EPA–HQ–OAR–2009–0472–1164.

[373] 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* Docket EPA–HQ–OAR–2009–0472–1191.

[374] WHO (2002) Concise International Chemical Assessment Document 40: Formaldehyde. Published under the joint sponsorship of the United Nations Environment Programme, the International Labour Organization, and the World Health Organization, and produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals. Geneva. Docket EPA–HQ–OAR–2009–0472–1199.

[375] 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*. Docket EPA–HQ–OAR–2009–0472–0390.

[376] 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*.

[377] 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. Docket EPA–HQ–OAR–2009–0472–0387.

[378] 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*.

acetaldehyde exposure.[379] [380] 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.[381] 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. 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.[382] These data and additional studies regarding acute effects of human exposure to acrolein are summarized in EPA's 2003 IRIS Human Health Assessment for acrolein.[383] Evidence available from studies in humans indicate that levels as low as 0.09 ppm (0.21 mg/m^3) for five minutes may elicit subjective complaints of eye irritation with increasing concentrations leading to more extensive eye, nose and respiratory symptoms.[384] Lesions to the lungs and upper respiratory tract of rats, rabbits, and hamsters have been observed after subchronic exposure to acrolein.[385] Acute exposure effects in animal studies report bronchial hyper-responsiveness.[386] In a recent study, the acute respiratory irritant effects of exposure to 1.1 ppm acrolein were more pronounced in mice with allergic airway disease by comparison to non-diseased mice which also showed decreases in respiratory rate.[387] Based on these animal data and demonstration of similar effects in humans (*e.g.,* reduction in respiratory rate), individuals with compromised respiratory function (*e.g.,* emphysema, asthma) are expected to be at increased risk of developing adverse responses to strong respiratory irritants such as acrolein.

EPA determined in 2003 that the human carcinogenic potential of acrolein could not be determined because the available data were inadequate. No information was available on the carcinogenic effects of acrolein in humans and the animal data provided inadequate evidence of carcinogenicity.[388] The IARC determined in 1995 that acrolein was not classifiable as to its carcinogenicity in humans.[389]

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.[390] [391] 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.[392] The draft reassessment completed external peer review.[393] Based on external peer review comments received, additional analyses are being undertaken. This external review draft does not represent official agency opinion and was released solely for the purposes of external peer review and public comment. The National Toxicology Program listed naphthalene as "reasonably anticipated to be a human carcinogen" in 2004 on the basis of bioassays reporting clear evidence of carcinogenicity in rats and some evidence of carcinogenicity in mice.[394] California EPA has released a new risk assessment for naphthalene, and the

[379] 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.

[380] Appleman, L.M., R.A. Woutersen, and V.J. Feron. 1982. Inhalation toxicity of acetaldehyde in rats. I. Acute and subacute studies. *Toxicology.* 23: 293–297. Docket EPA–HQ–OAR–2009–0472–0392.

[381] Myou, S.; Fujimura, M.; Nishi K.; Ohka, T.; and Matsuda, T. 1993. Aerosolized acetaldehyde induces histamine-mediated bronchoconstriction in asthmatics. *Am. Rev. Respir.Dis.*148(4 Pt 1): 940–3. Docket EPA–HQ–OAR–2009–0472–0408.

[382] Sim VM, Pattle RE. Effect of possible smog irritants on human subjects JAMA165: 1980–2010, 1957. Docket EPA–HQ–OAR–2009–0472–0395.

[383] U.S. EPA (U.S. Environmental Protection Agency). (2003) Toxicological review of acrolein in support of summary information on Integrated Risk Information System (IRIS) National Center for Environmental Assessment, Washington, DC. EPA/635/R–03/003. Available online at: *http://www.epa.gov/ncea/iris.*

[384] 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 Docket EPA–HQ–OAR–2009–0472–0394.

[385] Integrated Risk Information System File of Acrolein. Office of Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available at *http://www.epa.gov/iris/subst/0364.htm.* Docket EPA–HQ–OAR–2009–0472–0391.

[386] U.S. EPA (U.S. Environmental Protection Agency). (2003) Toxicological review of acrolein in support of summary information on Integrated Risk Information System (IRIS) National Center for Environmental Assessment, Washington, DC. EPA/635/R–03/003. Available online at: *http://www.epa.gov/ncea/iris.*

[387] 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. Docket EPA–HQ–OAR–2009–0472–0396.

[388] 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.*

[389] 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. Docket EPA–HQ–OAR–2009–0472–0393.

[390] Perera, F.P.; Rauh, V.; Tsai, W–Y.; *et al.* (2002) Effect of transplacental exposure to environmental pollutants on birth outcomes in a multiethnic population. *Environ Health Perspect.* 111: 201–205. Docket EPA–HQ–OAR–2009–0472–0372.

[391] Perera, F.P.; Rauh, V.; Whyatt, R.M.; Tsai, W.Y.; Tang, D.; Diaz, D.; Hoepner, L.; Barr, D.; Tu, Y.H.; Camann, D.; Kinney, P. (2006) Effect of prenatal exposure to airborne polycyclic aromatic hydrocarbons on neurodevelopment in the first 3 years of life among inner-city children. Environ Health Perspect 114: 1287–1292. Docket EPA–HQ–OAR–2009–0472–0373.

[392] 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.* Docket EPA–HQ–OAR–2009–0472–0272.

[393] Oak Ridge Institute for Science and Education. (2004). External Peer Review for the IRIS Reassessment of the Inhalation Carcinogenicity of Naphthalene. August 2004. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=84403.* Docket EPA–HQ–OAR–2009–0472–0273.

[394] 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.*

IARC has reevaluated naphthalene and re-classified it as Group 2B: possibly carcinogenic to humans.[395] Naphthalene also causes a number of chronic non-cancer effects in animals, including abnormal cell changes and growth in respiratory and nasal tissues.[396]

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 final rule. Mobile source air toxic compounds that would potentially be impacted include ethylbenzene, propionaldehyde, toluene, and xylene. Information regarding the health effects of these compounds can be found in EPA's IRIS database.[397]

f. Exposure and Health Effects Associated With Traffic

Populations who live, work, or attend school near major roads experience elevated exposure concentrations to a wide range of air pollutants, as well as higher risks for a number of adverse health effects. While the previous sections of this preamble have focused on the health effects associated with individual criteria pollutants or air toxics, this section discusses the mixture of different exposures near major roadways, rather than the effects of any single pollutant. As such, this section emphasizes traffic-related air pollution, in general, as the relevant indicator of exposure rather than any particular pollutant.

Concentrations of many traffic-generated air pollutants are elevated for up to 300–500 meters downwind of roads with high traffic volumes.[398] Numerous sources on roads contribute to elevated roadside concentrations, including exhaust and evaporative emissions, and resuspension of road dust and tire and brake wear. Concentrations of several criteria and hazardous air pollutants are elevated near major roads. Furthermore, different semi-volatile organic compounds and chemical components of particulate matter, including elemental carbon, organic material, and trace metals, have been reported at higher concentrations near major roads.

Populations near major roads experience greater risk of certain adverse health effects. The Health Effects Institute published a report on the health effects of traffic-related air pollution.[399] It concluded that evidence is "sufficient to infer the presence of a causal association" between traffic exposure and exacerbation of childhood asthma symptoms. The HEI report also concludes that the evidence is either "sufficient" or "suggestive but not sufficient" for a causal association between traffic exposure and new childhood asthma cases. A review of asthma studies by Salam et al. (2008) reaches similar conclusions.[400] The HEI report also concludes that there is "suggestive" evidence for pulmonary function deficits associated with traffic exposure, but concluded that there is "inadequate and insufficient" evidence for causal associations with respiratory health care utilization, adult-onset asthma, COPD symptoms, and allergy. A review by Holguin (2008) notes that the effects of traffic on asthma may be modified by nutrition status, medication use, and genetic factors.[401]

The HEI report also concludes that evidence is "suggestive" of a causal association between traffic exposure and all-cause and cardiovascular mortality. There is also evidence of an association between traffic-related air pollutants and cardiovascular effects such as changes in heart rhythm, heart attack, and cardiovascular disease. The HEI report characterizes this evidence as "suggestive" of a causal association, and an independent epidemiological literature review by Adar and Kaufman (2007) concludes that there is "consistent evidence" linking traffic-related pollution and adverse cardiovascular health outcomes.[402]

Some studies have reported associations between traffic exposure and other health effects, such as birth outcomes (*e.g.,* low birth weight) and childhood cancer. The HEI report concludes that there is currently "inadequate and insufficient" evidence for a causal association between these effects and traffic exposure. A review by Raaschou-Nielsen and Reynolds (2006) concluded that evidence of an association between childhood cancer and traffic-related air pollutants is weak, but noted the inability to draw firm conclusions based on limited evidence.[403]

There is a large population in the U.S. living in close proximity of major roads. According to the Census Bureau's American Housing Survey for 2007, approximately 20 million residences in the U.S., 15.6% of all homes, are located within 300 feet (91 m) of a highway with 4+ lanes, a railroad, or an airport.[404] Therefore, at current population of approximately 309 million, assuming that population and housing similarly distributed, there are over 48 million people in the U.S. living near such sources. The HEI report also notes that in two North American cities, Los Angeles and Toronto, over 40% of each city's population live within 500 meters of a highway or 100 meters of a major road. It also notes that about 33% of each city's population resides within 50 meters of major roads. Together, the evidence suggests that a large U.S. population lives in areas with elevated traffic-related air pollution.

People living near roads are often socioeconomically disadvantaged. According to the 2007 American Housing Survey, a renter-occupied property is over twice as likely as an owner-occupied property to be located near a highway with 4+ lanes, railroad or airport. In the same survey, the median household income of rental housing occupants was less than half that of owner-occupants ($28,921/ $59,886). Numerous studies in individual urban areas report higher levels of traffic-related air pollutants in areas with high minority or poor populations.[405] [406] [407]

[395] International Agency for Research on Cancer (IARC). (2002). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans. Vol. 82. Lyon, France. Docket EPA–HQ–OAR–2009–0472–0274.

[396] 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.*

[397] U.S. EPA Integrated Risk Information System (IRIS) database is available at: *http://www.epa.gov/iris.*

[398] Zhou, Y.; Levy, J.I. (2007) Factors influencing the spatial extent of mobile source air pollution impacts: a meta-analysis. BMC Public Health 7: 89. doi:10.1186/1471–2458–7–89.

[399] HEI Panel on the Health Effects of Air Pollution. (2010) Traffic-related air pollution: a critical review of the literature on emissions, exposure, and health effects. [Online at *http://www.healtheffects.org*].

[400] Salam, M.T.; Islam, T.; Gilliland, F.D. (2008) Recent evidence for adverse effects of residential proximity to traffic sources on asthma. Current Opin Pulm Med 14: 3–8.

[401] Holguin, F. (2008) Traffic, outdoor air pollution, and asthma. Immunol Allergy Clinics North Am 28: 577–588.

[402] Adar, S.D.; Kaufman, J.D. (2007) Cardiovascular disease and air pollutants: evaluating and improving epidemiological data implicating traffic exposure. Inhal Toxicol 19: 135–149.

[403] Raaschou-Nielsen, O.; Reynolds, P. (2006) Air pollution and childhood cancer: A review of the epidemiological literature. Int J Cancer 118: 2920–2929.

[404] U.S. Census Bureau (2008) American Housing Survey for the United States in 2007. Series H–150 (National Data), Table 1A–6. [Accessed at *http://www.census.gov/hhes/www/housing/ahs/ahs07/ahs07.html* on January 22, 2009]

[405] Lena, T.S.; Ochieng, V.; Carter, M.; Holguín-Veras, J.; Kinney, P.L. (2002) Elemental carbon and $PM_{2.5}$ levels in an urban community heavily impacted by truck traffic. Environ Health Perspect 110: 1009–1015.

[406] Wier, M.; Sciammas, C.; Seto, E.; Bhatia, R.; Rivard, T. (2009) Health, traffic, and environmental

Students may also be exposed in situations where schools are located near major roads. In a study of nine metropolitan areas across the U.S., Appatova et al. (2008) found that on average greater than 33% of schools were located within 400 m of an Interstate, U.S., or State highway, while 12% were located within 100 m.[408] The study also found that among the metropolitan areas studied, schools in the Eastern U.S. were more often sited near major roadways than schools in the Western U.S.

Demographic studies of students in schools near major roadways suggest that this population is more likely than the general student population to be of non-white race or Hispanic ethnicity, and more often live in low socioeconomic status locations.[409 410 411] There is some inconsistency in the evidence, which may be due to different local development patterns and measures of traffic and geographic scale used in the studies.[408]

4. Environmental Effects of Non-GHG Pollutants

In this section we discuss some of the environmental effects of PM and its precursors such as visibility impairment, atmospheric deposition, and materials damage and soiling, as well as environmental effects associated with the presence of ozone in the ambient air, such as impacts on plants, including trees, agronomic crops and urban ornamentals, and environmental effects associated with air toxics. No substantive comments were received on the environmental effects of non-GHG pollutants.

a. Visibility

Visibility can be defined as the degree to which the atmosphere is transparent to visible light.[412] Visibility impairment is caused by light scattering and absorption by suspended particles and gases. Visibility is important because it has direct significance to people's enjoyment of daily activities in all parts of the country. Individuals value good visibility for the well-being it provides them directly, where they live and work, and in places where they enjoy recreational opportunities. Visibility is also highly valued in significant natural areas, such as national parks and wilderness areas, and special emphasis is given to protecting visibility in these areas. For more information on visibility see the final 2009 PM ISA.[413]

EPA is pursuing a two-part strategy to address visibility. First, 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, and has set secondary $PM_{2.5}$ standards.[414] The secondary $PM_{2.5}$ standards act in conjunction with the regional haze program. The regional haze rule (64 FR 35714) was put in place in July 1999 to protect the visibility in mandatory class I Federal areas. There are 156 national parks, forests and wilderness areas categorized as mandatory class I Federal areas (62 FR 38680–81, July 18, 1997).[415] 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 Air Quality Criteria Document 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.[416]

Adverse impacts on water quality can occur when atmospheric contaminants deposit to the water surface or when

justice: collaborative research and community action in San Francisco, California. Am J Public Health 99: S499–S504.

[407] Forkenbrock, D.J. and L.A. Schweitzer, *Environmental Justice and Transportation Investment Policy.* Iowa City: University of Iowa, 1997.

[408] Appatova, A.S.; Ryan, P.H.; LeMasters, G.K.; Grinshpun, S.A. (2008) Proximal exposure of public schools and students to major roadways: a nationwide U.S. survey. J Environ Plan Mgmt

[409] Green, R.S.; Smorodinsky, S.; Kim, J.J.; McLaughlin, R.; Ostro, B. (2004) Proximity of California public schools to busy roads. Environ Health Perspect 112: 61–66.

[410] Houston, D.; Ong, P.; Wu, J.; Winer, A. (2006) Proximity of licensed child care facilities to near-roadway vehicle pollution. Am J Public Health 96: 1611–1617.

[411] Wu, Y.; Batterman, S. (2006) Proximity of schools in Detroit, Michigan to automobile and truck traffic. J Exposure Sci Environ Epidemiol 16: 457–470.

[412] National Research Council, 1993. Protecting Visibility in National Parks and Wilderness Areas. National Academy of Sciences Committee on Haze in National Parks and Wilderness Areas. National Academy Press, Washington, DC. Docket EPA–HQ–OAR–2005–0161. This book can be viewed on the National Academy Press Web site at *http://www.nap.edu/books/0309048443/html/.*

[413] U.S. EPA (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, 2009. Docket EPA–HQ–OAR–2009–0472–11295.

[414] The existing annual primary and secondary $PM_{2.5}$ standards have been remanded and are being addressed in the currently ongoing PM NAAQS review.

[415] These areas are defined in CAA section 162 as those national parks exceeding 6,000 acres, wilderness areas and memorial parks exceeding 5,000 acres, and all international parks which were in existence on August 7, 1977.

[416] U.S. EPA (2000) Deposition of Air Pollutants to the Great Waters: Third Report to Congress. Office of Air Quality Planning and Standards. EPA–453/R–00–0005. Docket EPA–HQ–OAR–2009–0472–0091.

material deposited on the land enters a waterbody through runoff. Potential impacts of atmospheric deposition to waterbodies include those related to both nutrient and toxic inputs. Adverse effects to human health and welfare can occur from the addition of excess nitrogen via atmospheric deposition. The nitrogen-nutrient enrichment contributes to toxic algae blooms and zones of depleted oxygen, which can lead to fish kills, frequently in coastal waters. Deposition of heavy metals or other toxics may lead to the human ingestion of contaminated fish, impairment of drinking water, damage to the marine ecology, and limits to recreational uses. Several studies have been conducted in U.S. coastal waters and in the Great Lakes Region in which the role of ambient PM deposition and runoff is investigated.[417] [418] [419] [420] [421]

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 leads to nutrient enrichment and altered biogeochemical cycling. In aquatic systems increased nitrogen can alter species assemblages and cause eutrophication. In terrestrial systems nitrogen loading can lead to loss of nitrogen sensitive lichen species, decreased biodiversity of grasslands, meadows and other sensitive habitats, and increased potential for invasive species. For a broader explanation of the topics treated here, refer to the description in Section 7.1.2 of the RIA.

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).

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.[422] In laboratory experiments, a wide range of tolerance to VOCs has been observed.[423] 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.[424]

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.[425] [426] [427] 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

Air quality modeling was performed to assess the impact of the vehicle standards on criteria and air toxic pollutants. In this section, we present information on current modeled levels of pollution as well as projections for 2030, with respect to ambient $PM_{2.5}$, ozone, selected air toxics, visibility levels and nitrogen and sulfur deposition. The air quality modeling results indicate that the GHG standards have relatively small but measureable impacts on ambient concentrations of these pollutants. The results are discussed in more detail below and in Section 7.2 of the RIA. No substantive

[417] U.S. EPA (2004) National Coastal Condition Report II. Office of Research and Development/ Office of Water. EPA–620/R–03/002. Docket EPA–HQ–OAR–2009–0472–0089.

[418] 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. Docket EPA–HQ–OAR–2009–0472–11297.

[419] Kim, G., N. Hussain, J.R. Scudlark, and T.M. Church. 2000. Factors influencing the atmospheric depositional fluxes of stable Pb, 210Pb, and 7Be into Chesapeake Bay. *J. Atmos. Chem.* 36: 65–79. Docket EPA–HQ–OAR–2009–0472–11299.

[420] Lu, R., R.P. Turco, K. Stolzenbach, *et al.* 2003. Dry deposition of airborne trace metals on the Los Angeles Basin and adjacent coastal waters. *J. Geophys. Res.* 108(D2, 4074): AAC 11–1 to 11–24. Docket EPA–HQ–OAR–2009–0472–11296.

[421] Marvin, C.H., M.N. Charlton, E.J. Reiner, et al. 2002. Surficial sediment contamination in Lakes Erie and Ontario: A comparative analysis. *J. Great Lakes Res.* 28(3): 437–450. Docket EPA–HQ–OAR–2009–0472–11300.

[422] U.S. EPA. 1991. Effects of organic chemicals in the atmosphere on terrestrial plants. EPA/600/3–91/001. Docket EPA–HQ–OAR–2009–0472–0401.

[423] Cape JN, ID Leith, J Binnie, J Content, M Donkin, M Skewes, DN Price AR Brown, AD Sharpe. 2003. Effects of VOCs on herbaceous plants in an open-top chamber experiment. Environ. Pollut. 124:341–343. Docket EPA–HQ–OAR–2009–0472–0357.

[424] Cape JN, ID Leith, J Binnie, J Content, M Donkin, M Skewes, DN Price AR Brown, AD Sharpe. 2003. Effects of VOCs on herbaceous plants in an open-top chamber experiment. Environ. Pollut. 124:341–343. Docket EPA–HQ–OAR–2009–0472–0357.

[425] Viskari E–L. 2000. Epicuticular wax of Norway spruce needles as indicator of traffic pollutant deposition. Water, Air, and Soil Pollut. 121:327–337. Docket EPA–HQ–OAR–2009–0472–1128.

[426] Ugrekhelidze D, F Korte, G Kvesitadze. 1997. Uptake and transformation of benzene and toluene by plant leaves. Ecotox. Environ. Safety 37:24–29. Docket EPA–HQ–OAR–2009–0472–1142.

[427] Kammerbauer H, H Selinger, R Rommelt, A Ziegler-Jons, D Knoppik, B Hock. 1987. Toxic components of motor vehicle emissions for the spruce Picea abies. Environ. Pollut. 48:235–243. Docket EPA–HQ–OAR–2009–0472–0358.

comments were received on our plans for non-GHG air quality modeling that were detailed in the proposal for this rule.

We used the Community Multi-scale Air Quality (CMAQ) photochemical model, version 4.7.1, for our analysis. This version of CMAQ includes a number of improvements to previous versions of the model. These improvements are discussed in Section 7.2 of the RIA.

a. Particulate Matter

i. Current Levels

$PM_{2.5}$ concentrations exceeding the level of the $PM_{2.5}$ NAAQS occur in many parts of the country. In 2005, EPA designated 39 nonattainment areas for the 1997 $PM_{2.5}$ 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 revised in 2006 and the 2006 24-hour $PM_{2.5}$ NAAQS became effective on December 18, 2006. On October 8, 2009, the EPA issued final nonattainment area designations for the 2006 24-hour $PM_{2.5}$ NAAQS (74 FR 58688, November 13, 2009). These designations include 31 areas composed of 120 full or partial counties with a population of over 70 million. In total, there are 54 $PM_{2.5}$ nonattainment areas composed of 243 counties with a population of almost 102 million people.

ii. Projected Levels Without This Rule

States with $PM_{2.5}$ nonattainment areas are required to take action to bring those areas into compliance in the future. Areas designated as not attaining the 1997 $PM_{2.5}$ NAAQS will need to attain the 1997 standards in the 2010 to 2015 time frame, and then maintain them thereafter. The 2006 24-hour $PM_{2.5}$ nonattainment areas will be required to attain the 2006 24-hour $PM_{2.5}$ NAAQS in the 2014 to 2019 time frame and then be required to maintain the 2006 24-hour $PM_{2.5}$ NAAQS thereafter. The vehicle standards finalized in this action become effective in 2012 and therefore may be useful to states in attaining or maintaining the $PM_{2.5}$ NAAQS.

EPA has already adopted many emission control programs that are expected to reduce ambient $PM_{2.5}$ levels and which will assist in reducing the number of areas that fail to achieve the $PM_{2.5}$ NAAQS. Even so, our air quality modeling projects that in 2030, with all current controls but excluding the impacts of the vehicle standards adopted here, at least 9 counties with a population of almost 28 million may not attain the 1997 annual $PM_{2.5}$ standard of 15 $\mu g/m^3$ and 26 counties with a population of over 41 million may not attain the 2006 24-hour $PM_{2.5}$ standard of 35 $\mu g/m^3$. These numbers do not account for those areas that are close to (*e.g.,* within 10 percent of) the $PM_{2.5}$ standards. These areas, although not violating the standards, will also benefit from any reductions in $PM_{2.5}$ ensuring long-term maintenance of the $PM_{2.5}$ NAAQS.

iii. Projected Levels With This Rule

Air quality modeling performed for this final rule shows that in 2030 the majority of the modeled counties will see decreases of less than 0.05 $\mu g/m^3$ in their annual $PM_{2.5}$ design values. The decreases in annual $PM_{2.5}$ design values that we see in some counties are likely due to emission reductions related to lower gasoline production at existing oil refineries; reductions in direct $PM_{2.5}$ emissions and $PM_{2.5}$ precursor emissions (NO_X and SO_X) contribute to reductions in ambient concentrations of both direct $PM_{2.5}$ and secondarily-formed $PM_{2.5}$. The maximum projected decrease in an annual $PM_{2.5}$ design value is 0.07 $\mu g/m^3$ in Harris County, TX. There are also a few counties that are projected to see increases of no more than 0.01 $\mu g/m^3$ in their annual $PM_{2.5}$ design values. These small increases in annual $PM_{2.5}$ design values are likely related to downstream emission increases. On a population-weighted basis, the average modeled 2030 annual $PM_{2.5}$ design value is projected to decrease by 0.01 $\mu g/m^3$ due to this final rule. Those counties that are projected to be above the annual $PM_{2.5}$ standard in 2030 will see slightly larger population-weighted decreases of 0.03 $\mu g/m^3$ in their design values due to this final rule.

In addition to looking at annual $PM_{2.5}$ design values, we also modeled the impact of the standards on 24-hour $PM_{2.5}$ design values. Air quality modeling performed for this final rule shows that in 2030 the majority of the modeled counties will see changes of between -0.05 $\mu g/m^3$ and +0.05 $\mu g/m^3$ in their 24-hour $PM_{2.5}$ design values. The decreases in 24-hour $PM_{2.5}$ design values that we see in some counties are likely due to emission reductions related to lower gasoline production at existing oil refineries; reductions in direct $PM_{2.5}$ emissions and $PM_{2.5}$ precursor emissions (NO_X and SO_X) contribute to reductions in ambient concentrations of both direct $PM_{2.5}$ and secondarily-formed $PM_{2.5}$. The maximum projected decrease in a 24-hour $PM_{2.5}$ design value is 0.21 $\mu g/m^3$ in Harris County, TX. There are also some counties that are projected to see increases of less than 0.05 $\mu g/m^3$ in their 24-hour $PM_{2.5}$ design values. These small increases in 24-hour $PM_{2.5}$ design values are likely related to downstream emission increases. On a population-weighted basis, the average modeled 2030 24-hour $PM_{2.5}$ design value is projected to decrease by 0.01 $\mu g/m^3$ due to this final rule. Those counties that are projected to be above the 24-hour $PM_{2.5}$ standard in 2030 will see slightly larger population-weighted decreases of 0.05 $\mu g/m^3$ in their design values due to this final rule.

b. Ozone

i. Current Levels

8-hour ozone concentrations exceeding the level of the ozone NAAQS occur in many parts of the country. In 2008, the EPA amended the ozone NAAQS (73 FR 16436, March 27, 2008). The final 2008 ozone NAAQS rule set forth revisions to the previous 1997 NAAQS for ozone to provide increased protection of public health and welfare. EPA recently proposed to reconsider the 2008 ozone NAAQS (75 FR 2938, January 19, 2010). Because of the uncertainty the reconsideration proposal creates regarding the continued applicability of the 2008 ozone NAAQS, EPA has used its authority to extend by 1 year the deadline for promulgating designations for those NAAQS (75 FR 2936, January 19, 2010). The new deadline is March 12, 2011. EPA intends to complete the reconsideration by August 31, 2010. If EPA establishes new ozone NAAQS as a result of the reconsideration, they would replace the 2008 ozone NAAQS and requirements to designate areas and implement the 2008 NAAQS would no longer apply.

As of January 6, 2010 there are 51 areas designated as nonattainment for the 1997 8-hour ozone NAAQS, comprising 266 full or partial counties with a total population of over 122 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. Table III.G.5–1 provides an estimate, based on 2005–07 air quality data, of the counties with design values greater than the 2008 8-hour ozone NAAQS of 0.075 ppm.

TABLE III.G.5–1—COUNTIES WITH DESIGN VALUES GREATER THAN THE OZONE NAAQS

	Number of counties	Population [a]
1997 Ozone Standard: Counties within the 54 areas currently designated as nonattainment (as of 1/6/10)	266	122,343,799
2008 Ozone Standard: Additional counties that would not meet the 2008 NAAQS (based on 2006–2008 air quality data) [b]	156	36,678,478
Total	422	159,022,277

NOTES:
[a] Population numbers are from 2000 census data.
[b] Area designations for the 2008 ozone NAAQS have not yet been made. Nonattainment for the 2008 Ozone NAAQS would be based on three years of air quality data from later years. Also, the county numbers in this row include only the counties with monitors violating the 2008 Ozone NAAQS. The numbers in this table may be an underestimate of the number of counties and populations that will eventually be included in areas with multiple counties designated nonattainment.

ii. Projected Levels Without This Rule

States with 8-hour ozone nonattainment areas are required to take action to bring those areas into compliance in the future. Based on the final rule designating and classifying 8-hour ozone nonattainment areas for the 1997 standard (69 FR 23951, April 30, 2004), most 8-hour ozone nonattainment areas will be required to attain the ozone NAAQS in the 2007 to 2013 time frame and then maintain the NAAQS thereafter. As noted, EPA is reconsidering the 2008 ozone NAAQS. If EPA promulgates different ozone NAAQS in 2010 as a result of the reconsideration, these standards would replace the 2008 ozone NAAQS and there would no longer be a requirement to designate areas for the 2008 NAAQS. EPA would designate nonattainment areas for a potential new 2010 primary ozone NAAQS in 2011. The attainment dates for areas designated nonattainment for a potential new 2010 primary ozone NAAQS are likely to be in the 2014 to 2031 timeframe, depending on the severity of the problem.[428]

EPA has already adopted many emission control programs that are expected to reduce ambient ozone levels and assist in reducing the number of areas that fail to achieve the ozone NAAQS. Even so, our air quality modeling projects that in 2030, with all current controls but excluding the impacts of the vehicle standards, up to 16 counties with a population of almost 35 million may not attain the 2008 ozone standard of 0.075 ppm (75 ppb). These numbers do not account for those areas that are close to (*e.g.,* within 10 percent of) the 2008 ozone standard. These areas, although not violating the standards, will also be impacted by changes in ozone as they work to ensure long-term maintenance of the ozone NAAQS.

iii. Projected Levels With This Rule

We do not expect this rule to have a meaningful impact on ozone concentrations, given the small magnitude of the ozone impacts and the fact that much of the impact is due to ethanol assumptions that are independent of this rule. Our modeling projects increases in ozone design value concentrations in many areas of the country and decreases in ozone design value concentrations in a few areas. However, the increases in ozone design values are not due to the standards finalized in this rule, but are related to our assumptions about the volume of ethanol that will be blended into gasoline. The ethanol volumes will be occurring as a result of the recent Renewable Fuel Standards (RFS2) rule.[429]

The ethanol volume assumptions are discussed in the introduction to Section III.G of this preamble. We attribute decreased fuel consumption and production from this program to gasoline only, while assuming constant ethanol volumes in our reference and control cases. Holding ethanol volumes constant while decreasing gasoline volumes increases the market share of 10% ethanol (E10) in the control case. However, the increased E10 market share is projected to occur regardless of this rule; in the RFS2 analysis we project 100% E10 by 2014. The air quality impacts of this effect are included in our analyses for the recent RFS2 rule. As the RFS2 analyses indicate, increasing usage of E10 fuels (when compared with E0 fuels) can increase NO_X emissions and thereby increase ozone concentrations, especially in NO_X-limited areas where relatively small amounts of NO_X enable ozone to form rapidly.[430]

The majority of the ozone design value increases are less than 0.1 ppb. The maximum projected increase in an 8-hour ozone design value is 0.25 ppb in Richland County, South Carolina. As mentioned above there are some areas which see decreases in their ozone design values. The decreases in ambient ozone concentration are likely due to projected upstream emissions decreases in NO_X and VOCs from reduced gasoline production. The maximum decrease projected in an 8-hour ozone design value is 0.22 ppb in Riverside County, California. On a population-weighted basis, the average modeled 8-hour ozone design values are projected to increase by 0.01 ppb in 2030 and the design values for those counties that are projected to be above the 2008 ozone standard in 2030 will see population-weighted decreases of 0.10 ppb.

c. Air Toxics

i. Current Levels

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.[431] 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 most recent Mobile Source Air Toxics Rule.[432] According to the National Air Toxic Assessment

[428] U.S. EPA 2010, Fact Sheet Revisions to Ozone Standards. *http://www.epa.gov/groundlevelozone/pdfs/fs20100106std.pdf.*

[429] EPA 2010, Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis. EPA–420–R–10–006, February 2010. Docket EPA–HQ–OAR–2009–0472–11332. *See also* 75 FR 14670, March 26, 2010.

[430] Sections 3.4.2.1.2 and 3.4.3.3 of the Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis, EPA–420–R–10–006, February 2010. Docket EPA–HQ–OAR–2009–0472–11332.

[431] U.S. EPA (2009) 2002 National-Scale Air Toxics Assessment. *http://www.epa.gov/ttn/atw/nata2002/.* Docket EPA–HQ–OAR–2009–0472–11321.

[432] U.S. Environmental Protection Agency (2007). Control of Hazardous Air Pollutants from Mobile Sources; Final Rule. 72 FR 8434, February 26, 2007. Docket EPA–HQ–OAR–2009–0472–0271, 0271.1 and 0271.2.

(NATA) for 2002,[433] mobile sources were responsible for 47 percent of outdoor toxic emissions, over 50 percent of the cancer risk, and over 80 percent of the noncancer hazard. Benzene is the largest contributor to cancer risk of all 124 pollutants quantitatively assessed in the 2002 NATA and mobile sources were responsible for 59 percent of benzene emissions in 2002. Over the years, EPA has implemented a number of mobile source and fuel controls resulting in VOC reductions, which also reduce benzene and other air toxic emissions.

ii. Projected Levels

Our modeling indicates that the GHG standards have relatively little impact on national average ambient concentrations of the modeled air toxics. Additional detail on the air toxics results can be found in Section 7.2.2.3 of the RIA.

d. Nitrogen and Sulfur Deposition

i. Current Levels

Over the past two decades, the EPA has undertaken numerous efforts to reduce nitrogen and sulfur deposition across the U.S. Analyses of long-term monitoring data for the U.S. show that deposition of both nitrogen and sulfur compounds has decreased over the last 17 years although many areas continue to be negatively impacted by deposition. Deposition of inorganic nitrogen and sulfur species routinely measured in the U.S. between 2004 and 2006 were as high as 9.6 kilograms of nitrogen per hectare per year (kg N/ha/yr) and 21.3 kilograms of sulfur per hectare per year (kg S/ha/yr). The data show that reductions were more substantial for sulfur compounds than for nitrogen compounds. These numbers are generated by the U.S. national monitoring network and they likely underestimate nitrogen deposition because neither ammonia nor organic nitrogen is measured. In the eastern U.S., where data are most abundant, total sulfur deposition decreased by about 44% between 1990 and 2007, while total nitrogen deposition decreased by 25% over the same time frame.[434]

ii. Projected Levels

Our air quality modeling does not show substantial overall nationwide impacts on the annual total sulfur and nitrogen deposition occurring across the U.S. as a result of the vehicle standards required by this rule. For sulfur deposition the vehicle standards will result in annual percent decreases of 0.5% to more than 2% in locations with refineries as a result of the lower output from refineries due to less gasoline usage. These locations include the Texas and Louisiana portions of the Gulf Coast; the Washington DC area; Chicago, IL; portions of Oklahoma and northern Texas; Bismarck, North Dakota; Billings, Montana; Casper, Wyoming; Salt Lake City, Utah; Seattle, Washington; and San Francisco, Los Angeles, and San Luis Obispo, California. The remainder of the country will see only minimal changes in sulfur deposition, ranging from decreases of less than 0.5% to increases of less than 0.5%. For a map of 2030 sulfur deposition impacts and additional information on these impacts, *see* Section 7.2.2.5 of the RIA. The impacts of the vehicle standards on nitrogen deposition are minimal, ranging from decreases of up to 0.5% to increases of up to 0.5%.

e. Visibility

i. Current Levels

As mentioned in Section III.G.5.a, millions of people live in nonattainment areas for the $PM_{2.5}$ NAAQS. These populations, as well as large numbers of individuals who travel to these areas, are likely to experience visibility impairment. In addition, while visibility trends have improved in mandatory class I Federal areas, the most recent data show that these areas continue to suffer from visibility impairment. In summary, visibility impairment is experienced throughout the U.S., in multi-State regions, urban areas, and remote mandatory class I Federal areas.

ii. Projected Levels

Air quality modeling conducted for this final rule was used to project visibility conditions in 138 mandatory class I Federal areas across the U.S. in 2030. The results show that all the modeled areas will continue to have annual average deciview levels above background in 2030.[435] The results also indicate that the majority of the modeled mandatory class I Federal areas will see no change in their visibility, but some mandatory class I Federal areas will see improvements in visibility due to the vehicle standards and a few mandatory class I Federal areas will see visibility decreases. The average visibility at all modeled mandatory class I Federal areas on the 20% worst days is projected to improve by 0.002 deciviews, or 0.01%, in 2030. Section 7.2.2.6.2 of the RIA contains more detail on the visibility portion of the air quality modeling.

H. What are the estimated cost, economic, and other impacts of the program?

In this section, EPA presents the costs and impacts of EPA's 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 average fuel economy increases 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. These costs and benefits are appropriately analyzed separately by each agency and should not be added together.

This section outlines the basis for assessing the benefits and costs of the GHG 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 upfront 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, because they affect people in ways other than the effect on the market for and use of new vehicles and are generally not taken into account by the purchaser of the vehicle. The external effects include the climate impacts, the effects on non-GHG pollutants, energy security impacts, 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

[433] U.S. EPA (2009) 2002 National-Scale Air Toxics Assessment. *http://www.epa.gov/ttn/atw/nata2002/.* Docket EPA–HQ–OAR–2009–0472–11321.

[434] U.S. EPA. U.S. EPA's 2008 Report on the Environment (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–07/045F (NTIS PB2008–112484). Docket EPA–HQ–OAR–2009–0472–11298. Updated data available online at: *http://cfpub.epa.gov/eroe/index.cfm?fuseaction=detail.viewInd&ch=46&subtop=341&lv=list.listByChapter&r=201744.*

[435] The level of visibility impairment in an area is based on the light-extinction coefficient and a unitless visibility index, called a "deciview", which is used in the valuation of visibility. The deciview metric provides a scale for perceived visual changes over the entire range of conditions, from clear to hazy. Under many scenic conditions, the average person can generally perceive a change of one deciview. The higher the deciview value, the worse the visibility. Thus, an improvement in visibility is a decrease in deciview value.

role of private benefits in assessing the benefits and costs of the program: If consumers optimize their purchases of fuel economy, with full information and perfect foresight, in perfectly efficient markets, it is possible that they have already considered these benefits in their vehicle purchase decisions. If so, then no net private benefits would result from the program, because consumers would already buy vehicles with the amount of fuel economy that is optimal for them; requiring additional fuel economy would alter both the purchase prices of new cars and their lifetime streams of operating costs in ways that will inevitably reduce consumers' well-being. If these conditions do not hold, then the private benefits and costs would both count toward the program's benefits. Section III.H.1 discusses this issue more fully.

The net benefits of EPA's final program consist of the effects of the program on:

- 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, and other flexibilities built into the final program),
- Fuel savings associated with reduced fuel usage resulting from the program,
- Greenhouse gas emissions,
- Other pollutants,
- Noise, congestion, accidents,
- Energy security impacts,
- Reduced refueling events
- Increased driving due to the "rebound" effect.

EPA also presents the cost-effectiveness of the standards.

The total monetized benefits (excluding fuel savings) under the program are projected to be $17.5 to $41.8 billion in 2030, using a 3 percent discount rate applied to the valuation of $PM_{2.5}$-related premature mortality and depending on the value used for the social cost of carbon. The total monetized benefits (excluding fuel savings) under the program are projected to be $17.4 to $41.7 billion in 2030, using a 7 percent discount rate applied to the valuation of $PM_{2.5}$-related premature mortality and depending on the value used for the social cost of carbon. These benefits are summarized below in Table III.H.10–2. The costs of the program in 2030 are estimated to be approximately $15.8 billion for new vehicle technology less $79.8 billion in savings realized by consumers through fewer fuel expenditures (calculated using pre-tax fuel prices). These costs are summarized below in Table III.H.10–1. The estimates developed here use as a baseline for comparison the fuel economy associated with MY 2011 vehicles. To the extent that greater fuel economy improvements than those assumed to occur under the baseline may have occurred due to market forces alone (absent the rule), the analysis overestimates private and social net benefits.

EPA has undertaken an analysis of the economy-wide impacts of the GHG tailpipe standards as an exploratory exercise that EPA believes could provide additional insights into the potential impacts of the program.[436] These results were not a factor regarding the appropriateness of the GHG tailpipe standards. It is important to note that the results of this modeling exercise are dependent on the assumptions associated with how producers will make fuel economy improvements and how consumers will respond to increases in higher vehicle costs and improved vehicle fuel economy as a result of the program. 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 rule are summarized in the following sections and are presented in more detail in the RIA for this rulemaking.

1. Conceptual Framework for Evaluating Consumer Impacts

For this 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 an economic conundrum. On the one hand, consumers are expected to gain significantly from the rules, as the increased cost of fuel efficient cars appears to be far smaller than the fuel savings. Yet these technologies are readily available; financially savvy consumers could have sought vehicles with improved fuel efficiency, and auto makers seeking those customers could have offered them. Assuming full information, perfect foresight, perfect competition, and financially rational consumers and producers, standard economic theory suggests that normal market operations would have provided the private net gains to consumers, and the only benefits of the rule would be due to external benefits. If our analysis projects net private benefits that consumers have not realized in this perfectly functioning market, then increased fuel economy should be accompanied by a corresponding loss in consumer welfare. This calculation assumes that consumers accurately predict and act on all the benefits they will get from a new vehicle, and that producers market products providing those benefits. The existence of large private net benefits from this rule, then, suggests either that the assumptions noted above do not hold, or that EPA's analysis has missed some factor(s) tied to improved fuel economy that reduce(s) consumer welfare.

With respect to the latter, EPA believes the costs of the technologies developed for this rule take into account the cost needed to ensure that all vehicle qualities (including performance, reliability, and size) stay constant, except for fuel economy and vehicle price. As a result, there would need to be some other changed qualities that would reduce the benefits consumers receive from their vehicles. Changing circumstances (*e.g.,* increased demand for horsepower in response to a drop in fuel prices), and any changes in vehicle attributes that manufacturers elect to make may result in additional private impacts to vehicle buyers from requiring increased fuel economy. Most comments generally supported the cost estimates and the maintenance of vehicle quality, though two comments expressed concern over unspecified losses to vehicle quality. Even if there is some such unidentified loss (which, given existing evidence and modeling capabilities, is very difficult to quantify), EPA believes that under realistic assumptions, the private gains from the rule, together with the social gains (in the form of reduction of externalities), will continue to substantially outweigh the costs.

The central conundrum has been referred to as the Energy Paradox in this setting (and in several others).[437] In short, the problem is that consumers appear not to purchase products that are in their economic self-interest. There are

[436] *See* Memorandum to Docket, "Economy-Wide Impacts of Proposed Greenhouse Gas Tailpipe Standards," March 4, 2010. Docket EPA–HQ–OAR–2009–0472.

[437] Jaffe, A.B., and Stavins, R.N. (1994). The Energy Paradox and the Diffusion of Conservation Technology. Resource and Energy Economics, 16(2), 91–122. Docket EPA–HQ–OAR–2009–0472–11415.

strong theoretical reasons why this might be so:[438]

- Consumers might be myopic and hence undervalue the long-term.
- Consumers might lack information or a full appreciation of information even when it is presented.
- Consumers might be especially averse to the short-term losses associated with the higher prices of energy efficient products relative to the uncertain future fuel savings, even if the expected present value of those fuel savings exceeds the cost (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, and the lack of salience might lead consumers to neglect an attribute that it would be in their economic interest to consider.
- In the case of vehicle fuel efficiency, and perhaps as a result of one or more of the foregoing factors, consumers may have relatively few choices to purchase vehicles with greater fuel economy once other characteristics, such as vehicle class, are chosen.[439]

A great deal of work in behavioral economics identifies and elaborates factors of this sort, which help account for the Energy Paradox.[440] 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.[441] For example, it might well be questioned whether significant reductions in refueling time, and corresponding private savings, are fully internalized when consumers are making purchasing decisions.

Considerable research findings indicate that the Energy Paradox is real and significant but the literature has not reached a consensus about the reasons for its existence. Several researchers have found evidence suggesting that consumers do not give full or appropriate weight to fuel economy in purchasing decisions. For example, Sanstad and Howarth[442] argue that consumers optimize behavior without full information by resorting to imprecise but convenient rules of thumb. Some studies find that a substantial portion of this undervaluation can be explained by inaccurate assessments of energy savings, or by uncertainty and irreversibility of energy investments due to fluctuations in energy prices.[443] For a number of reasons, consumers may undervalue future energy savings due to routine mistakes in how they evaluate these trade-offs. For instance, the calculation of fuel savings is complex, and consumers may not make it correctly.[444] The attribute of fuel economy may be insufficiently salient, leading to a situation in which consumers pay less than $1 for an expected $1 benefit in terms of discounted gasoline costs.[445] Larrick and Soll (2008) find 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).[446] 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. Cost calculations based on the average do not distinguish between those that may gain or lose as a result of the policy.[447] Studies regularly show that fuel economy plays a role in consumers' vehicle purchases, but modeling that role is still in development, and there is no consensus that most consumers make fully informed tradeoffs.[448]

Some studies find that a substantial portion of the Energy Paradox can be explained in models of consumer behavior. For instance, one set of studies finds that accounting for uncertainty in fuel savings over time due to unanticipated changes in fuel prices goes a long way toward explaining this paradox. In this case, consumers give up some uncertain future fuel savings to avoid higher upfront costs.

A recent review commissioned by EPA supports the finding of great variability, by looking at one key parameter: The role of fuel economy in consumers' vehicle purchase decisions.[449] The review finds no

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[438] For an overview, *see id.*

[439] For instance, the range of fuel economy (combined city and highway) available among all listed 2010 6-cylinder minivans is 18 to 20 miles per gallon. With a manual-transmission 4-cylinder minivan, it is possible to get 24 mpg. *See http://www.fueleconomy.gov,* which is jointly maintained by the U.S. Department of Energy and the EPA. For recent but unpublished evidence, see Allcott, Hunt, and Nathan Wozny, "Gasoline Prices, Fuel Economy, and the Energy Paradox" (2010), available at *http://web.mit.edu/allcott/www/Allcott%20and%20Wozny%202010%20-%20Gasoline%20Prices,%20Fuel%20Economy,%20and%20the%20Energy%20Paradox.pdf.*

[440] Jaffe, A.B., and Stavins, R.N. (1994). The Energy Paradox and the Diffusion of Conservation Technology. Resource and Energy Economics, 16(2), 91–122. Docket EPA–HQ–OAR–2009–0472–11415. *See* also Allcott and Wozny, supra note.

[441] For example, it might be maintained that, at the time of purchase, consumers take full account of the time spent refueling 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.

[442] Sanstad, A., and R. Howarth (1994). "'Normal' Markets, Market Imperfections, and Energy Efficiency." Energy Policy 22(10): 811–818 (Docket EPA–HQ–OAR–2009–0472–11416).

[443] 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 (Docket EPA–HQ–OAR–2009–0472–11538); 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 (Docket EPA–HQ–OAR–2009–0472–11539); 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 (Docket EPA–HQ–OAR–2009–0472–11540); Hassett, K., and G. Metcalf (1995), "Energy Tax Credits and Residential Conservation Investment: Evidence from Panel Data," *Journal of Public Economics* 57: 201–217 (Docket EPA–HQ–OAR–2009–0472–11543); Metcalf, G., and K. Hassett (1999), "Measuring the Energy Savings from Home Improvement Investments: Evidence from Monthly Billing Data," *The Review of Economics and Statistics* 81(3): 516–528 (Docket EPA–HQ–OAR–2009–0472–0051); van Soest D., and E. Bulte (2001), "Does the Energy-Efficiency Paradox Exist? Technological Progress and Uncertainty." *Environmental and Resource Economics* 18: 101–12 (Docket EPA–HQ–OAR–2009–0472–11542).

[444] 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–2009–0472–0041).

[445] Allcott, Hunt, and Nathan Wozny, "Gasoline Prices, Fuel Economy, and the Energy Paradox" (2010), available at *http://web.mit.edu/allcott/www/Allcott%20and%20Wozny%202010%20-%20Gasoline%20Prices,%20Fuel%20Economy,%20and%20the%20Energy%20Paradox.pdf* (Docket EPA–HQ–OAR–2009–0472–11554).

[446] Sanstad, A., and R. Howarth (1994). "'Normal' Markets, Market Imperfections, and Energy Efficiency." Energy Policy 22(10): 811–818 (Docket EPA–HQ–OAR–2009–0472–11415); Larrick, R. P., and J.B. Soll (2008). "The MPG illusion." *Science* 320: 1593–1594 (Docket EPA–HQ–OAR–2009–0472–0043).

[447] Hausman J., Joskow P. (1982). "Evaluating the Costs and Benefits of Appliance Efficiency Standards." *American Economic Review* 72: 220–25 (Docket EPA–HQ–OAR–2009–0472–11541).

[448] *E.g.,* Goldberg, Pinelopi Koujianou, "Product Differentiation and Oligopoly in International Markets: The Case of the U.S. Automobile Industry," *Econometrica* 63(4) (July 1995): 891–951 (Docket EPA–HQ–OAR–2009–0472–0021); Goldberg, Pinelopi Koujianou, "The Effects of the Corporate Average Fuel Efficiency Standards in the U.S.," *Journal of Industrial Economics* 46(1) (March 1998): 1–33 (Docket EPA–HQ–OAR–2009–0472–0017); 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–2009–0472–0044).

[449] Greene, David L. "How Consumers Value Fuel Economy: A Literature Review." EPA Report EPA–420–R–10–008, March 2010 (Docket EPA–HQ–OAR–2009–0472–11575).

consensus on the role of fuel economy in consumer purchase decisions. Of 27 studies, significant numbers of them find that consumers undervalue, overvalue, or value approximately correctly the fuel savings that they will receive from improved fuel economy. The variation in the value of fuel economy in these studies is so high that it appears to be inappropriate to identify one central estimate from the literature. Thus, estimating consumer response to higher vehicle fuel economy is still unsettled science.

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, and poor ability to calculate savings. Also as noted, fuel economy may not be as salient as other vehicle characteristics when a consumer is considering vehicles. If these arguments are valid, then there will be significant gains to consumers of the government mandating additional fuel economy.

EPA requested and received a number of comments discussing the role of the Energy Paradox in consumer vehicle purchase decisions. Ten commenters, primarily from a number of academic and non-governmental organizations, argued that there is a gap between the fuel economy that consumers purchased and the cost-effective amount, due to a number of market and behavioral phenomena. These include consumers having inadequate information about future fuel savings relative to up-front costs; imperfect competition among auto manufacturers; lack of choice over fuel economy within classes; lack of salience of fuel economy relative to other vehicle features at the time of vehicle purchase; consumer use of heuristic decision-making processes or other rules of thumb, rather than analyzing fuel economy decisions; consumer risk and loss aversion leading to more attention to up-front costs than future fuel savings; and consumer emphasis on visible, status-providing features of vehicles more than on relatively invisible features such as fuel economy. The RIA, Chapter 8.1.2, includes further discussion of these phenomena.

Because of the gap between the fuel economy consumers purchase and the cost-effective amount, those and additional commenters support using the full value of fuel savings as a benefit of the rule. A few asserted, in addition, that auto companies would benefit from offering vehicles with improved fuel economy. Automakers might underprovide fuel economy because they believe consumers would not buy it, or that it is not as salient as price when consumers are buying a vehicle. The commenters who supported the existence of the gap cite these phenomena as a basis for regulation of fuel economy. In contrast, two commenters (the United Auto Workers and one nonprofit research organization) argued that the market for fuel economy works efficiently; consumers reveal through their purchase decisions that additional fuel economy is not important for them. These commenters expressed concern that regulation to promote more fuel economy would limit consumers' choices as well as the value of the vehicles to consumers. Yet other commenters (including some states) noted that the rule protects the existing variety and choice of vehicles in the market; for this reason, the value of vehicles to consumers should not suffer as a result of the rule.

While acknowledging the diversity of perspectives, EPA continues to include the full fuel savings as private benefits of the rule. Improved fuel economy will significantly reduce consumer expenditures on fuel, thus benefiting consumers. It is true that limitations in modeling affect our ability to estimate how much of these savings would have occurred in the absence of the rule. For example, some of the technologies predicted to be adopted in response to the rule may already be developing due to shifts in consumer demand for fuel economy. It is possible that some of these savings would have occurred in the absence of the rule. To the extent that greater fuel economy improvements than those assumed to occur under the baseline may have occurred due to market forces alone (absent the rule), the analysis overestimates private and social net benefits. In the absence of robust means to identify the changes in fuel economy that would have occurred without the rule, we estimate the benefits and costs under the assumption that the rule will lead to more fuel-efficient vehicles than would have occurred without the rule. As discussed below, limitations in modeling also affect our ability to estimate the effects of the rule on net benefits in the market for vehicles.

Consumer vehicle choice models estimate what vehicles consumers buy based on vehicle and consumer characteristics. In principle, such models could provide a means of understanding both the role of fuel economy in consumers' purchase decisions and the effects of this rule on the benefits that consumers will get from vehicles. The NPRM included a discussion of the wide variation in the structure and results of these models. Models or model results have not frequently been systematically compared to each other. When they have, the results show large variation over, for instance, the value that consumers place on additional fuel economy. As a result, EPA found that further assessment needed to be done before adopting a consumer vehicle choice model. In the NPRM, EPA asked for comment on the state of the art of consumer vehicle choice modeling and whether it is sufficiently developed for use in regulatory analysis.

The responses were varied. Of the six commenters on this issue, five supported EPA's performing consumer vehicle choice modeling, but only in general terms; they did not provide recommendations for how to evaluate the quality of different models or identify a model appropriate for EPA's purposes. One commenter argued that, if key differences across models were controlled, then different models would produce similar results, but there were no suggestions for what choices to make to control the key differences. One commenter specifically asked for estimates that quantify losses to consumer welfare. Two commenters mentioned the importance of taking into account any losses in vehicle attributes due to increasing fuel economy, but without specific guidance for how to do so. Some commenters, including some who supported the use of these models, highlighted some of the models' potential limitations. Two commenters noted the challenges of modeling for vehicles that are not yet in the market. Most consumer vehicle choice models are based on existing vehicle fleets. Future vehicles will present combinations of vehicle characteristics not previously seen in markets, such as higher fuel economy and higher price with other characteristics constant; the existing models may not do well in predicting consumer responses to these changes. One comment suggested that the models might be sufficient for predicting changes in consumer purchase patterns, but not for calculating the welfare gains and losses to consumers of the changes.

EPA has not used a consumer vehicle choice model for the final rule analysis, due to concerns we explained in the proposal (and discussed in Chapter 8.1 of the RIA), and because no new information became available to resolve those concerns. It is likely that variation exists in measuring consumer response to changes in fuel economy as well as other vehicle characteristics, such as performance. Thus, there does not appear to be evidence at this time to develop robust estimates of consumer welfare effects of changes in vehicle attributes. As noted earlier, EPA's and NHTSA's cost estimates are based on maintaining these other vehicle attributes. Comments generally supported the finding that our cost and technology estimates succeeded in maintaining these other attributes.

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 program. These issues are discussed in detail in RIA Chapter 8.1.2.

The next issue is the potential for loss in consumer welfare due to the rule. As mentioned above (and discussed more thoroughly in Section III.D of this preamble), the technology cost estimates developed here take into account the costs to hold other vehicle attributes, such as size and performance, constant. In addition, the analysis assumes that the full technology costs are passed along to consumers. With these assumptions, because welfare losses are monetary estimates of how much consumers would have to be compensated to be made as well off as in the absence of the change,[450] the price increase measures the loss to the consumer.[451] Assuming that the full technology cost gets passed along to the consumer as an increase in price, the technology cost thus measures the welfare loss to the consumer. Increasing fuel economy would have to lead to other changes in the vehicles that consumers find undesirable for there to be additional losses not included in the technology costs.

At this time EPA has no available methods to estimate potential additional effects on consumers not included in the technology cost estimates, *e.g.,* due to changes in vehicles that consumers find undesirable, shifts in consumer demand for other attributes, and uncertainties about the long term reliability of new technologies. Comments on the rule generally supported EPA's analysis of the technology costs and the assumption that other vehicle characteristics were not adversely affected. Any consumer welfare loss cannot be quantified at this time. For reasons stated above, EPA believes that any such loss is likely far smaller than the private gains, including fuel savings and reduced refueling time.

Chapter 8.1 of the RIA discusses in more depth the research on the Energy Paradox and the state of the art of consumer vehicle choice modeling.

2. Costs Associated With the Vehicle Program

In this section, EPA presents our estimate of the costs associated with the final vehicle program. The presentation here summarizes the costs associated with the new vehicle technology expected to be added to meet the new GHG standards, including hardware costs to comply with the 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 RIA, and Chapter 3 of the Joint TSD. For more detail on the outputs of the OMEGA model and the overall vehicle program costs summarized here, the reader is directed to Chapters 4 and 7 of the RIA.

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. Some comments were received that addressed the technology costs that served as inputs to the OMEGA model as was mentioned in Section II.E. While those comments did not result in changes to the technology cost inputs, the technology cost estimates for a select group of technologies have changed since the NPRM thus changing the vehicle program costs presented here. These changes, as summarized in Section II.E and in Chapter 3 of the Joint TSD, were made in response to updated cost estimates, from the FEV teardown study, available to the agencies shortly after publication of the NPRM, not in response to comments. Those cost changes are summarized in Section II.E and in Chapter 3 of the Joint TSD. EPA believes that we have been conservative in estimating the vehicle hardware costs associated with this rule.

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 new 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 early credit generation and advanced vehicle technology credits.

a. Vehicle Compliance Costs Associated With the 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.[452] 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 rule relative to what the future vehicle fleet would be expected to look like absent this 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

[450] This approach describes the economic concept of compensating variation, a payment of money after a change that would make a consumer as well off after the change as before it. A related concept, equivalent variation, estimates the income change that would be an alternative to the change taking place. The difference between them is whether the consumer's point of reference is her welfare before the change (compensating variation) or after the change (equivalent variation). In practice, these two measures are typically very close together.

[451] Indeed, it is likely to be an overestimate of the loss to the consumer, because the consumer has choices other than buying the same vehicle with a higher price; she could choose a different vehicle, or decide not to buy a new vehicle. The consumer would choose one of those options only if the alternative involves less loss than paying the higher price. Thus, the increase in price that the consumer faces would be the upper bound of loss of consumer welfare, unless there are other changes to the vehicle due to the fuel economy improvements that make the vehicle less desirable to consumers.

[452] "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.

light on the long term (2022 and later) cost impacts of the program.[453] 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 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.[454] 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 will be incurred. Once the program has been fully implemented, some of the indirect costs will no longer be attributable to these standards and, as such, a lower ICM factor is applied to direct costs in 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.[455] 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 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. Note that, in general the comments received were supportive of our use of ICMs as opposed to the more traditional Retail Price Equivalent (RPE).[456] However, we did receive some comment that we applied inappropriate ICM factors to some technologies. We have not changed our approach in response to those comments as explained in greater detail in our Response to Comments document.

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 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 Chapter 3 of the Joint TSD.

The technology cost estimates discussed in Section III.D and detailed in Chapter 3 of the Joint TSD are used to build up technology package cost estimates which are then used as inputs to the OMEGA model. EPA discusses our technology packages and package costs in Chapter 1 of the RIA. 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, TLAAS, 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 rule. 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 is applied because some indirect costs decrease or are no longer considered attributable to the program (*e.g.,* warranty costs go down). 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 Chapter 6 of the RIA.

TABLE III.H.2–1—INDUSTRY AVERAGE VEHICLE COMPLIANCE COSTS ASSOCIATED WITH THE TAILPIPE CO_2 STANDARDS

[$/vehicle in 2007 dollars]

Calendar year	$/car	$/truck	$/vehicle (car & truck combined)
2012	$342	$314	$331

[453] Note that the assumption made here is that the standards 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 rule in the years prior to 2022 would be eliminated in 2022 and later.

[454] Need to add the recent reference for this study by RTI. Alex Rogozhin et al., *Automobile Industry Regail 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).

[455] Gloria Helfand and Todd Sherwood, "Documentation of the Development of Indirect Cost Multipliers for Three Automotive Technologies," Office of Transportation and Air Quality, U.S. EPA, August 2009 (Docket EPA–HQ–OAR–2009–0472).

[456] 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.

TABLE III.H.2–1—INDUSTRY AVERAGE VEHICLE COMPLIANCE COSTS ASSOCIATED WITH THE TAILPIPE CO_2 STANDARDS—Continued

[$/vehicle in 2007 dollars]

Calendar year	$/car	$/truck	$/vehicle (car & truck combined)
2013	507	496	503
2014	631	652	639
2015	749	820	774
2016	869	1,098	948
2017	869	1,098	947
2018	869	1,098	945
2019	869	1,098	943
2020	869	1,098	940
2021	869	1,098	939
2022	817	1,032	882
2030	817	1,032	878
2040	817	1,032	875
2050	817	1,032	875

b. Annual Costs of the Vehicle Program

The costs presented here represent the incremental costs for newly added technology to comply with the final 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 VEHICLE PROGRAM

[$Millions of 2007 dollars]

Year	Quantified annual costs
2012	$4,900
2013	8,000
2014	10,300
2015	12,700
2016	15,600
2020	15,600
2030	15,800
2040	17,400
2050	19,000
NPV, 3%	345,900
NPV, 7%	191,900

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 rule 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 RIA and 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. EPA has also calculated the cost per metric ton of GHG emission reductions including the savings associated with reduced fuel consumption (presented below in Section III.H.4). This latter calculation does not include the other benefits associated with this rule such as those associated with criteria pollutant reductions or energy security benefits as discussed later in sections III.H.4 through III.H.9. By including the fuel savings in the cost estimates, the cost per ton is less than $0, since the estimated value of fuel savings outweighs the vehicle program costs. With regard to the CH_4 and N_2O standards, since these standards will be emissions caps designed to ensure that manufacturers do not backslide from current levels, EPA has not estimated costs associated with the standards (since the standards will not require any change from current practices nor does EPA estimate they will result in emissions reductions).

The results for CO_2e costs per ton under the rule 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	Vehicle program cost [a] ($millions)	Fuel savings [b] ($millions)	CO_2e reduced (million metric tons)	Cost per ton of the vehicle program only [a]	Cost per ton of the vehicle program with fuel savings [b]
2020	$15,600	−$35,700	160	$100	−$130
2030	15,800	−79,800	310	50	−210
2040	17,400	−119,300	400	40	−250
2050	19,000	−171,200	510	40	−300

[a] Costs here include vehicle compliance costs and do not include any fuel savings.
[b] Fuel savings calculated using pre-tax fuel prices.

4. Reduction in Fuel Consumption and Its Impacts

a. What are the projected changes in fuel consumption?

The new CO_2 standards will result in significant improvements in the fuel efficiency of affected vehicles. Drivers of those vehicles will see corresponding savings associated with reduced fuel expenditures. EPA has estimated the impacts on fuel consumption for both the tailpipe CO_2 standards and the A/C credit program. To do this, fuel consumption is calculated using both current CO_2 emission levels and the new CO_2 standards. The difference between these estimates represents the net savings from the CO_2 standards. Note that the total number of miles that vehicles are driven each year is different under 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. EPA also notes that consumers who drive more than our average estimates for vehicle miles traveled (VMT) will experience more fuel savings; consumers who drive less than our average VMT estimates will experience less fuel savings.

The expected impacts on fuel consumption are shown in Table III.H.4–1. The gallons shown in the tables reflect impacts from the new CO_2 standards, including the A/C credit program, and include increased consumption resulting from the rebound effect.

TABLE III.H.4–1—FUEL CONSUMPTION IMPACTS OF THE VEHICLE STANDARDS AND A/C CREDIT PROGRAMS

[Million gallons]

Year	Total
2012	550
2013	1,320
2014	2,330
2015	3,750
2016	5,670
2020	12,590
2030	24,730
2040	32,620
2050	41,520

b. What are the monetized fuel savings?

Using the fuel consumption estimates presented in Section III.H.4.a, EPA can calculate the monetized fuel savings associated with the 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 2010 Early Release.[457] AEO is the government consensus estimate used by NHTSA and many other government agencies to estimate the projected price of fuel. EPA has done this calculation using both the pre-tax and post-tax fuel prices. Since the post-tax fuel prices are what consumers pay, the fuel savings calculated using these prices represent the savings consumers will see. The pre-tax fuel savings are those savings that society will see. These results are shown in Table III.H.4–2. Note that in Section III.H.10, EPA presents the benefit-cost of the rule and, for that reason, presents only the pre-tax fuel savings.

TABLE III.H.4–2—ESTIMATED MONETIZED FUEL SAVINGS

[Millions of 2007 dollars]

Calendar year	Fuel savings (pre-tax)	Fuel savings (post-tax)
2012	$1,137	$1,400
2013	2,923	3,800
2014	5,708	6,900
2015	9,612	11,300
2016	14,816	17,400
2020	35,739	41,100
2030	79,838	89,100
2040	119,324	131,700
2050	171,248	186,300
NPV, 3%	1,545,638	1,723,900
NPV, 7%	672,629	755,700

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 rule. As discussed further in Section III.H.1, it is a conundrum from an economic perspective that these large fuel savings have not been provided by automakers and purchased by consumers. A number of behavioral and market phenomena may lead to this disparity between the fuel economy that makes financial sense to consumers and the fuel economy they purchase. Regardless how consumers make their decisions on how much fuel economy to purchase, EPA expects that, in the aggregate, they will gain these fuel savings, which will provide actual money in consumers' pockets. We received considerable comment on this issue, as discussed in Section III.H.1, and the issue is discussed further in Chapter 8 of the RIA.

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

[457] Energy Information Administration. Annual Energy Outlook 2010 Early Release. Supplemental Transportation Tables. December 2009. *http://www.eia.doe.gov/oiaf/aeo/supplement/sup_tran.xls.*

vehicle, and vehicle owners respond to this reduction in operating costs by driving slightly more.

For this rule, 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,[458] and falls within the range of the larger body of historical work on the rebound effect.[459] 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.[460] 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.[461] The rebound effect is also further discussed in Chapter 4 of the Joint TSD which reviews the relevant literature and discusses in more depth the reasoning for the rebound values used here.

We received several comments on the proposed value of the rebound effect. The California Air Resources Board (CARB) and the New Jersey Department of Environmental Protection supported the use of a 10% rebound effect, although CARB encouraged EPA to consider lowering the value to 5%. Other commenters, such as the Missouri Department of Natural Resources, the International Council on Clean Transportation (ICCT), the Center for Biological Diversity, and the Consumer Federation of America, recommended using a lower rebound effect. ICCT specifically recommended that the dynamic rebound effect methodology utilized by Small & Van Dender was the most appropriate methodology, which would support a rebound effect of 5% or lower. In contrast, the National Association of Dealerships asserted that the rebound effect should be higher (*e.g.,* in the lower range of the 15–30% historical range), but did not submit any data to support this claim.

While we appreciate the input provided by commenters, we did not receive any new data or analysis to justify revising our initial estimates of the rebound effect at this time. Based on the positive comments we received, we will continue using the dynamic rebound effect to help inform our estimate of the rebound effect in future rulemakings. However, given the relatively new nature of this analytical approach, we believe the larger body of historical studies should also be considered when determining the value of the rebound effect. As we described in the Technical Support Document, the more recent literature suggests that the rebound effect is 10% or lower, whereas the larger body of historical studies suggests a higher rebound effect. Therefore, we will continue to use the 10% rebound effect for this rulemaking. However, we plan to update our estimate of the rebound effect in future rulemakings as new data becomes available.

We also invited comments on whether we should also explore other alternatives for estimating the rebound effect, such as whether it would be appropriate to use the price elasticity of demand for gasoline to guide the choice of a value for the rebound effect. We received only one comment on this issue from ICCT. In their comments, ICCT stated that the short run elasticity can provide a useful point of comparison for rebound effect estimates, but it should not be used to guide the choice of a value for the rebound effect. Therefore, we have not incorporated this metric into our analysis.

5. Impacts on U.S. Vehicle Sales and Payback Period

a. Vehicle Sales Impacts

This analysis compares two effects. On the one hand, the vehicles will become more expensive, which would, by itself, discourage sales. On the other hand, the vehicles will have improved fuel economy and thus lower operating costs. If consumers do not accurately compare the value of fuel savings with the increased cost of fuel economy technology in their vehicle purchase decisions, as discussed in Preamble III.H.1, they will continue to behave in this way after this rule. If auto makers have accurately gauged how consumers consider fuel economy when purchasing vehicles and have provided the amount that consumers want in vehicles, then consumers should not be expected to want the more fuel-efficient vehicles. After all, auto makers would have provided as much fuel economy as consumers want. If, on the other hand, auto makers underestimated consumer demand for fuel economy, as suggested by some commenters and discussed in Preamble Section III.H.1 and RIA Section 8.1.2, then this rule may lead to production of more desirable vehicles, and vehicle sales may increase. This assumption implies that auto makers have missed some profit-making opportunities.

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.[462] 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 GHG standards and assumes 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.[463] 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-

[458] 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–2009–0472–0018).

[459] 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–2009–0472–0012).

[460] 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–2009–0472–0002).

[461] Revised Report by David Greene of Oak Ridge National Laboratory to EPA, "Rebound 2007: Analysis of National Light-Duty Vehicle Travel Statistics," February 9, 2010 (Docket EPA–HQ–OAR–2009–0472–0220). This paper has been accepted for an upcoming special issue of Energy Policy, although the publication date has not yet been determined.

[462] 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–2009–0472–0015); 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–2009–0472–0016); 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–2009–0472–0017).

[463] 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–2009–0472–0007).

duty vehicle loan.[464] The one commenter on this analysis stated that use of the five-year payback period was reasonable. 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 received no comments on these adjustments. The only change to these adjustments between the NPRM and this discussion is an updating of the interest rate on auto loans. EPA estimates that, with corrections for these factors, the effect on consumer expenditures of the cost of the new technology should be 0.914 times the cost of the technology at a 3% discount rate, and 0.876 times the cost of the technology at a 7% discount rate. The details of this calculation are in the RIA, Chapter 8.1.

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. The values have changed slightly from the NPRM, due to changes in fuel prices and fuel savings, technology costs, and baseline vehicle sales projections, in addition to the adjustment in financing costs.

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 fuel savings associated with this rule are expected to exceed the technology costs, the effective prices of vehicles (the adjusted increase in technology cost less the fuel savings over five years) to consumers will fall, and consumers will buy more new vehicles. As a result, the lower net cost of the vehicles is projected to lead to an increase in sales for both cars and trucks.

As discussed above, this result depends on the assumption that more fuel efficient vehicles that yield net consumer benefits over five years would not otherwise be offered on the vehicle market due to market failures on the part of vehicle manufacturers. If vehicles that achieve the fuel economy standards prescribed by today's rulemaking would already be available, but consumers chose not to purchase them, then this rulemaking would not result in an increase in vehicle sales, because it does not alter how consumers make decisions about which vehicles to purchase. In addition, this analysis has not accounted for a number of factors that might affect consumer vehicle purchases, such as changing market conditions, changes in vehicle characteristics that might accompany improvements in fuel economy, or consumers considering a different "payback period" for their fuel economy purchases. If consumers use a shorter payback period, the sales impacts will be less positive, possibly negative; if consumers use a higher payback period, the impacts will be more positive. Also, this is an aggregate analysis; some individual consumers (those who drive less than estimated here) will face lower net benefits, while others (who drive more than estimated here) will have even greater savings. These complications add considerable uncertainty to our vehicle sales impact analysis.

TABLE III.H.5–1—VEHICLE SALES IMPACTS USING A 3% DISCOUNT RATE

	Change in car sales	% Change	Change in truck sales	% Change
2012	67,500	0.7	62,100	1.1
2013	76,000	0.8	190,200	3.2
2014	114,000	1.1	254,900	4.3
2015	222,200	2.1	352,800	6.1
2016	360,500	3.3	488,000	8.6

Table III.H.5–1 shows the impacts on new vehicle sales using a 3% discount rate. The fuel savings over five years 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	% Change	Change in truck sales	% Change
2012	62,800	0.7	58,300	1
2013	70,500	0.7	92,300	1.5
2014	106,100	1	127,700	2.1

[464] As discussed further in Section III.H.1, 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, and possibly due to sensitivity of results to modeling and data used. A survey by Greene (Greene, David L. "How Consumers Value Fuel Economy: A Literature Review." EPA Report EPA–420–R–10–008, March 2010 (Docket EPA–HQ–OAR–2009–0472–11575)) finds that estimates in the literature of the value that consumers place on fuel economy when buying a vehicle range from negative—consumers would pay to *reduce* fuel economy—to more than 1000 times the value of fuel savings.

TABLE III.H.5–2—NEW VEHICLE SALES IMPACTS USING A 7% DISCOUNT RATE—Continued

	Change in car sales	% Change	Change in truck sales	% Change
2015	208,400	2	194,200	3.3
2016	339,400	3.1	280,000	4.9

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 (*i.e.,* 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 this rule on fuel use and emissions.

Because the agencies are uncertain about how the value of projected fuel savings from this rule 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.

A detailed discussion of the vehicle sales impacts methodology is provided in the Chapter 8 of EPA's RIA.

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 new standards. In other words, how long would it take for the expected fuel savings to outweigh the increased cost of a new vehicle? For example, a new 2016 MY vehicle is estimated to cost $948 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.H.10) for details on fuel savings). But how many months or years would pass before the fuel savings exceed the upfront cost of $948?

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 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). Not included here are the likely A/C-related maintenance savings as discussed in Chapter 2 of EPA's 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 think about most while in the showroom considering a new car purchase. Car/truck fleet weighting is handled as described in Chapter 1 of the Joint TSD. As can be seen in the table, it will take under 3 years (2 years and 7 months at a 3% discount rate, 2 years and 9 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 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	$1,018	$424	$418	$410
2		$420	$820	$790
3		$414	$1,204	$1,139
4		$402	$1,567	$1,457

[a] Increased vehicle cost due to the rule is $948; 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 RIA.

[b] Calculated using AEO 2010 Early Release 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 February 9, 2010, the national average interest rate for a 5 year new car loan was 6.54 percent. If the increased vehicle cost is spread out over 5 years at 6.54 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 $177 in discounted net savings (3% discount rate) 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 $15 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	$245	$424	$177	$173
2	$245	$420	$167	$158
3	$245	$414	$157	$142
4	$245	$402	$142	$124
5	$245	$391	$127	$107
6	$0	$374	$318	$258

[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 6.54 percent.
[b] Calculated using AEO 2010 Early Release 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 $3,100 at a 3% discount rate, or $2,300 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	$1,018	$4,306	$3,303
Credit [a]	1,140	4,306	3,166
7% discount rate			
Cash	1,018	3,381	2,396
Credit [a]	1,040	3,381	2,340

[a] Assumes a 5 year loan at 6.54 percent.
[b] Fuel savings here were calculated using AEO 2010 Early Release 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. Social Cost of Carbon

In today's final rule, EPA and NHTSA assigned a dollar value to reductions in CO_2 emissions using the marginal dollar value of climate-related damages resulting from carbon emissions, also referred to as "social cost of carbon" (SCC). The SCC estimates used in today's rule were recently developed by an interagency process, in which EPA and NHTSA participated. As part of the interagency group, EPA and NHTSA have critically evaluated the new SCC estimates and endorse them for use in these regulatory analyses, for the reasons presented below. The SCC TSD, *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,* presents a more detailed description of the methodology used to generate the new estimates, the underlying assumptions, and the limitations of the new SCC estimates.

Under Executive Order 12866, agencies are required, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the SCC estimates presented here is to incorporate the social benefits of reducing carbon dioxide (CO_2) emissions from light-duty vehicles into a cost-benefit analysis of this final rule, which has a small, or "marginal," impact on cumulative global emissions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

The interagency process that developed these SCC estimates involved a group of technical experts from numerous agencies, which met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literatures. In this way, key uncertainties and model differences transparently and consistently inform the range of SCC estimates used in this rulemaking process.

The interagency group selected four SCC values for use in regulatory analyses, which EPA and NHTSA have applied to this final rule. Three values are based on the average SCC from three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95th percentile SCC estimate across all three models at a 3 percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution.

TABLE III.H.6–1—SOCIAL COST OF CO_2, 2010—2050[a]

[in 2007 dollars]

Year	Discount Rate			
	5% Avg	3% Avg	2.5% Avg	3% 95th
2010	5	21	35	65
2015	6	24	38	73
2020	7	26	42	81
2025	8	30	46	90
2030	10	33	50	100
2035	11	36	54	110
2040	13	39	58	119
2045	14	42	62	128
2050	16	45	65	136

[a] The SCC estimates presented above have been rounded to nearest dollar for consistency with the benefits analysis. The SCC TSD presents estimates rounded to the nearest tenth of a cent.

i. Monetizing Carbon Dioxide Emissions

The "social cost of carbon" (SCC) is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. We report estimates of the social cost of carbon in dollars per metric ton of carbon dioxide throughout this document.

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of serious challenges. A 2009 report from the National Academies of Science points out that any assessment will suffer from uncertainty, speculation, and lack of information about (1) future emissions of greenhouse gases, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages.[465] As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

Despite the serious limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing carbon dioxide emissions. Under Executive Order 12866, agencies are required, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." EPA and NHTSA have used the SCC estimates to incorporate social benefits from reducing carbon dioxide emissions from light-duty vehicles into a cost-benefit analysis of this final rule, which has a small, or "marginal," impact on cumulative global emissions. Most Federal regulatory actions can be expected to have marginal impacts on global emissions.

For policies that have marginal impacts on global emissions, the benefits from reduced (or costs from increased) emissions in any future year can be estimated by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years. This approach assumes that the marginal damages from increased emissions are constant for small departures from the baseline emissions path, an approximation that is reasonable for policies that have effects on emissions that are small relative to cumulative global carbon dioxide emissions. For policies that have a large (non-marginal) impact on global cumulative emissions, there is a separate question of whether the SCC is an appropriate tool for calculating the benefits of reduced emissions; we do not attempt to answer that question here.

As noted above, the interagency group convened on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key inputs and assumptions in order to generate SCC estimates. In addition to EPA and NHTSA, agencies that actively participated in the interagency process included the Departments of Agriculture, Commerce, Energy, and Treasury. This process was convened by the Council of Economic Advisers and the Office of Management and Budget, with active participation and regular input from the Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy. The main objective of this process was to develop a range of SCC values using a defensible

[465] National Research Council (2009). *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* National Academies Press.

set of input assumptions that are grounded in the existing literature. In this way, key uncertainties and model differences can more transparently and consistently inform the range of SCC estimates used in the rulemaking process.

The interagency group selected four global SCC estimates for use in regulatory analyses. For 2010, these estimates are $5, $21, $35, and $65 (in 2007 dollars). The first three estimates are based on the average SCC across models and socio-economic and emissions scenarios at the 5, 3, and 2.5 percent discount rates, respectively. The fourth value is included to represent the higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. For this purpose, we use the SCC value for the 95th percentile at a 3 percent discount rate. The central value is the average SCC across models at the 3 percent discount rate. For purposes of capturing the uncertainties involved in regulatory impact analysis, we emphasize the importance and value of considering the full range. These SCC estimates also grow over time. For instance, the central value increases to $24 per ton of CO_2 in 2015 and $26 per ton of CO_2 in 2020. See the SCC TSD for the full range of annual SCC estimates from 2010 to 2050.

These new SCC estimates represent global measures and the center of our current attention because of the distinctive nature of the climate change problem. The climate change problem is highly unusual in at least two respects. First, it involves a global externality: Emissions of most greenhouse gases contribute to damages around the world even when they are emitted in the United States. Consequently, to address the global nature of the problem, the SCC must incorporate the full (global) damages caused by GHG emissions. Second, climate change presents a problem that the United States alone cannot solve. Even if the United States were to reduce its greenhouse gas emissions to zero, that step would be far from enough to avoid substantial climate change. Other countries would also need to take action to reduce emissions if significant changes in the global climate are to be avoided.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. Specifically, the interagency group has set a preliminary goal of revisiting the SCC values within two years or at such time as substantially updated models become available, and to continue to support research in this area. In the meantime, the interagency group will continue to explore the issues raised in the SCC TSD and consider public comments as part of the ongoing interagency process.

ii. Social Cost of Carbon Values Used in Past Regulatory Analyses

To date, economic analyses for Federal regulations have used a wide range of values to estimate the benefits associated with reducing carbon dioxide emissions. In the final model year 2011 CAFE rule, the Department of Transportation (DOT) used both a "domestic" SCC value of $2 per ton of CO_2 and a "global" SCC value of $33 per ton of CO_2 for 2007 emission reductions (in 2007 dollars), increasing both values at 2.4 percent per year. It also included a sensitivity analysis at $80 per ton of CO_2. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

A 2008 regulation proposed by DOT assumed a domestic SCC value of $7 per ton CO_2 (in 2006 dollars) for 2011 emission reductions (with a range of $0-$14 for sensitivity analysis), also increasing at 2.4 percent per year. A regulation finalized by DOE in October of 2008 used a domestic SCC range of $0 to $20 per ton CO_2 for 2007 emission reductions (in 2007 dollars). In addition, EPA's 2008 Advance Notice of Proposed Rulemaking for Greenhouse Gases identified what it described as "very preliminary" SCC estimates subject to revision. EPA's global mean values were $68 and $40 per ton CO_2 for discount rates of approximately 2 percent and 3 percent, respectively (in 2006 dollars for 2007 emissions).

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted.

The outcome of the preliminary assessment by the interagency group was a set of five interim values: Global SCC estimates for 2007 (in 2006 dollars) of $55, $33, $19, $10, and $5 per ton of CO_2. The $33 and $5 values represented model-weighted means of the published estimates produced from the most recently available versions of three integrated assessment models (DICE, PAGE, and FUND) at approximately 3 and 5 percent discount rates.[466] The $55 and $10 values were derived by adjusting the published estimates for uncertainty in the discount rate (using factors developed by Newell and Pizer (2003)) at 3 and 5 percent discount rates, respectively.[467] The $19 value was chosen as a central value between the $5 and $33 per ton estimates. All of these values were assumed to increase at 3 percent annually to represent growth in incremental damages over time as the magnitude of climate change increases.

These interim values represent the first sustained interagency effort within the U.S. Government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules and were offered for public comment in connection with proposed rules. In particular, EPA and NHTSA used the interim SCC estimates in the joint proposal leading to this final rule.

iii. Approach and Key Assumptions

Since the release of the interim values, interagency group has reconvened on a regular basis to generate improved SCC estimates, which EPA and NHTSA used in this final rule. Specifically, the group has considered public comments and further explored the technical literature in relevant fields. The general approach to estimating SCC values was to run the three integrated assessment models (FUND, DICE, and PAGE) using the following inputs agreed upon by the interagency group:

- A Roe and Baker distribution for the climate sensitivity parameter bounded between 0 and 10 with a median of 3 °C and a cumulative probability between 2 and 4.5 °C of two-thirds.[468]

[466] The DICE (Dynamic Integrated Climate and Economy) model by William Nordhaus evolved from a series of energy models and was first presented in 1990 (Nordhaus and Boyer 2000, Nordhaus 2008). The PAGE (Policy Analysis of the Greenhouse Effect) model was developed by Chris Hope in 1991 for use by European decision-makers in assessing the marginal impact of carbon emissions (Hope 2006, Hope 2008). The FUND (Climate Framework for Uncertainty, Negotiation, and Distribution) model, developed by Richard Tol in the early 1990s, originally to study international capital transfers in climate policy, is now widely used to study climate impacts (*e.g.,* Tol 2002a, Tol 2002b, Anthoff *et al.* 2009, Tol 2009).

[467] Newell, R., and W. Pizer. 2003. Discounting the distant future: How much do uncertain rates increase valuations? *Journal of Environmental Economics and Management* 46: 52–71.

[468] Roe, G., and M. Baker. 2007. "Why is climate sensitivity so unpredictable?" *Science* 318:629–632.

• Five sets of GDP, population and carbon emissions trajectories based on the recent Stanford Energy Modeling Forum, EMF–22.

• Constant annual discount rates of 2.5, 3, and 5 percent.

The SCC TSD presents a summary of the results and details, the modeling exercise and the choices and assumptions that underlie the resulting estimates of the SCC. The complete model results are available in the docket for this final rule [EPA–HQ–OAR–2009–0472].

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable since they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The National Academy of Science (2009) points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. The SCC TSD highlights a number of concerns and problems that should be addressed by the research community, including research programs housed in many of the agencies participating in the interagency process to estimate the SCC.

The U.S. Government will periodically review and reconsider estimates of the SCC used for cost-benefit analyses to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling. In this context, statements recognizing the limitations of the analysis and calling for further research take on exceptional significance. The interagency group offers the new SCC values with all due humility about the uncertainties embedded in them and with a sincere promise to continue work to improve them.

iv. Use of New SCC Estimates To Calculate GHG Benefits for This Final Rule

The table below summarizes the total GHG benefits for the lifetime of the rule, which are calculated by using the four new SCC values. Specifically, EPA calculated the total monetized benefits in each year by multiplying the marginal benefits estimates per metric ton of CO_2 (the SCC) by the reductions in CO_2 for that year.

TABLE III.H.6–2—MONETIZED CO_2 BENEFITS OF VEHICLE PROGRAM, CO_2 EMISSIONS [a b]

[Million 2007$]

Year	CO_2 emissions reduction (Million metric tons)	Benefits			
		Avg SCC at 5% ($5–$16) [c]	Avg SCC at 3% ($21–$45) [c]	Avg SCC at 2.5% ($35–$65) [c]	95th percentile SCC at 3% ($65–$136) [c]
2020	139	$900	$3,700	$5,800	$11,000
2030	273	2,700	8,900	14,000	27,000
2040	360	4,600	14,000	21,000	43,000
2050	459	7,200	21,000	30,000	62,000

[a] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

[b] Numbers may not compute exactly from Tables III.H.6–1 and III.H.6–2 due to rounding.

[c] As noted above, SCC increases over time; tables lists ranges for years 2010 through 2050. See Table III.H.6–1 for the SCC estimates corresponding to the years in this table.

b. Summary of the Response to Comments

EPA and NHTSA received extensive public comments about the scientific, economic, and ethical issues involved in estimating the SCC, including the proposed rule's estimates of the value of emissions reductions from new cars and trucks.[469] In particular, the comments addressed the methodology used to derive the interim SCC estimates, limitations of integrated assessment models, discount rate selection, treatment of uncertainty and catastrophic impacts, use of global and domestic SCC, and the presentation and use of SCC estimates. The rest of this preamble section briefly summarizes EPA's response to the comments; the Response to Comments document provides the complete responses to all comments received.

EPA received extensive comments about the methodology and discount rates used to derive the interim SCC estimates. While one commenter from the auto industry noted that the interim methodology was acceptable given available data, many commenters (representing academic and environmental organizations) expressed concerns that the filters were too narrow, stated that model-weighting averaging was inappropriate, and recommended that EPA use lower discount rates. These commenters also discussed alternative approaches to select discount rates and generally recommended that EPA use lower rates to give more weight to climate damages experienced by future generations.

For the final rule, EPA conducted new analyses of SCC. EPA did not continue with its interim approach to derive estimates from the existing literature and instead conducted new model runs that produced a vast amount of SCC data at three separate certainty-equivalent discount rates (2.5, 3, and 5 percent). As discussed further in the SCC TSD, this modeling exercise resulted in a fuller distribution of SCC estimates and better accounted for uncertainty through a Monte Carlo analysis. Comments on specific issues are addressed in the Response to Comments document.

EPA received comments on the limitations of the integrated assessment models concluding that the selection of models and reliance on the model authors' datasets contributed to the downward bias of the interim SCC estimates. In this final rule, EPA relied on the default values in each model for the remaining parameter; research gaps

[469] EPA estimated GHG benefits in the proposed rule using a set of interim SCC values developed by an interagency group, in which EPA and NHTSA participated. As discussed in the SCC TSD, the interagency group selected the interim estimates from the existing literature and agreed to use those interim estimates in regulatory analyses until it could develop a more comprehensive characterization of the SCC.

and practical constraints required EPA to limit its modification of the models to socioeconomic and emissions scenarios, climate sensitivity, and discount rate. While EPA recognizes that the models' translations of physical impacts to economic values are incomplete, approximate, and highly uncertain, it regards them as the best currently available representations. EPA also considered, for each model, the treatment of uncertainty, catastrophic impacts, and omitted impacts, and as discussed in the SCC TSD and the Response to Comments document, used best available information and techniques to quantify such impacts as feasible and supplemented the SCC with qualitative assessments. Comments on specific issues are addressed in the Response to Comments document.

Six commenters, representing academia and environmental organizations, supported the proposed rule's preference for global SCC estimates while several industry groups stated that under the Clean Air Act, EPA is prohibited from using global estimates. EPA agrees that a global measure of GHG mitigation benefits is both appropriate and lawful for EPA to consider in evaluating the benefits of GHG emissions standards adopted under section 202(a). Global climate change represents a problem that the United States cannot solve alone without global action, and for a variety of reasons there is a value to the U.S. from domestic emissions reductions that reduce the harm occurring globally. This is not exercise of regulatory authority over conduct occurring overseas, but instead is a reasonable exercise of discretion in how to place a monetary value on a reduction in domestic emissions. See the Response to Comments document for a complete discussion of this issue.

Finally, EPA received various comments regarding the presentation of the SCC methodology and resulting estimates. EPA has responded to these concerns by presenting a detailed discussion about the methodology, including key model assumptions, as well as uncertainties and research gaps associated with the SCC estimates and the implications for the SCC estimates. Among these key assumptions and uncertainties are issues involving discount rates, climate sensitivity and socioeconomic scenario assumptions, incomplete treatment of potential catastrophic impacts, incomplete treatment of non-catastrophic impacts, uncertainty in extrapolation of damages to high temperatures, incomplete treatment of adaptation and technological change, and assumptions about risk aversion to high-impact outcomes (*see* SCC TSD).

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 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 standards are also significant sources of mobile source air pollution such as direct PM, NO_X, VOCs and air toxics. The standards will affect exhaust emissions of these pollutants from vehicles. They will also affect emissions from upstream sources related to changes in fuel consumption. Changes in ambient ozone, $PM_{2.5}$, and air toxics that will result from the 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.

As many commenters noted, it is important to quantify the health and environmental impacts associated with the final rule 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 timeframe of several decades or longer.

This section is split into two sub-sections: The first presents the PM- and ozone-related health and environmental impacts associated with the final rule in calendar year (CY) 2030; the second presents the PM-related benefits-per-ton values used to monetize the PM-related co-benefits associated with the model year (MY) analysis of the final rule.[470]

a. Quantified and Monetized Non-GHG Human Health Benefits of the 2030 Calendar Year (CY) Analysis

This analysis reflects the impact of the final light-duty GHG rule in 2030 compared to a future-year reference scenario without the rule in place. Overall, we estimate that the final rule will lead to a net decrease in $PM_{2.5}$-related health impacts (see Section III.G.5 of this preamble for more information about the air quality modeling results). While the PM-related air quality impacts are relatively small, the decrease in population-weighted national average $PM_{2.5}$ exposure results in a net decrease in adverse PM-related human health impacts (the decrease in national population-weighted annual average $PM_{2.5}$ is 0.0036 $\mu g/m^3$).

The air quality modeling (discussed in Section III.G.5) projects very small increases in ozone concentrations in many areas, but these are driven by the ethanol production volumes mandated by the recently finalized RFS2 rule and are not due to the standards finalized in this rule. While the ozone-related impacts are very small, the increase in population-weighted national average ozone exposure results in a small increase in ozone-related health impacts (population-weighted maximum 8-hour average ozone increases by 0.0104 ppb).

We base our analysis of the final rule's impact on human health in 2030 on peer-reviewed studies of air quality and human health effects.[471] [472] These methods are described in more detail in the RIA that accompanies this action. Our benefits methods are also consistent with recent rulemaking analyses such as the proposed Portland Cement National Emissions Standards for Hazardous Air Pollutants (NESHAP) RIA,[473] the final NO_2 NAAQS,[474] and the final Category 3 Marine Engine rule.[475] To model the

[470] EPA typically analyzes rule impacts (emissions, air quality, costs and benefits) in the year in which they occur; for this analysis, we selected 2030 as a representative future year. We refer to this analysis as the "Calendar Year" (CY) analysis. EPA also conducted a separate analysis of the impacts over the model year lifetimes of the 2012 through 2016 model year vehicles. We refer to this analysis as the "Model Year" (MY) analysis. In contrast to the CY analysis, the MY lifetime analysis shows the lifetime impacts of the program on each of these MY fleets over the course of its lifetime.

[471] U.S. Environmental Protection Agency. (2006). *Final Regulatory Impact Analysis (RIA) for the National Ambient Air Quality Standards for Particulate Matter.* Prepared by: Office of Air and Radiation. Retrieved March 26, 2009 at *http://www.epa.gov/ttn/ecas/ria.html.* EPA–HQ–OAR–2009–0472–0240.

[472] 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. Retrieved March 26, 2009 at *http://www.epa.gov/ttn/ecas/ria.html.* EPA–HQ–OAR–2009–0472–0238.

[473] U.S. Environmental Protection Agency (U.S. EPA). 2009. Regulatory Impact Analysis: National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry. Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. Available on the Internet at *http://www.epa.gov/ttn/ecas/regdata/RIAs/portlandcementria_4-20-09.pdf.* Accessed March 15, 2010. EPA–HQ–OAR–2009–0472–0241.

[474] U.S. Environmental Protection Agency (U.S. EPA). 2010. Final NO_2 NAAQS Regulatory Impact Analysis (RIA). Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. Available on the Internet at *http://www.epa.gov/ttn/ecas/regdata/RIAs/FinalNO2RIAfulldocument.pdf.* Accessed March 15, 2010. EPA–HQ–OAR–2009–0472–0237.

[475] U.S. Environmental Protection Agency. 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel

ozone and PM air quality impacts of the final rule, we used the Community Multiscale Air Quality (CMAQ) model (see Section III.G.5). The modeled ambient air quality data serves as an input to the Environmental Benefits Mapping and Analysis Program (BenMAP).[476] BenMAP is a computer program developed by the U.S. EPA that integrates a number of the modeling elements used in previous analyses (*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.

The range of total monetized ozone- and PM-related health impacts is presented in Table III.H.7–1. We present total benefits based on the PM- and ozone-related premature mortality function used. The benefits ranges therefore reflect the addition of each estimate of ozone-related premature mortality (each with its own row in Table III.H.7–1) to estimates of PM-related premature mortality. These estimates represent EPA's preferred approach to characterizing a best estimate of benefits. As is the nature of Regulatory Impact Analyses (RIAs), the assumptions and methods used to estimate air quality benefits evolve to reflect the Agency's most current interpretation of the scientific and economic literature.

TABLE III.H.7–1—ESTIMATED 2030 MONETIZED PM- AND OZONE-RELATED HEALTH BENEFITS [a]

2030 Total Ozone and PM Benefits—PM Mortality Derived from American Cancer Society Analysis and Six-Cities Analysis [a]

Premature Ozone Mortality Function	Reference	Total Benefits (Millions, 2007$, 3% Discount Rate) [b c d]	Total Benefits (Millions, 2007$, 7% Discount Rate) [b c d]
Multi-city analyses	Bell *et al.,* 2004	Total: $510–$1,300 PM: $550–$1,300 Ozone: −$40	Total: $460–$1,200 PM: $500–$1,200 Ozone: −$40
	Huang *et al.,* 2005	Total: $490–$1,300 PM: $550–$1,300 Ozone: −$64	Total: $440–$1,200 PM: $500–$1,200 Ozone: −$64
	Schwartz, 2005	Total: $490–$1,300 PM: $550–$1,300 Ozone: −$60	Total: $440–$1,200 PM: $500–$1,200 Ozone: −$60
Meta-analyses	Bell *et al.,* 2005	Total: $430–$1,200 PM: $550–$1,300 Ozone: −$120	Total: $380–$1,100 PM: $500–$1,200 Ozone: −$120
	Ito *et al.,* 2005	Total: $380–$1,200 PM: $550–$1,300 Ozone: −$170	Total: $330–$1,000 PM: $500–$1,200 Ozone: −$170
	Levy *et al.,* 2005	Total: $380–$1,200 PM: $550–$1,300 Ozone: −$170	Total: $330–$1,000 PM: $500–$1,200 Ozone: −$170

Notes:

[a] Total includes premature mortality-related and morbidity-related ozone and $PM_{2.5}$ benefits. Range was developed by adding the estimate from the ozone premature mortality function to the estimate of $PM_{2.5}$-related premature mortality derived from either the ACS study (Pope *et al.,* 2002)[477] or the Six-Cities study (Laden et al., 2006).[478]

[b] Note that total benefits presented here do not include a number of unquantified benefits categories. A detailed listing of unquantified health and welfare effects is provided in Table III.H.7–2.

[c] Results reflect the use of both a 3 and 7 percent discount rate, as recommended by EPA's Guidelines for Preparing Economic Analyses and OMB Circular A–4. Results are rounded to two significant digits for ease of presentation and computation.

[d] Negatives indicate a disbenefit, or an increase in health effect incidence.

The benefits in Table III.H.7–1 include all of the human health impacts we are able to quantify and monetize at this time. However, the full complement of human health and welfare effects associated with PM and ozone remain unquantified because of current limitations in methods or available data. We have not quantified a number of known or suspected health effects linked with ozone and PM for which appropriate health impact functions are not available or which do not provide easily interpretable outcomes (*e.g.,* changes in heart rate variability). Additionally, we are unable to quantify a number of known welfare effects, including reduced acid and particulate deposition damage to cultural monuments and other materials, and environmental benefits due to reductions of impacts of eutrophication in coastal areas. These are listed in Table III.H.7–2. As a result, the health benefits quantified in this section are likely underestimates of the total benefits attributable to the final rule.

Engines. EPA–420–R–09–019, December 2009. Prepared by Office of Air and Radiation. *http://www.epa.gov/otaq/regs/nonroad/marine/ci/420r09019.pdf.* Accessed February 9, 2010. EPA–HQ–OAR–2009–0472–0283.

[476] Information on BenMAP, including downloads of the software, can be found at *http://www.epa.gov/ttn/ecas/benmodels.html.*

[477] Pope, C.A., III, R.T. Burnett, M.J. Thun, E.E. Calle, D. Krewski, K. Ito, and G.D. Thurston (2002). "Lung Cancer, Cardiopulmonary Mortality, and Long-term Exposure to Fine Particulate Air Pollution." Journal of the American Medical Association 287:1132–1141. EPA–HQ–OAR–2009–0472–0263.

[478] Laden, F., J. Schwartz, F.E. Speizer, and D.W. Dockery (2006). Reduction in Fine Particulate Air Pollution and Mortality. American Journal of Respiratory and Critical Care Medicine. 173:667–672. EPA–HQ–OAR–2009–0472–1661.

TABLE III.H.7–2—UNQUANTIFIED AND NON-MONETIZED POTENTIAL EFFECTS

Pollutant/effects	Effects not included in analysis—changes in:
Ozone Health [a]	Chronic respiratory damage [b]. Premature aging of the lungs [b]. Non-asthma respiratory emergency room visits. Exposure to UVb (+/−) [e].
Ozone Welfare	Yields for —commercial forests. —some fruits and vegetables. —non-commercial crops. Damage to urban ornamental plants. Impacts on recreational demand from damaged forest aesthetics. Ecosystem functions. Exposure to UVb (+/−) [e].
PM Health [c]	Premature mortality—short term exposures [d]. Low birth weight. Pulmonary function. Chronic respiratory diseases other than chronic bronchitis. Non-asthma respiratory emergency room visits. Exposure to UVb (+/−) [e].
PM Welfare	Residential and recreational visibility in non-Class I areas. Soiling and materials damage. Damage to ecosystem functions. Exposure to UVb (+/−) [e].
Nitrogen and Sulfate Deposition Welfare	Commercial forests due to acidic sulfate and nitrate deposition. Commercial freshwater fishing due to acidic deposition. Recreation in terrestrial ecosystems due to acidic deposition. Existence values for currently healthy ecosystems. Commercial fishing, agriculture, and forests due to nitrogen deposition. Recreation in estuarine ecosystems due to nitrogen deposition. Ecosystem functions. Passive fertilization.
CO Health	Behavioral effects.
HC/Toxics Health [f]	Cancer (benzene, 1,3-butadiene, formaldehyde, acetaldehyde). Anemia (benzene). Disruption of production of blood components (benzene). Reduction in the number of blood platelets (benzene). Excessive bone marrow formation (benzene). Depression of lymphocyte counts (benzene). Reproductive and developmental effects (1,3-butadiene). Irritation of eyes and mucus membranes (formaldehyde). Respiratory irritation (formaldehyde). Asthma attacks in asthmatics (formaldehyde). Asthma-like symptoms in non-asthmatics (formaldehyde). Irritation of the eyes, skin, and respiratory tract (acetaldehyde). Upper respiratory tract irritation and congestion (acrolein).
HC/Toxics Welfare	Direct toxic effects to animals. Bioaccumulation in the food chain. Damage to ecosystem function. Odor.

Notes:

[a] The public health impact of biological responses such as increased airway responsiveness to stimuli, inflammation in the lung, acute inflammation and respiratory cell damage, and increased susceptibility to respiratory infection are likely partially represented by our quantified endpoints.

[b] The public health impact of effects such as chronic respiratory damage and premature aging of the lungs may be partially represented by quantified endpoints such as hospital admissions or premature mortality, but a number of other related health impacts, such as doctor visits and decreased athletic performance, remain unquantified.

[c] In addition to primary economic endpoints, there are a number of biological responses that have been associated with PM health effects including morphological changes and altered host defense mechanisms. The public health impact of these biological responses may be partly represented by our quantified endpoints.

[d] While some of the effects of short-term exposures are likely to be captured in the estimates, there may be premature mortality due to short-term exposure to PM not captured in the cohort studies used in this analysis. However, the PM mortality results derived from the expert elicitation do take into account premature mortality effects of short term exposures.

[e] May result in benefits or disbenefits.

[f] Many of the key hydrocarbons related to this rule are also hazardous air pollutants listed in the CAA.

While there will be impacts associated with air toxic pollutant emission changes that result from the final rule, we do 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.[479] 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, we did not have the methods and tools available for national-scale application in time for the analysis of the final rule.[480]

EPA is also unaware of specific information identifying any effects on listed endangered species from the small fluctuations in pollutant concentrations associated with this rule (*see* Section III.G.5). Furthermore, our current modeling tools are not designed to trace fluctuations in ambient concentration levels to potential impacts on particular endangered species.

i. Quantified Human Health Impacts

Tables III.H.7–3 and III.H.7–4 present the annual $PM_{2.5}$ and ozone health impacts in the 48 contiguous U.S. states associated with the final rule for 2030. For each endpoint presented in Tables III.H.7–3 and III.H.7–4, we provide both the mean estimate and the 90% confidence interval.

Using EPA's preferred estimates, based on the American Cancer Society (ACS) and Six-Cities studies and no threshold assumption in the model of mortality, we estimate that the final rule will result in between 60 and 150 cases of avoided $PM_{2.5}$-related premature deaths annually in 2030. As a sensitivity analysis, when the range of expert opinion is used, we estimate between 22 and 200 fewer premature mortalities in 2030 (*see* Table 7.7 in the RIA that accompanies this rule). For ozone-related premature mortality in 2030, we estimate a range of between 4 to 18 additional premature mortalities related to the ethanol production volumes mandated by the recently finalized RFS2 rule[481] (and reflected in the air quality modeling for this rule), but are not due to the final standards themselves.

TABLE III.H.7–3—ESTIMATED $PM_{2.5}$-RELATED HEALTH IMPACTS[a]

Health effect	2030 Annual reduction in incidence (5th%–95th%ile)
Premature Mortality—Derived from epidemiology literature:[b]	
Adult, age 30+, ACS Cohort Study (Pope *et al.,* 2002)	60 (23–96)
Adult, age 25+, Six-Cities Study (Laden *et al.,* 2006)	150 (83–220)
Infant, age <1 year (Woodruff *et al.,* 1997)	0 (0–1)
Chronic bronchitis (adult, age 26 and over)	42 (8–77)
Non-fatal myocardial infarction (adult, age 18 and over)	100 (38–170)
Hospital admissions—respiratory (all ages)[c]	13 (7–20)
Hospital admissions—cardiovascular (adults, age >18)[d]	32 (23–38)
Emergency room visits for asthma (age 18 years and younger)	42 (25–59)
Acute bronchitis (children, age 8–12)	95 (0–190)
Lower respiratory symptoms (children, age 7–14)	1,100 (540–1,700)
Upper respiratory symptoms (asthmatic children, age 9–18)	850 (270–1,400)
Asthma exacerbation (asthmatic children, age 6–18)	1,000 (120–2,900)
Work loss days	7,600 (6,600–8,500)
Minor restricted activity days (adults age 18–65)	45,000 (38,000–52,000)

Notes:

[a] Incidence is rounded to two significant digits. Estimates represent incidence within the 48 contiguous United States.

[b] PM-related adult mortality based upon the American Cancer Society (ACS) Cohort Study (Pope *et al.,* 2002) and the Six-Cities Study (Laden *et al.,* 2006). Note that these are two alternative estimates of adult mortality and should not be summed. PM-related infant mortality based upon a study by Woodruff, Grillo, and Schoendorf (1997).[482]

[c] Respiratory hospital admissions for PM include admissions for chronic obstructive pulmonary disease (COPD), pneumonia and asthma.

[d] Cardiovascular hospital admissions for PM include total cardiovascular and subcategories for ischemic heart disease, dysrhythmias, and heart failure.

TABLE III.H.7–4—ESTIMATED OZONE-RELATED HEALTH IMPACTS[a]

Health effect	2030 Annual reduction in incidence (5th%–95th%ile)
Premature Mortality, All ages[b]	
Multi-City Analyses:	
Bell *et al.* (2004)—Non-accidental	−4 (−8–0)
Huang *et al.* (2005)—Cardiopulmonary	−7 (−14–1)

[479] 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.* EPA–HQ–OAR–2009–0472–0244.

[480] In April 2009, EPA hosted a workshop on estimating the benefits or reducing hazardous air pollutants. This workshop built upon the work accomplished in the June 2000 Science Advisory Board/EPA Workshop on the Benefits of Reductions in Exposure to Hazardous Air Pollutants, which generated thoughtful discussion on approaches to estimating human health benefits from reductions in air toxics exposure, but no consensus was reached on methods that could be implemented in the near term for a broad selection of air toxics. Please visit *http://epa.gov/air/toxicair/2009workshop.html.* for more information about the workshop and its associated materials.

[481] EPA 2010, Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis. EPA–420–R–10–006. February 2010. Docket EPA–HQ–OAR–2009–0472–11332. EPA–HQ–OAR–2009–0472–11332. *See also* 75 FR 14670, March 26, 2010.

[482] Woodruff, T.J., J. Grillo, and K.C. Schoendorf. 1997. "The Relationship Between Selected Causes of Postneonatal Infant Mortality and Particulate Air Pollution in the United States." *Environmental Health Perspectives* 105(6):608–612. EPA–HQ–OAR–2009–0472–0382.

TABLE III.H.7–4—ESTIMATED OZONE-RELATED HEALTH IMPACTS [a]—Continued

Health effect	2030 Annual reduction in incidence (5th%–95th%ile)
Schwartz (2005)—Non-accidental	−6 (−13–1)
Meta-analyses:	
Bell *et al.* (2005)—All cause	−13 (−24–−2)
Ito *et al.* (2005)—Non-accidental	−18 (−30–−6)
Levy *et al.* (2005)—All cause	−18 (−28–−9)
Hospital admissions—respiratory causes (adult, 65 and older) [c]	−38 (−86–−6)
Hospital admissions—respiratory causes (children, under 2)	−6 (−13–1)
Emergency room visit for asthma (all ages)	−16 (−51–8)
Minor restricted activity days (adults, age 18–65)	−18,000 (−40,000–3,700)
School absence days	−7,700 (−16,000–1,200)

Notes:

[a] Negatives indicate a disbenefit, or an increase in health effect incidence. Incidence is rounded to two significant digits. Estimates represent incidence within the 48 contiguous U.S.

[b] Estimates of ozone-related premature mortality are based upon incidence estimates derived from several alternative studies: Bell *et al.* (2004); Huang *et al.* (2005); Schwartz (2005); Bell *et al.* (2005); Ito *et al.* (2005); Levy *et al.* (2005). The estimates of ozone-related premature mortality should therefore not be summed.

[c] Respiratory hospital admissions for ozone include admissions for all respiratory causes and subcategories for COPD and pneumonia.

ii. Monetized Benefits

Table III.H.7–5 presents the estimated monetary value of changes in the incidence of ozone and $PM_{2.5}$-related health effects. All monetized estimates are stated in 2007$. These estimates account for growth in real gross domestic product (GDP) per capita between the present and 2030. Our estimate of total monetized benefits in 2030 for the final rule, using the ACS and Six-Cities PM mortality studies and the range of ozone mortality assumptions, is between $380 and $1,300 million, assuming a 3 percent discount rate, or between $330 and $1,200 million, assuming a 7 percent discount rate. As the results indicate, total benefits are driven primarily by the reduction in $PM_{2.5}$-related premature fatalities each year.

TABLE III.H.7–5—ESTIMATED MONETARY VALUE OF CHANGES IN INCIDENCE OF HEALTH AND WELFARE EFFECTS

[In Millions of 2007$] [a b]

$PM_{2.5}$-related health effect		2030 (5th and 95th%ile)
Premature Mortality—Derived from Epidemiology Studies [c d].	Adult, age 30+—ACS study (Pope *et al.,* 2002)	
	3% discount rate	$510 ($70–$1,300)
	7% discount rate	$460 ($63–$1,200)
	Adult, age 25+—Six-Cities study (Laden *et al.,* 2006)	
	3% discount rate	$1,300 ($190–$3,300)
	7% discount rate	$1,200 ($180–$3,000)
	Infant Mortality, <1 year—(Woodruff *et al.* 1997)	$1.8 ($0–$7.0)
Chronic bronchitis (adults, 26 and over)		$22 ($1.9–$77)
Non-fatal acute myocardial infarctions		
3% discount rate		$14 ($3.9–$35)
7% discount rate		$14 ($3.6–$35)
Hospital admissions for respiratory causes		$0.20 ($0.01–$0.29)
Hospital admissions for cardiovascular causes		$0.91 ($0.58–$1.3)
Emergency room visits for asthma		$0.016 ($0.009–$0.024)
Acute bronchitis (children, age 8–12)		$0.007 ($0–$0.018)
Lower respiratory symptoms (children, 7–14)		$0.022 ($0.009–$0.043)
Upper respiratory symptoms (asthma, 9–11)		$0.027 ($0.008–$0.061)
Asthma exacerbations		$0.058 ($0.006–$0.17)
Work loss days		$1.2 ($1.0–$1.3)
Minor restricted-activity days (MRADs)		$2.9 ($1.7–$4.2)
Ozone-related Health Effect		
Premature Mortality, All ages—Derived from Multi-city analyses.	Bell *et al.,* 2004	−$38 (−$110–$4.2)
	Huang *et al.,* 2005	−$62 (−$180–$4.7)
	Schwartz, 2005	−$58 (−$170–$8.8)
Premature Mortality, All ages—Derived from Meta-analyses.	Bell *et al.,* 2005	−$120 (−$330–−$7.9)
	Ito *et al.,* 2005	−$170 (−$430–−$19)
	Levy *et al.,* 2005	−$170 (−$410–−$21)
Hospital admissions—respiratory causes (adult, 65 and older)		−$0.92 (−$2.1–$0.27)

TABLE III.H.7–5—ESTIMATED MONETARY VALUE OF CHANGES IN INCIDENCE OF HEALTH AND WELFARE EFFECTS—Continued

[In Millions of 2007$] [a b]

$PM_{2.5}$-related health effect	2030 (5th and 95th%ile)
Hospital admissions—respiratory causes (children, under 2)	−$.21 (−$.45–$0.031)
Emergency room visit for asthma (all ages)	−$0.006 (−$0.018–$0.003)
Minor restricted activity days (adults, age 18–65)	−$1.2 (−$2.7–$0.25)
School absence days	−$0.71 (−$1.4–$0.11)

Notes:

[a] Negatives indicate a disbenefit, or an increase in health effect incidence. Monetary benefits are rounded to two significant digits for ease of presentation and computation. PM and ozone benefits are nationwide.

[b] Monetary benefits adjusted to account for growth in real GDP per capita between 1990 and the analysis year (2030).

[c] Valuation assumes discounting over the SAB recommended 20 year segmented lag structure. Results reflect the use of 3 percent and 7 percent discount rates consistent with EPA and OMB guidelines for preparing economic analyses.

iii. What are the limitations of the benefits analysis?

Every benefit-cost analysis examining the potential effects of a change in environmental protection requirements is limited to some extent by data gaps, limitations in model capabilities (such as geographic coverage), and uncertainties in the underlying scientific and economic studies used to configure the benefit and cost models. Limitations of the scientific literature often result in the inability to estimate quantitative changes in health and environmental effects, such as potential increases in premature mortality associated with increased exposure to carbon monoxide. Deficiencies in the economics literature often result in the inability to assign economic values even to those health and environmental outcomes which can be quantified. These general uncertainties in the underlying scientific and economics literature, which can lead to valuations that are higher or lower, are discussed in detail in the RIA and its supporting references. Key uncertainties that have a bearing on the results of the benefit-cost analysis of the final rule include the following:

- The exclusion of potentially significant and unquantified benefit categories (such as health, odor, and ecological impacts of air toxics, ozone, and PM);
- Errors in measurement and projection for variables such as population growth;
- Uncertainties in the estimation of future year emissions inventories and air quality;
- Uncertainty in the estimated relationships of health and welfare effects to changes in pollutant concentrations including the shape of the C–R function, the size of the effect estimates, and the relative toxicity of the many components of the PM mixture;
- Uncertainties in exposure estimation; and
- Uncertainties associated with the effect of potential future actions to limit emissions.

As Table III.H.7–5 indicates, total benefits are driven primarily by the reduction in $PM_{2.5}$-related premature mortalities each year. Some key assumptions underlying the premature mortality estimates include the following, which may also contribute to uncertainty:

- Inhalation of fine particles is causally associated with premature death at concentrations near those experienced by most Americans on a daily basis. Although biological mechanisms for this effect have not yet been completely established, the weight of the available epidemiological, toxicological, and experimental evidence supports an assumption of causality. The impacts of including a probabilistic representation of causality were explored in the expert elicitation-based results of the PM NAAQS RIA.
- All fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because PM produced via transported precursors emitted from engines may differ significantly from PM precursors released from electric generating units and other industrial sources. However, no clear scientific grounds exist for supporting differential effects estimates by particle type.
- The C–R function for fine particles is approximately 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, including both regions that may be in attainment with $PM_{2.5}$ standards and those that are at risk of not meeting the standards.
- There is uncertainty in the magnitude of the association between ozone and premature mortality. The range of ozone impacts associated with the final rule is estimated based on the risk of several sources of ozone-related mortality effect estimates. In a recent report on the estimation of ozone-related premature mortality published by the National Research Council, 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.[483] EPA has requested advice from the National Academy of Sciences on how best to quantify uncertainty in the relationship between ozone exposure and premature mortality in the context of quantifying benefits.

Acknowledging omissions and uncertainties, we present a best estimate of the total benefits based on our interpretation of the best available scientific literature and methods supported by EPA's technical peer review panel, the Science Advisory Board's Health Effects Subcommittee (SAB–HES). The National Academies of Science (NRC, 2002) has also reviewed EPA's methodology for analyzing the health benefits of measures taken to reduce air pollution. EPA addressed many of these comments in the analysis of the final PM NAAQS.[484 485] This

[483] National Research Council (NRC), 2008. Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution. The National Academies Press: Washington, DC. EPA–HQ–OAR–2009–0472–0322.

[484] National Research Council (NRC). 2002. Estimating the Public Health Benefits of Proposed Air Pollution Regulations. The National Academies Press: Washington, DC.

[485] U.S. Environmental Protection Agency. October 2006. *Final Regulatory Impact Analysis (RIA) for the National Ambient Air Quality* Continued

analysis incorporates this most recent work to the extent possible.

b. PM-Related Monetized Benefits of the Model Year (MY) Analysis

As described in Section III.G, the final standards will reduce emissions of several criteria and toxic pollutants and precursors. In the MY 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 $PM_{2.5}$.

The MY 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 associated with the MY analysis 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 the final rule.

The dollar-per-ton estimates used in this analysis are provided in Table III.H.7–6. 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 rule.

TABLE III.H.7–6—BENEFITS-PER-TON VALUES (2007$) DERIVED USING THE ACS COHORT STUDY FOR PM-RELATED PREMATURE MORTALITY (POPE ET AL., 2002) [a]

Year [c]	All sources [d]		Stationary (non-EGU) sources		Mobile sources	
	SO_X	VOC	NO_X	Direct $PM_{2.5}$	NO_X	Direct $PM_{2.5}$
Estimated Using a 3 Percent Discount Rate [b]						
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
Estimated Using a 7 Percent Discount Rate [b]						
2015	26,000	1,100	4,200	200,000	4,400	240,000
2020	28,000	1,200	4,600	220,000	4,800	270,000
2030	33,000	1,400	5,500	250,000	5,800	320,000
2040	39,000	1,600	6,600	300,000	6,900	380,000

[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 either a 3 percent or 7 percent discount rate in the valuation of premature mortality to account for a twenty-year segmented cessation lag.

[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,[486] the proposed Portland Cement National Emissions Standards for Hazardous Air Pollutants (NESHAP) RIA,[487] and the final NO_2 NAAQS (U.S. EPA, 2009b).[488] Table III.H.7–7 shows the quantified and unquantified $PM_{2.5}$-related co-benefits captured in those benefit-per-ton estimates.

TABLE III.H.7–7—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	Subchronic bronchitis cases. Low birth weight. Pulmonary function. Chronic respiratory diseases other than chronic bronchitis. Non-asthma respiratory emergency room visits. Visibility.

Standards for Particulate Matter. Prepared by: Office of Air and Radiation. Available at *http://www.epa.gov/ttn/ecas/ria.html.* EPA–HQ–OAR–2009–0472–0240.

[486] U.S. Environmental Protection Agency (U.S. EPA). 2008. 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.* Accessed March 15, 2010. EPA–HQ–OAR–2009–0472–0108.

[487] U.S. Environmental Protection Agency (U.S. EPA). 2009. Regulatory Impact Analysis: National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry. Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. Available on the Internet at *http://www.epa.gov/ttn/ecas/regdata/RIAs/portlandcementria_4–20–09.pdf.* Accessed March 15, 2010. EPA–HQ–OAR–2009–0472–0241.

[488] U.S. Environmental Protection Agency (U.S. EPA). 2010. Final NO2 NAAQS Regulatory Impact Analysis (RIA). Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. Available on the Internet at *http://www.epa.gov/ttn/ecas/regdata/RIAs/FinalNO2RIAfulldocument.pdf.* Accessed March 15, 2010. EPA–HQ–OAR–2009–0472–0237.

TABLE III.H.7–7—HUMAN HEALTH AND WELFARE EFFECTS OF $PM_{2.5}$—Continued

Pollutant/effect	Quantified and monetized in primary estimates	Unquantified effects changes in
	Minor restricted-activity days Work loss days Asthma exacerbations (asthmatic population) Infant mortality	Household soiling.

Consistent with the NO_2 NAAQS,[489] 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)[490] accompanying the recent final ozone NAAQS RIA. Readers can also refer to Fann *et al.* (2009)[491] for a detailed description of the benefit-per-ton methodology.[492] A more detailed description of the benefit-per-ton estimates is also provided in the 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.

• Dollar-per-ton estimates 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. In Section III.G, we describe the full-scale air quality modeling conducted for the 2030 calendar year analysis in an effort to capture this variability.

• There are several health benefits categories that EPA was unable to quantify in the MY analysis due to limitations associated with using benefits-per-ton estimates, several of which could be substantial. Because NO_X and VOC emissions are also precursors to ozone, changes in NO_X and VOC would also impact ozone formation and the health effects associated with ozone exposure. Benefits-per-ton estimates do not exist for ozone, however, 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 of the RIA that accompanies this rule for a description of the quantification and monetization of health impacts for the CY analysis and a description of the unquantified co-pollutant benefits associated with this rulemaking.

• 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 this 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. Timing and resource constraints precluded EPA from conducting full-scale photochemical air quality modeling for the MY analysis. We have, however, conducted national-scale air quality modeling for the CY analysis to analyze the impacts of the standards on $PM_{2.5}$, ozone, and selected air toxics.

8. Energy Security Impacts

This rule 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 caused by potential sudden disruptions in the supply of imported petroleum to the U.S. This reduction in

[489] Although we summarize the main issues in this chapter, we encourage interested readers to see the benefits chapter of the final NO_2 NAAQS for a more detailed description of recent changes to the PM benefits presentation and preference for the no-threshold model.

[490] 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*. EPA–HQ–OAR–2009–0472–0228.

[491] 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. EPA–HQ–OAR–2009–0472–0229.

[492] 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*. EPA–HQ–OAR–2009–0472–0227.

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 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 percent of total U.S. imports of all goods and services.[493] In 2008, the U.S. imported 66 percent of the petroleum it consumed, and the transportation sector accounted for 70 percent of total U.S. petroleum consumption. This compares to approximately 37 percent of petroleum from imports and 55 percent of consumption from petroleum in the transportation sector in 1975.[494] 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 worked with Oak Ridge National Laboratory (ORNL), which has developed approaches for evaluating the economic costs and energy security implications of oil use. The energy security estimates provided below are based upon a methodology developed in a peer-reviewed study entitled "*The Energy Security Benefits of Reduced Oil Use, 2006–2015,*" completed in March 2008. This study is included as part of the docket for this rulemaking.[495 496]

When conducting this 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 hard to quantify.

One commenter on this rule felt that the magnitude of the economic disruption portion of the energy security benefit may be too high. This commenter cites a recent paper written by Stephen P.A. Brown and Hillard G. Huntington, entitled "*Estimating U.S. Oil Security Premiums*" (September 2009) as the basis for their comment. The Agency reviewed this paper and found that it conducted a somewhat different analysis than the one conducted by ORNL in support of this rule. The Brown and Huntington paper focuses on policies and the energy security implications of increasing U.S. demand for oil (or at least holding U.S. oil consumption constant), while the ORNL analysis examines the energy security implications of decreasing U.S. oil consumption and oil imports. These asymmetrical analyses would be expected to yield somewhat different energy security results.

However, even given the different scenarios considered, the Brown and Huntington estimates are roughly similar to the ORNL estimates. For example, for an increase in U.S. consumption that leads to an increase in U.S. imports of oil, Brown and Huntington estimate a 2015 disruption premium of $4.87 per barrel, with an uncertainty range from $1.03 to $14.10 per barrel. The corresponding 2015 estimate for ORNL as the result of a reduction in U.S. oil imports is $6.70 per barrel, with an uncertainty range of $3.11 to $10.67 per barrel. Given that the two studies analyze different scenarios, since the Brown and Huntington disruption premiums are well within the uncertainty range of the ORNL study, and given that the ORNL scenario matches the specific oil market impacts anticipated from the rule while the Brown and Huntington paper does not, the Agency has concluded that the ORNL disruption security premium estimates are more applicable for analyzing this final rule.

In the energy security literature, the macroeconomic disruption component of the energy security premium traditionally has included both (1) increased payments for petroleum imports associated with a rapid increase in world oil prices, and (2) the GDP losses and adjustment costs that result from projected future oil price shocks. One commenter suggested that the increased payments associated with rapid increases in petroleum prices (*i.e.,* price increases in a disrupted market) represent transfers from U.S. oil consumers to petroleum suppliers rather than real economic costs, and therefore, should not be counted as a benefit.

This approach would represent a significant departure from how the macroeconomic disruption costs associated with oil price shocks have been quantified in the broader energy security literature, and the Agencies believe it should be analyzed in more detail before being applied in a regulatory context. In addition, the Agencies also believe that there are compelling reasons to treat higher oil import costs during oil supply disruptions differently than simple wealth transfers that reflect the exercise of market power by petroleum sellers or consumers. According to the OMB definition of a transfer: "Benefit and cost estimates should reflect real resource use. Transfer payments are monetary payments from one group to another that do not affect total resources available to society. * * * The net reduction in the total surplus (consumer plus producer) is a real cost to society, but the transfer from buyers to sellers resulting from a higher price is not a real cost since the net reduction automatically accounts for the transfer from buyers to sellers."[497] In other words, pure transfers do not lead to changes in the allocation or consumption of economic resources, whereas changes in the resource allocation or use produce real economic costs or benefits.

While price increases during oil price disruptions can result in large transfers of wealth, they also result in a combination of real resource shortages, costly short-run shifts in energy supply, behavioral and demand adjustments by energy users, and other response costs. Unlike pure transfers, the root cause of

[493] Source: U.S. Bureau of Economic Analysis, U.S. International Transactions Accounts Data, as shown on June 24, 2009.

[494] 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.

[495] 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).

[496] 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).

[497] OMB Circular A–4, September 17, 2003. See *http://www.whitehouse.gov/omb/assets/omb/circulars/a004/a-4.pdf.*

the disruption price increase is a real resource supply reduction due, for example, to disaster or war. Regions where supplies are disrupted (*i.e.,* the U.S.) suffer very high costs. Businesses' and households' emergency responses to supply disruptions and rapid price increases are likely to consume some real economic resources, in addition to causing financial losses to the U.S. economy that are matched by offsetting gains elsewhere in the global economy.

While households and businesses can reduce their petroleum consumption, invest in fuel switching technologies, or use futures markets to insulate themselves in advance against the potential costs of rapid increases in oil prices, when deciding how extensively to do so, they are unlikely to account for the effect of their petroleum consumption on the magnitude of costs that supply interruptions and accompanying price shocks impose on others. As a consequence, the U.S. economy as a whole will not make sufficient use of these mechanisms to insulate itself from the real costs of rapid increases in energy prices and outlays that usually accompany oil supply interruptions.[498] Therefore, the ORNL estimate of macroeconomic disruption and adjustment costs that the Agencies use to value energy security benefits includes the increased oil import costs stemming from oil price shocks that are unanticipated and not internalized by advance actions of U.S. consumers of petroleum products. The Agencies believe that, as the ORNL analysis argues, the uninternalized oil import costs that occur during oil supply interruptions represents a real cost associated with U.S. petroleum consumption and imports, and that reducing its value by lowering domestic petroleum consumption and imports thus represents a real economic benefit from lower fuel consumption.

For this rule, ORNL estimated the energy security premium by incorporating the oil price forecast of the Energy Information Administration's 2009 Annual Energy Outlook (AEO) to its model. The Agency considered, but rejected the option, of further updating this analysis using the oil price estimates provided by the AEO 2010. Given the broad uncertainty bands around oil price forecasts and the relatively modest change in oil price forecasts between the AEO 2009 and AEO 2010, the Agency felt that updating to AEO 2010 oil prices would not significantly change the results of this energy security analysis. Finally, the EPA used its OMEGA model in conjunction with ORNL's energy security premium estimates to develop the total energy security benefits for a number of different years; please refer to Table III.H.8–1 for this information for years 2015, 2020, 2030 and 2040,[499] 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 Joint TSD Chapter 4.

Because the price of oil is determined globally, supply and demand shocks anywhere in the world will have an adverse impact on the United States (and on all other oil consuming countries). The total economic costs of those shocks to the U.S. will depend on both U.S. petroleum consumption and imports of petroleum and refined products. The analysis relied upon to estimate energy security benefits from reducing U.S. petroleum consumption estimates the value of energy security using the estimated oil *import* premium, and is thus consistent with how much of the energy security literature reports energy security impacts. Since this rule is expected to have little impact on the U.S. supply of crude petroleum, a reduction in U.S. fuel consumption is expected to be reflected predominantly in reduced imports of petroleum and refined fuel. The estimated energy security premium associated with a reduction in U.S. petroleum *consumption* that leads to a reduction in imports would likely be somewhat larger, due to diminished sensitivity of the U.S. economy to oil supply shocks that would accompany the reduction in oil consumption.

In addition, while the estimates of energy security externalities used in this analysis depend on a combination of U.S. petroleum consumption and imports, they have been expressed as per barrel of petroleum imported into the U.S. The Agencies' analyses apply these estimates to the reduction in U.S. imports of crude petroleum and refined products that is projected to result from the rule in order to determine the benefits that are likely to result from fuel savings and the consequent reduction in imports. Thus, the estimates of energy security externalities have been used in this analysis in a way that is completely consistent with how they are defined and measured in the ORNL analysis.

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 rule, such as the benefits of reducing greenhouse gas emissions, are calculated using a global value? 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-

[498] For a more complete discussion of the reasons why the oil import cost component of the macroeconomic disruption and adjustment costs includes some real costs and does not represent a pure transfer, see Paul N. Leiby, Estimating the Energy Security Benefits of Reduced U.S. Oil Imports: Final Report, ORNL–TM–2007–028, Oak Ridge National Laboratory, March 14, 2008, pp. 21–25.

[499] 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.

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. OMB's Circular A–4 gives guidance in this regard. Domestic pecuniary benefits (or transfers between buyers and sellers) generally should not be included because they do not represent real resource costs, though A–4 notes that transfers to the U.S. from other countries may be counted as benefits as long as the analysis is conducted from a U.S. perspective.

Energy security is broadly defined as protecting the U.S. economy against circumstances that threaten significant short- and long-term increases in energy costs. Energy security is inherently a domestic benefit. Accordingly, it is possible to argue that the use of the domestic monopsony benefit may not necessarily be in conflict with the use of the global SCC, because the global SCC represents the benefits against which the costs of our (*i.e.,* the U.S.'s) domestic mitigation efforts should be judged. In the final analysis, the Agency has determined that using only the macroeconomic disruption component of the energy security benefit is the appropriate metric for this rule.

At proposal, the Agency took the position that since a global perspective was being taken with the use of the global SCC, that the monopsony benefits "net out" and were a transfer. Two commenters felt that the monopsony effect should be excluded from net benefits calculations for the rule since it is a "pecuniary" externality or does not represent an efficiency gain. One of the commenters suggested that EPA instead conduct a distributional analysis of the monopsony impacts of the final rule. The Agency disagrees that all pecuniary externalities should necessarily be excluded from net benefits calculations as a general rule. In this case considered here, the oil market is non-competitive, and if the social decision-making unit of interest is the U.S., there is an argument for accounting for the monopsony premium to assess the excess transfer of wealth caused by the exercise of cartel power outside of the U.S.

However, for the final rule, the Agency continues to take a global perspective with respect to climate change by using the global SCC. Therefore, the Agency did not count monopsony benefits since they "net out" with losses to other countries outside the U.S. Since a global perspective has been taken, a distributional analysis was not undertaken for this final rule, since the losses to the losers (oil producers that export oil to the U.S.) would equal the gains to the winners (U.S. consumers of imported oil). As a result, the Agency has included only the macroeconomic disruption portion of the energy security benefits to monetize the total energy security benefits of this rule. Hence, the 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.[500] The reduced oil estimates were derived from the OMEGA model, as explained in Section III.F 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 rule, which assumed that each gallon of fuel saved reduces total U.S. imports of crude oil or refined products by 0.95 gallons.[501]

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	$0.57
2020	$2.17
2030	$4.55
2040	$6.00

[500] Estimated reductions in U.S. imports of finished petroleum products and crude oil are 95% of 89 million barrels (MMB) in 2015, 300 MMB in 2020, 590 MMB in 2030, and 778 MMB in 2040.

[501] 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.

9. Other Impacts

There are other impacts associated with the 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 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 Joint TSD that accompanies this rule for more information about these impacts and how EPA and NHTSA use them in their analyses.

Note that for the estimated value of less frequent refueling events, EPA's estimate is subject to a number of uncertainties which we discuss in detail in Chapter 4.1.11 of the Joint TSD, and the actual value could be higher or lower than the value presented here. Specifically, the analysis makes three assumptions: (a) That manufacturers will not adjust fuel tank capacities downward (from the current average of 19.3 gallons) when they improve the fuel economy of their vehicle models. (b) that the average fuel purchase (55 percent of fuel tank capacity) is the typical fuel purchase. (c) that 100 percent of all refueling is demand-based; *i.e.,* that every gallon of fuel which is saved would reduce the need to return to the refueling station. A new research project is being planned by DOT which will include a detailed study of refueling events, and which is expected to improve upon these assumptions. These assumptions and the new DOT research project are discussed in detail in Joint TSD Chapter 4.2.10.

TABLE III.H.9–1—OTHER IMPACTS ASSOCIATED WITH THE LIGHT-DUTY VEHICLE GHG PROGRAM

[Millions of 2007 dollars]

	2020	2030	2040	2050	NPV, 3%	NPV, 7%
Value of Less Frequent Refueling	$2,400	$4,800	$6,300	$8,000	$87,900	$40,100
Value of Increased Driving [a]	4,200	8,800	13,000	18,400	171,500	75,500
Accidents, Noise, Congestion	−2,300	−4,600	−6,100	−7,800	−84,800	−38,600

[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 rule. 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 7 percent discount rate. In this table, fuel savings are calculated using pre-tax fuel prices.

Consumers are expected to receive the fuel savings presented here. The cost estimates for the fuel-saving technology are based on designs that will hold all vehicle attributes constant except fuel economy and technology cost. This analysis also assumes that consumers will not change the vehicles that they purchase. Automakers may redesign vehicles as part of their compliance strategies. The redesigns should be expected to make the vehicles more attractive to consumers, because the ability to hold all other attributes constant means that the only reason to change them is to make them more marketable to consumers. In addition, consumers may choose to purchase different vehicles than they would in the absence of this rule. These changes may affect the net benefits that consumers receive from their vehicles. If consumers can buy the same vehicle as before, except with increased price and fuel economy, then the increase in vehicle price is the maximum loss in welfare to the consumer, because compensating the increase in price would leave her able to buy her previous vehicle with no change. If she decides to purchase a different vehicle, or not to purchase a vehicle, she would do so only if she were better off than buying her original choice. Because of the unsettled state of the modeling of consumer choices (discussed in Section III.H.1 and in RIA Section 8.1.2), this analysis does not measure these effects. If the technology costs are not sufficient to maintain other vehicle attributes, then it is possible that automakers would be required to make less marketable vehicles in order to comply with the rule; as a result, there may be an additional loss in consumer welfare due to the rule. While EPA received comments expressing concern over the possibility of these losses, there were no specific losses identified.

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	$15,600	$15,800	$17,400	$19,000	$345,900	$191,900
Fuel Savings [a]	−35,700	−79,800	−119,300	−171,200	−1,545,600	−672,600
Quantified Annual Costs	−20,100	−64,000	−101,900	−152,200	−1,199,700	−480,700

[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 CO_2 emissions—and consequently the annual quantified benefits (*i.e.,* total benefits)—for each of four SCC values considered by EPA. As discussed in the RIA Section 7.5, the IPCC Fourth Assessment Report (2007) concluded that that the benefit estimates from CO_2 reductions are "very likely" 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, these monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4, N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in non-CO_2 GHGs, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and SCC and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

TABLE III.H.10–2—ESTIMATED SOCIETAL BENEFITS ASSOCIATED WITH THE LIGHT-DUTY VEHICLE GHG PROGRAM

[Millions of 2007 dollars]

Benefits category	2020	2030	2040	2050	NPV, 3% [a]	NPV, 7% [a]
Reduced CO_2 Emissions at each assumed SCC value [b c]						
Avg SCC at 5%	$900	$2,700	$4,600	$7,200	$34,500	$34,500
Avg SCC at 3%	3,700	8,900	14,000	21,000	176,700	176,700
Avg SCC at 2.5%	5,800	14,000	21,000	30,000	299,600	299,600
95th percentile SCC at 3%	11,000	27,000	43,000	62,000	538,500	538,500
Criteria Pollutant Benefits [d e f g]	B	1,200–1,300	1,200–1,300	1,200–1,300	21,000	14,000
Energy Security Impacts (price shock)	2,200	4,500	6,000	7,600	81,900	36,900

TABLE III.H.10–2—ESTIMATED SOCIETAL BENEFITS ASSOCIATED WITH THE LIGHT-DUTY VEHICLE GHG PROGRAM—Continued

[Millions of 2007 dollars]

Benefits category	2020	2030	2040	2050	NPV, 3% [a]	NPV, 7% [a]
Reduced Refueling	2,400	4,800	6,300	8,000	87,900	40,100
Value of Increased Driving [h]	4,200	8,800	13,000	18,400	171,500	75,500
Accidents, Noise, Congestion	−2,300	−4,600	−6,100	−7,800	−84,800	−38,600
Quantified Annual Benefits at each assumed SCC value [b c]						
Avg SCC at 5%	7,400	17,500	25,100	34,700	312,000	162,400
Avg SCC at 3%	10,200	23,700	34,500	48,500	454,200	304,600
Avg SCC at 2.5%	12,300	28,800	41,500	57,500	577,100	427,500
95th percentile SCC at 3%	17,500	41,800	63,500	89,500	816,000	666,400

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

[b] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

[c] Section III.H.6 notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: for Average SCC at 5%: $5–$16; for Average SCC at 3%: $21–$45; for Average SCC at 2.5%: $36–$65; and for 95th percentile SCC at 3%: $65–$136. Section III.H.6 also presents these SCC estimates.

[d] Note that "B" indicates unquantified criteria pollutant benefits in the year 2020. For the final rule, we only modeled the rule's $PM_{2.5}$- and ozone-related impacts in the calendar year 2030. For the purposes of estimating a stream of future-year criteria pollutant benefits, we assume that the benefits out to 2050 are equal to, and no less than, those modeled in 2030 as reflected by the stream of estimated future emission reductions. The NPV of criteria pollutant-related benefits should therefore be considered a conservative estimate of the potential benefits associated with the final rule.

[e] The benefits presented in this table include an estimate of PM-related premature mortality derived from Laden *et al.,* 2006, and the ozone-related premature mortality estimate derived from Bell *et al.,* 2004. If the benefit estimates were based on the ACS study of PM-related premature mortality (Pope *et al.,* 2002) and the Levy *et al.,* 2005 study of ozone-related premature mortality, the values would be as much as 70% smaller.

[f] The calendar year benefits presented in this table assume either a 3% discount rate in the valuation of PM-related premature mortality ($1,300 million) or a 7% discount rate ($1,200 million) to account for a twenty-year segmented cessation lag. Note that the benefits estimated using a 3% discount rate were used to calculate the NPV using a 3% discount rate and the benefits estimated using a 7% discount rate were used to calculate the NPV using a 7% discount rate. For benefits totals presented at each calendar year, we used the mid-point of the criteria pollutant benefits range ($1,250).

[g] Note that the co-pollutant impacts presented here do not include the full complement of endpoints that, if quantified and monetized, would change the total monetized estimate of impacts. The full complement of human health and welfare effects associated with PM and ozone remain unquantified because of current limitations in methods or available data. We have not quantified a number of known or suspected health effects linked with ozone and PM for which appropriate health impact functions are not available or which do not provide easily interpretable outcomes (*e.g.,* changes in heart rate variability). Additionally, we are unable to quantify a number of known welfare effects, including reduced acid and particulate deposition damage to cultural monuments and other materials, and environmental benefits due to reductions of impacts of eutrophication in coastal areas.

[h] 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 CO_2 emissions (and consequently the annual net benefits) for each of four SCC values considered by EPA. As noted above, the benefit estimates from CO_2 reductions are "very likely," according to the IPCC Fourth Assessment Report, 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 LIGHT-DUTY VEHICLE GHG PROGRAM [a]

[Millions of 2007 dollars]

	2020	2030	2040	2050	NPV, 3% [b]	NPV, 7% [b]
Quantified Annual Costs	−$20,100	−$64,000	−$101,900	−$152,200	−$1,199,700	−$480,700
Quantified Annual Benefits at each assumed SCC value [c d]						
Avg SCC at 5%	7,400	17,500	25,100	34,700	312,000	162,400
Avg SCC at 3%	10,200	23,700	34,500	48,500	454,200	304,600
Avg SCC at 2.5%	12,300	28,800	41,500	57,500	577,100	427,500
95th percentile SCC at 3%	17,500	41,800	63,500	89,500	816,000	666,400
Quantified Net Benefits at each assumed SCC value [c d]						
Avg SCC at 5%	27,500	81,500	127,000	186,900	1,511,700	643,100
Avg SCC at 3%	30,300	87,700	136,400	200,700	1,653,900	785,300
Avg SCC at 2.5%	32,400	92,800	143,400	209,700	1,776,800	908,200

TABLE III.H.10–3—QUANTIFIED NET BENEFITS ASSOCIATED WITH THE LIGHT-DUTY VEHICLE GHG PROGRAM [a]—Continued

[Millions of 2007 dollars]

	2020	2030	2040	2050	NPV, 3% [b]	NPV, 7% [b]
95th percentile SCC at 3%	37,600	105,800	165,400	241,700	2,015,700	1,147,100

[a] Fuel impacts were calculated using pre-tax fuel prices.

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

[c] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

[d] Section III.H.6 notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: For Average SCC at 5%: $5–$16; for Average SCC at 3%: $21–$45; for Average SCC at 2.5%: $36–$65; and for 95th percentile SCC at 3%: $65–$136. Section III.H.6 also presents these SCC estimates.

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 presented in Table III.H.10–1 through Table III.H.10–3, 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 RIA 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 four SCC values considered by EPA. As noted above, the benefit estimates from CO_2 reductions are "very likely," according to the IPCC Fourth Assessment Report, 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 LIFETIMES OF 2012–2016 MODEL YEAR VEHICLES

[Millions of 2007 dollars; 3% discount rate]

Monetized values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Cost of Noise, Accident, Congestion ($)	−$1,100	−$1,600	−$2,100	−$2,900	−$3,900	−$11,600
Pretax Fuel Savings ($)	16,100	23,900	32,200	46,000	63,500	181,800
Energy Security (price shock) ($) [a]	900	1,400	1,800	2,500	3,500	10,100
Value of Reduced Refueling time ($)	1,100	1,600	2,100	3,000	4,000	11,900
Value of Additional Driving ($)	2,400	3,400	4,400	6,000	7,900	24,000
Value of $PM_{2.5}$-related Health Impacts ($) [b c d]	700	900	1,300	1,800	2,400	7,000
Reduced CO_2 Emissions at each assumed SCC value [e f g]						
Avg SCC at 5%	400	500	700	1,000	1,300	3,800
Avg SCC at 3%	1,700	2,400	3,100	4,400	5,900	17,000
Avg SCC at 2.5%	2,700	3,900	5,200	7,200	9,700	29,000
95th percentile SCC at 3%	5,100	7,300	9,600	13,000	18,000	53,000
Total Benefits at each assumed SCC value [e f g]						
Avg SCC at 5%	20,500	30,100	40,400	57,400	78,700	227,000
Avg SCC at 3%	21,800	32,000	42,800	60,800	83,300	240,200
Avg SCC at 2.5%	22,800	33,500	44,900	63,600	87,100	252,200
95th percentile SCC at 3%	25,200	36,900	49,300	69,400	95,400	276,200

[a] Note that, due to a calculation error in the proposal, the energy security impacts for the model year analysis were roughly half what they should have been.

[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 associated with the vehicle model year lifetimes for the final rule.

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

[f] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

[g] Section III.H.6 notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: For Average SCC at 5%: \$5–\$16; for Average SCC at 3%: \$21–\$45; for Average SCC at 2.5%: \$36–\$65; and for 95th percentile SCC at 3%: \$65–\$136. Section III.H.6 also presents these SCC estimates.

TABLE III.H.10–5—ESTIMATED SOCIETAL BENEFITS ASSOCIATED WITH THE LIFETIMES OF 2012–2016 MODEL YEAR VEHICLES

[Millions of 2007 dollars; 7% discount rate]

Monetized values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Cost of Noise, Accident, Congestion (\$)	−\$900	−\$1,200	−\$1,600	−\$2,300	−\$3,100	−\$9,200
Pretax Fuel Savings (\$)	12,500	18,600	25,100	36,000	49,600	141,900
Energy Security (price shock) (\$) [a]	800	1,100	1,400	2,000	2,700	8,000
Value of Reduced Refueling time (\$)	900	1,300	1,700	2,400	3,200	9,400
Value of Additional Driving (\$)	1,900	2,700	3,500	4,700	6,200	19,000
Value of $PM_{2.5}$-related Health Impacts (\$) [b c d]	500	800	1,000	1,400	1,900	5,600
Reduced CO_2 Emissions at each assumed SCC value [e f g]						
Avg SCC at 5%	400	500	700	1,000	1,300	3,800
Avg SCC at 3%	1,700	2,400	3,100	4,400	5,900	17,000
Avg SCC at 2.5%	2,700	3,900	5,200	7,200	9,700	29,000
95th percentile SCC at 3%	5,100	7,300	9,600	13,000	18,000	53,000
Total Benefits at each assumed SCC value [e f g]						
Avg SCC at 5%	16,100	23,800	31,800	45,200	61,800	178,500
Avg SCC at 3%	17,400	25,700	34,200	48,600	66,400	191,700
Avg SCC at 2.5%	18,400	27,200	36,300	51,400	70,200	203,700
95th percentile SCC at 3%	20,800	30,600	40,700	57,200	78,500	227,700

[a] Note that, due to a calculation error in the proposal, the energy security impacts for the model year analysis were roughly half what they should have been.

[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 associated with the vehicle model year lifetimes for the final rule.

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

[f] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

[g] Section III.H.6 notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: For Average SCC at 5%: \$5–\$16; for Average SCC at 3%: \$21–\$45; for Average SCC at 2.5%: \$36–\$65; and for 95th percentile SCC at 3%: \$65–\$136. Section III.H.6 also presents these SCC estimates.

TABLE III.H.10–6—QUANTIFIED NET BENEFITS ASSOCIATED WITH THE LIFETIMES OF 2012–2016 MODEL YEAR VEHICLES

[Millions of 2007 dollars; 3% discount rate]

Monetized Values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Quantified Annual Costs (excluding fuel savings) [a]	\$4,900	\$8,000	\$10,300	\$12,700	\$15,600	\$51,500
Quantified Annual Benefits at each assumed SCC value [b c d]						
Avg SCC at 5%	20,500	30,100	40,400	57,400	78,700	227,000
Avg SCC at 3%	21,800	32,000	42,800	60,800	83,300	240,200

TABLE III.H.10–6—QUANTIFIED NET BENEFITS ASSOCIATED WITH THE LIFETIMES OF 2012–2016 MODEL YEAR VEHICLES—Continued

[Millions of 2007 dollars; 3% discount rate]

Monetized Values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Avg SCC at 2.5%	22,800	33,500	44,900	63,600	87,100	252,200
95th percentile SCC at 3%	25,200	36,900	49,300	69,400	95,400	276,200
Quantified Net Benefits at each assumed SCC value [b c d]						
Avg SCC at 5%	15,600	22,100	30,100	44,700	63,100	175,500
Avg SCC at 3%	16,900	24,000	32,500	48,100	67,700	188,700
Avg SCC at 2.5%	17,900	25,500	34,600	50,900	71,500	200,700
95th percentile SCC at 3%	20,300	28,900	39,000	56,700	79,800	224,700

[a] 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.

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

[c] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

[d] Section III.H.6 notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: For Average SCC at 5%: $5–$16; for Average SCC at 3%: $21–$45; for Average SCC at 2.5%: $36–$65; and for 95th percentile SCC at 3%: $65–$136. Section III.H.6 also presents these SCC estimates.

TABLE III.H.10–7—QUANTIFIED NET BENEFITS ASSOCIATED WITH THE LIFETIMES OF 2012–2016 MODEL YEAR VEHICLES

[Millions of 2007 dollars; 7% discount rate]

Monetized values (millions)	2012MY	2013MY	2014MY	2015MY	2016MY	Sum
Quantified Annual Costs (excluding fuel savings) [a]	$4,900	$8,000	$10,300	$12,700	$15,600	$51,500
Quantified Annual Benefits at each assumed SCC value [b c d]						
Avg SCC at 5%	16,100	23,800	31,800	45,200	61,800	178,500
Avg SCC at 3%	17,400	25,700	34,200	48,600	66,400	191,700
Avg SCC at 2.5%	18,400	27,200	36,300	51,400	70,200	203,700
95th percentile SCC at 3%	20,800	30,600	40,700	57,200	78,500	227,700
Quantified Net Benefits at each assumed SCC value [b c d]						
Avg SCC at 5%	11,200	15,800	21,500	32,500	46,200	127,000
Avg SCC at 3%	12,500	17,700	23,900	35,900	50,800	140,200
Avg SCC at 2.5%	13,500	19,200	26,000	38,700	54,600	152,200
95th percentile SCC at 3%	15,900	22,600	30,400	44,500	62,900	176,200

[a] 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.

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

[c] Monetized GHG benefits exclude the value of reductions in non-CO_2 GHG emissions (HFC, CH_4 and N_2O) expected under this final rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 emissions, the value of these reductions should not be interpreted as zero. Rather, the reductions in non-CO_2 GHGs will contribute to this rule's climate benefits, as explained in Section III.F.2. The SCC TSD notes the difference between the social cost of non-CO_2 emissions and CO_2 emissions, and specifies a goal to develop methods to value non-CO_2 emissions in future analyses.

[d] Section III.H.6 notes that SCC increases over time. Corresponding to the years in this table, the SCC estimates range as follows: For Average SCC at 5%: $5–$16; for Average SCC at 3%: $21–$45; for Average SCC at 2.5%: $36–$65; and for 95th percentile SCC at 3%: $65–$136. Section III.H.6 also presents these SCC estimates.

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 Final 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 final 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.,* and has been assigned OMB control number 0783.57. The information collection requirements are not enforceable until OMB approves them.

The Agency is finalizing requirements for manufacturers to submit 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.I.2–1, the total annual burden associated with this rule 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 new reporting requirements. Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

TABLE III.I.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. In addition, EPA is amending the table in 40 CFR part 9 of currently approved OMB control numbers for various regulations to list the regulatory citations for the information requirements contained in this final rule.

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 directly subject to the rule. 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.I.3–1 provides an overview of the primary SBA small business categories included in the light-duty vehicle sector:

TABLE III.I.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
—Independent commercial importers	$7 million annual sales	811111, 811112, 811198
	$23 million annual sales	441120
	100 employees	423110, 424990
—Alternative fuel vehicle converters	50 employees	336312, 336322, 336399
	750 employees	335312
	1,000 employees	454312, 485310, 811198
	$7 million annual sales.	

Notes:

[a] Light-duty vehicle entities that qualify as small businesses would not be subject to this rule. We are exempting 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 rule because we are certifying that the rule would not have a significant economic impact on a substantial number of small entities directly subject to the rule. As proposed, EPA is exempting manufacturers meeting SBA's business size criteria for small business as provided in 13 CFR 121.201, due to the short lead time to develop this 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 U.S. and foreign 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. EPA has identified a total of about 47 vehicle businesses; about 13 entities (or 28 percent) fit the Small Business Administration (SBA) criteria 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., and therefore the exemption will have a negligible impact on the GHG emissions reductions from the standards.

To ensure that EPA is aware of which companies would be exempt, EPA proposed to require 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. EPA has reconsidered the need for this additional submission under the regulations and is deleting it as not necessary. We already have information on the limited number of small entities that we expect would receive the benefits of the exemption, and do not need the proposed regulatory requirement to be able to effectively implement this exemption for those parties who in fact meet its terms. 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. Based on this, EPA is certifying that the rule would not have a significant economic impact on a substantial number of small entities.

c. Conclusions

I therefore certify that this 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 (74 FR 55292, Oct. 27, 2009), EPA used 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 that might occur as EPA considers regulations of GHGs. Concerns about the potential impacts of statutorily imposed PSD requirements on small entities were the subject of deliberations in that consultation and outreach. EPA has compiled a summary of that consultation and outreach, which is available in the docket for the Tailoring Rule (EPA–HQ–OAR–2009–0517).

4. Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), 2 U.S.C. 1531–1538, requires Federal agencies, unless otherwise prohibited by law, 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.

This rule is not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments. This rule 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 rule 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 action represents the least costly, most cost-effective approach to achieve the statutory requirements of the rule. The costs and benefits associated with the rule are discussed above and in the Final 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 applies 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 solicited comment on the proposed action from State and local officials. Many State and local governments submitted public comments on the rule, the majority of which were supportive of the EPA's greenhouse gas program. However, these entities did not provide comments indicating there would be a substantial direct effect on State or local governments resulting from this rule.

6. Executive Order 13175 (Consultation and Coordination With Indian Tribal Governments)

This action 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 will be affected only to the extent they purchase and use regulated vehicles. Thus, Executive Order 13175 does not apply to this action.

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 rule.[502] A summary of the analysis is presented below.

With respect to GHG emissions, the effects of climate change observed to

[502] 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. Docket EPA–HQ–OAR–2009–0472–11292.

date and projected to occur in the future include the increased likelihood of more frequent and intense heat waves. Specifically, EPA's analysis of the scientific assessment literature has determined that severe heat waves are projected to intensify in magnitude, frequency, and duration over the portions of the 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 finalized 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 extreme temperatures.

For non-GHG pollutants, EPA has determined that climate change is expected to increase regional ozone pollution, with associated risks in respiratory infection, aggravation of asthma, and premature death. The directional effect of climate change on ambient PM levels remains uncertain. However, disturbances such as wildfires are increasing in the 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.

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 finalized 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 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.

The rulemaking involves technical standards. Therefore, the Agency conducted a search to identify potentially applicable voluntary consensus standards. For CO_2, N_2O, and CH_4 emissions, we identified no such standards, and none were brought to our attention in comments. Therefore, EPA is collecting data over the same test cycles that are used for the CAFE program following standardized test methods and sampling procedures. This will minimize the amount of testing done by manufacturers, since manufacturers are already required to run these tests. For A/C system leakage improvement credits, EPA identified a Society of Automotive Engineers (SAE) methodology and EPA's approach is based closely on this SAE methodology. For the A/C system efficiency improvement credits, including the new idle test, EPA generally uses standardized test methods and sampling procedures. However, EPA knows of no consensus standard available for an A/C idle test to measure system efficiency improvements.

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 final 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 standards will affect climate change projections, and EPA has estimated reductions in projected global mean surface temperatures (Section III.F.3). Within communities experiencing climate change, certain parts of the population may be especially vulnerable; these include the poor, the elderly, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources.[503] In addition, the U.S. Climate Change Science Program [504] stated as one of its conclusions: "The United States is certainly capable of adapting to the collective impacts of climate change. However, there will still be certain individuals and locations where the adaptive capacity is less and these individuals and their communities will be disproportionally impacted by climate change." Therefore, these specific sub-populations may receive benefits from reductions in GHGs.

For non-GHG co-pollutants such as ozone, $PM_{2.5}$, and toxics, EPA has concluded that it is not practicable to determine whether there would be disproportionately high and adverse human health or environmental effects on minority and/or low income populations from this final rule.

11. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 *et seq.,* as added by the Small Business Regulatory Enforcement Fairness Act of 1996, generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report, which includes a copy of the rule, to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States prior to publication of the rule in the **Federal Register.** A Major rule cannot take effect until 60 days after it

[503] 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. Docket EPA–HQ–OAR–2009–0472–11292.

[504] CCSP (2008) *Analyses of the effects of global change on human health and welfare and human systems.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA.

is published in the **Federal Register.** This action is a "major rule" as defined by 5 U.S.C. 804(2). This rule will be effective July 6, 2010, *sixty days after date of publication in the* **Federal Register.**

J. Statutory Provisions and Legal Authority

Statutory authority for the vehicle controls finalized 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 Final Rule and Record of Decision for Passenger Car and Light Truck CAFE Standards for MYs 2012–2016

A. Executive Overview of NHTSA Final Rule

1. Introduction

The National Highway Traffic Safety Administration (NHTSA) is establishing Corporate Average Fuel Economy (CAFE) 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.[505] NHTSA's CAFE 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 27.6 mpg combined fuel economy level in MY 2011. NHTSA's final rule projects total fuel savings of approximately 61 billion gallons over the lifetimes of the vehicles sold in model years 2012–2016, with corresponding net societal benefits of over $180 billion using a 3 percent discount rate.[506]

The significance accorded to 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.[507] Using vehicle technology to improve fuel economy, thereby reducing tailpipe emissions of CO_2, is one of the three main measures of reducing those tailpipe emissions of CO_2.[508] The two other measures for 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 final rule by NHTSA with another agency, the Environmental Protection Agency. As discussed in Section I, NHTSA's final MYs 2012–2016 CAFE standards are part of a joint National Program. 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 final CAFE standards are consistent with the President's National Fuel Efficiency Policy announcement of May 19, 2009, which called 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 final 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.[509] 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

[505] 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 March 1, 2010).

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 March 1, 2010).

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 March 1, 2010).

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 March 1, 2010).

"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 March 1, 2010); 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/mae/people/faculty/socolow/ENVIRONMENTDec2004issue.pdf* (last accessed March 1, 2010).

[506] This value is based on what NHTSA refers to as "Reference Case" inputs, which are based on the assumptions that NHTSA has employed for its main analysis (as opposed to sensitivity analyses to examine the effect of variations in the assumptions on costs and benefits). The Reference Case inputs include fuel prices based on the AEO 2010 Reference Case, a 3 percent discount rate, a 10 percent rebound effect, a value for the social cost of carbon (SCC) of $21/metric ton CO_2 (in 2010, rising to $45/metric ton in 2050, at a 3 percent discount rate), etc. For a full listing of the Reference Case input assumptions, *see* Section IV.C.3 below.

[507] 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 March 1, 2010).

[508] 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 March 1, 2010).

[509] Energy Information Administration, Petroleum Basic Statistics, updated July 2009. *Available at http://www.eia.doe.gov/basics/quickoil.html* (last accessed March 1, 2010).

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. Since petroleum imports account for about 2 percent of GDP, increase in oil imports can create a discernable fiscal drag. As a consequence, measures that reduce petroleum consumption, such as fuel economy standards, will directly benefit 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 final rules that have the effect of addressing the urgent and closely intertwined challenges of energy independence and security and global warming. These final 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 final 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 in the rulemaking timeframe. The agencies' final rules 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 relatively short amount of lead time for the model years covered by the rulemaking and the serious current economic situation faced by this industry.

These joint standards are 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,[510] and with the Notice of Upcoming Joint Rulemaking signed by DOT and EPA on that date.[511] This joint final rule 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 below.

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.[512] 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 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 measuring the amount of CO_2 emitted from the tailpipe, rather than 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[513] 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 currently requires EPA to use the 1975 passenger car test procedures under which vehicle air conditioners are not turned on during fuel economy testing.[514] 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 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 to market factors, have resulted in saving billions of barrels of oil and avoiding billions of metric tons

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[510] 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 March 15, 2010).

[511] 74 FR 24007 (May 22, 2009).

[512] 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.

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

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

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,*[515] 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.[516] 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.*[517] 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 issued a final rule finding that emissions of GHGs from new motor vehicles and motor vehicle engines cause or contribute to air pollution that endanger public health and welfare.[518]

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 CO_2 emissions levels for passenger cars and some light trucks of 323 g/mil in 2009, decreasing to 205 g/mi in 2016, and 439 g/mi for light trucks in 2009, decreasing 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.[519] EPA withdrew the prior denial and granted California's request for a waiver on June 30, 2009.[520] 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 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 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. 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, 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 FR 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.[521] 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.

[515] 127 S.Ct. 1438 (2007).

[516] 68 FR 52922 (Sept. 8, 2003).

[517] 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.

[518] 74 FR 66496 (Dec. 15, 2009).

[519] 74 FR 66495 (Dec. 15, 2009). The endangerment finding was challenged by industry in a filing submitted December 23, 2009; a hearing date does not appear to have been set.

[520] 74 FR 32744 (July 8, 2009).

[521] Record of OIRA's action can be found at *http://www.reginfo.gov/public/do/eoHistReviewSearch* (last accessed March 1, 2010). 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."

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 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, 2009 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.[522] 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 of air conditioning systems, thereby reducing both fuel consumption and tailpipe emissions of CO_2.[523]

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 apply nationally under the National Program.

As requested in the President's memorandum, NHTSA 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 more information on how the proposed CAFE standards were developed with those comments in mind, see the NPRM and the supporting documents.

5. Summary of the Final MY 2012–2016 CAFE Standards

NHTSA is issuing 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.[524] Under the final CAFE standards, each light vehicle model produced for sale in the United States has a fuel economy target. The CAFE levels that must be met by the fleet of each manufacturer will 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:

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[522] Under 49 U.S.C. 32912(c), roughly, NHTSA may raise the penalty amount if the agency decides that doing so will increase energy conservation substantially without having a substantial deleterious impact on the economy, employment, or competition among automobile manufacturers.

[523] 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.

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

Figure IV.A.5-1 Final MY 2011 and Final MY 2012-2016

Passenger Car Fuel Economy Targets

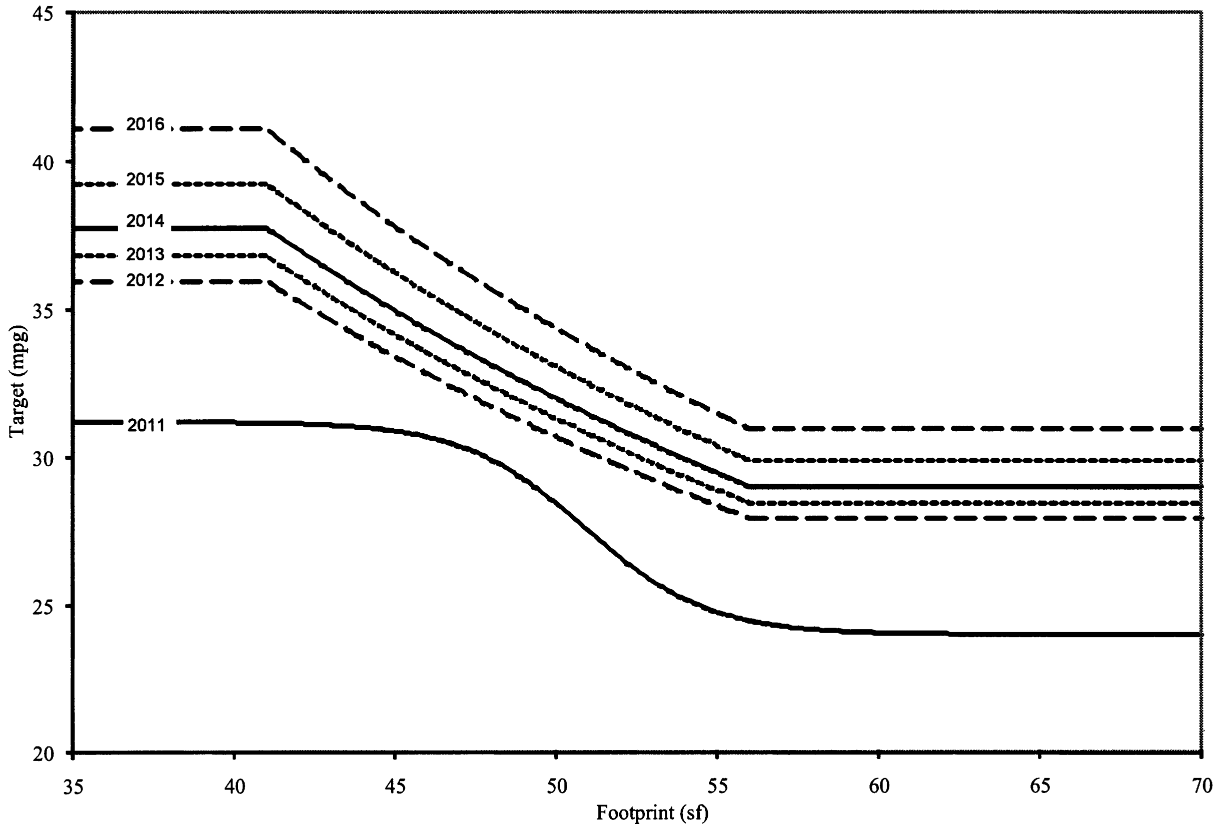
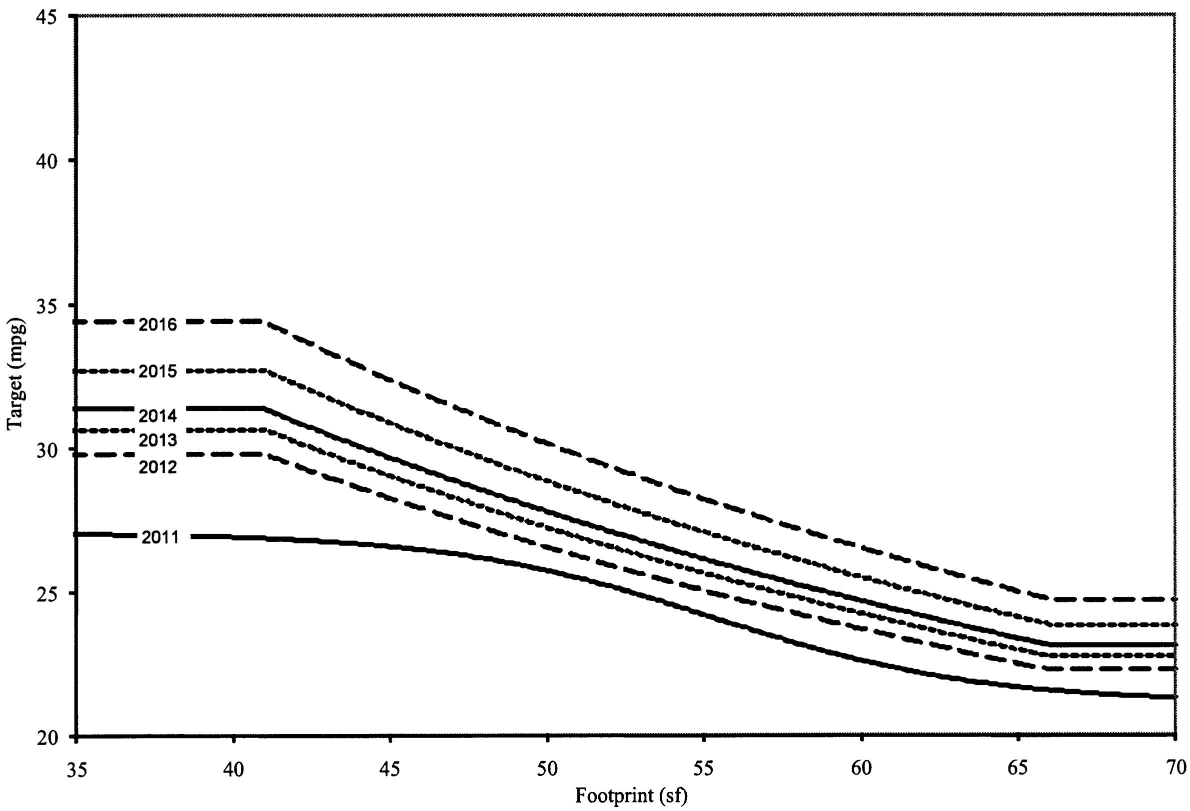


Figure IV.A.5-2 Final MY 2011 and Final MY 2012-2016

Light Truck Fuel Economy Targets



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Under these final 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 final rule of the MYs 2012–2016 vehicle fleet, NHTSA estimates that the targets shown above will result in the following estimated average required CAFE levels:

TABLE IV.A.5–1—ESTIMATED AVERAGE REQUIRED FUEL ECONOMY (MPG) UNDER FINAL STANDARDS

	2012	2013	2014	2015	2016
Passenger Cars	33.3	34.2	34.9	36.2	37.8
Light Trucks	25.4	26.0	26.6	27.5	28.8
Combined Cars & Trucks	29.7	30.5	31.3	32.6	34.1

For the reader's reference, these miles per gallon values would be equivalent to the following gallons per 100 miles values for passenger cars and light trucks:

	2012	2013	2014	2015	2016
Passenger Cars	3.00	2.93	2.86	2.76	2.65
Light Trucks	3.94	3.85	3.76	3.63	3.48
Combined Cars & Trucks	3.36	3.28	3.19	3.07	2.93

NHTSA estimates that average achieved fuel economy levels will correspondingly increase through MY 2016, but that manufacturers will, on average, undercomply [525] in some model years and overcomply [526] in others, reaching a combined average fuel economy of 33.7 mpg in MY 2016.[527] Table IV.A.5–1 is the estimated required fuel economy for the final CAFE standards while Table IV.A.5–2 includes the effects of some manufacturers' payment of CAFE fines and use of FFV credits. 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 assumed.

TABLE IV.A.5–2—ESTIMATED AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER FINAL STANDARDS

	2012	2013	2014	2015	2016
Passenger Cars	32.8	34.4	35.3	36.3	37.2
Light Trucks	25.1	26.0	27.0	27.6	28.5
Combined Cars & Trucks	29.3	30.6	31.7	32.6	33.7

For the reader's reference, these miles per gallon values would be equivalent to the following gallons per 100 miles values for passenger cars and light trucks:

	2012	2013	2014	2015	2016
Passenger Cars	3.05	2.91	2.83	2.76	2.69
Light Trucks	3.99	3.84	3.71	3.62	3.50
Combined Cars & Trucks	3.42	3.27	3.15	3.06	2.97

NHTSA estimates that these fuel economy increases will lead to fuel savings totaling 61 billion gallons during the lifetimes of vehicles sold in MYs 2012–2016 (all following tables assume Reference Case economic inputs):

TABLE IV.A.5–3—FUEL SAVED (BILLION GALLONS) UNDER FINAL STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.4	5.2	7.2	9.4	11.4	35.7
Light Trucks	1.8	3.7	5.3	6.5	8.1	25.4
Combined	4.2	8.9	12.5	16.0	19.5	61.0

The agency also estimates that these new CAFE standards will lead to corresponding reductions of CO_2 emissions totaling 655 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 FINAL STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	25	54	77	101	123	380
Light Trucks	19	40	57	71	88	275

[525] 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.

[526] 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).

[527] 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.5–4—AVOIDED CARBON DIOXIDE EMISSIONS (MMT) UNDER FINAL STANDARDS—Continued

	2012	2013	2014	2015	2016	Total
Combined	44	94	134	172	210	655

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.,* increased 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 final standards will produce significant benefits to society. NHTSA estimates that, in present value terms, these benefits would total over $180 billion over the useful lives of vehicles sold during MYs 2012–2016:

TABLE IV.A.5–5—PRESENT VALUE OF BENEFITS ($BILLION) UNDER FINAL CAFE STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	6.8	15.2	21.6	28.7	35.2	107.5
Light Trucks	5.1	10.7	15.5	19.4	24.3	75.0
Combined	11.9	25.8	37.1	48	59.5	182.5

NHTSA attributes most of these benefits—about $143 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) 2010. The Final Regulatory Impact Analysis (FRIA) accompanying today's final rule presents a detailed analysis of specific benefits of the final rule.

	Amount	Monetized value (discounted)	
		3% Discount rate	7% Discount rate
Fuel savings	61.0 billion gallons	$143.0 billion	$112.0 billion.
CO_2 emissions reductions [528]	655 mmt	$14.5 billion	$14.5 billion.

NHTSA estimates that the necessary increases in technology application will involve considerable monetary outlays, totaling $52 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 FINAL CAFE STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	4.1	5.4	6.9	8.2	9.5	34.2
Light Trucks	1.8	2.5	3.7	4.3	5.4	17.6
Combined	5.9	7.9	10.5	12.5	14.9	51.7

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 final standards would lead to increases in average new vehicle prices, ranging from $322 per vehicle in MY 2012 to $961 per vehicle in MY 2016:

TABLE IV.A.5–7—INCREMENTAL INCREASES IN AVERAGE NEW VEHICLE PRICES ($) UNDER FINAL CAFE STANDARDS

	2012	2013	2014	2015	2016
Passenger Cars	505	573	690	799	907
Light Trucks	322	416	621	752	961
Combined	434	513	665	782	926

[528] We note that the net present value of reduced CO_2 emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5 percent, 3 percent, and 2.5 percent) is used to calculate the net present value of the SCC for internal consistency. Additionally, we note that the SCC increases over time. *See Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,* Interagency Working Group on Social Cost of Carbon, United States Government, February 2010 (available in Docket No. NHTSA–2009–0059 for more information.

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, again assuming Reference Case inputs (except for the variation in discount rate). Numbers in parentheses represent negative values.

TABLE IV.A.5–8—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	5,903	7,890	10,512	12,539	14,904	51,748
Benefits:						
Savings in Lifetime Fuel Expenditures	9,265	20,178	29,083	37,700	46,823	143,048
Consumer Surplus from Additional Driving	696	1,504	2,150	2,754	3,387	10,491
Value of Savings in Refueling Time	706	1,383	1,939	2,464	2,950	9,443
Reduction in Petroleum Market Externalities	545	1,154	1,630	2,080	2,543	7,952
Reduction in Climate-Related Damages from Lower CO_2 Emissions [529]	921	2,025	2,940	3,840	4,804	14,528
Reduction in Health Damage Costs From Lower Emissions of Criteria Air Pollutants						
CO	0	0	0	0	0	0
VOC	42	76	102	125	149	494
NO_X	70	104	126	146	166	612
PM	205	434	612	776	946	2,974
SO_X	158	332	469	598	731	2,288
Dis-Benefits From Increased Driving						
Congestion Costs	(447)	(902)	(1,282)	(1,633)	(2,000)	(6,264)
Noise Costs	(9)	(18)	(25)	(32)	(39)	(122)
Crash Costs	(217)	(430)	(614)	(778)	(950)	(2,989)
Total Benefits	11,936	25,840	37,132	48,040	59,509	182,457
Net Benefits	6,033	17,950	26,619	35,501	44,606	130,709

TABLE IV.A.5–9—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	5,903	7,890	10,512	12,539	14,904	51,748
Benefits:						
Savings in Lifetime Fuel Expenditures	7,197	15,781	22,757	29,542	36,727	112,004
Consumer Surplus from Additional Driving	542	1,179	1,686	2,163	2,663	8,233
Value of Savings in Refueling Time	567	1,114	1,562	1,986	2,379	7,608
Reduction in Petroleum Market Externalities	432	917	1,296	1,654	2,023	6,322
Reduction in Climate-Related Damages From Lower CO_2 Emissions [530]	921	2,025	2,940	3,840	4,804	14,530
Reduction in Health Damage Costs From Lower Emissions of Criteria Air Pollutants						
CO	0	0	0	0	0	0
VOC	32	60	80	99	119	390
NO_x	53	80	98	114	131	476
PM	154	336	480	611	748	2,329
SO_x	125	265	373	475	581	1,819
Dis-Benefits From Increased Driving						
Congestion Costs	(355)	(719)	(1,021)	(1,302)	(1,595)	(4,992)
Noise Costs	(7)	(14)	(20)	(26)	(31)	(98)
Crash Costs	(173)	(342)	(488)	(619)	(756)	(2,378)

[529] *See supra* note 528.

TABLE IV.A.5–9—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
Total Benefits	9,488	20,682	29,743	38,537	47,793	146,243
Net Benefits	3,586	12,792	19,231	25,998	32,890	94,497

Neither EPCA nor EISA *requires* that NHTSA conduct a cost-benefitanalysis in determining average fuel economy standards, but too, neither precludes its use.[531] EPCA does require that NHTSA consider economic practicability among other factors, and NHTSA has concluded, as discussed elsewhere herein, that the standards it promulgates today are economically practicable. Further validating and supporting its conclusion that the standards it promulgates 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 final standards would be more than three times the magnitude of the corresponding costs, such that the final standards would produce net benefits of over $130 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,"[532] a majority of the 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 attribute-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.[533] 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 trade-offs that must be made if CAFE standards were increased by any significant amount.[534]

In response to these conclusions, NHTSA considered various attributes and ultimately issued footprint-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 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 increasing the fuel economy standards, both relating to externalities. The first and most important concern, it argued, is the accumulation in the atmosphere of greenhouse gases, principally carbon dioxide.[535]

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 of such increases 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.

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 it was then structured. While raising CAFE standards under the then-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.[536]

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."[537] 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

[530] *See supra* note 529.

[531] *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 sdirect 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.")

[532] 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 March 1, 2010). 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.

[533] NHTSA formerly used this approach for CAFE standards. EISA prohibits its use after MY 2010.

[534] NAS, p. 9. As discussed at length in prior CAFE rules, two members of the NAS Committee dissented from the majority opinion that there would be safety impacts to downweighting under a flat-standard system.

[535] NAS, pp. 2, 13, and 83.

[536] NAS, pp. 4–5 (Finding 10).

[537] NAS, p. 5 (Finding 12).

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.[538]

b. 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.[539] Reforming the CAFE program enabled it to achieve larger fuel savings, while enhancing safety and preventing adverse economic consequences.

As noted above, fuel economy standards were restructured so that they were 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 non-attribute-based CAFE, attribute-based CAFE enhances overall fuel savings while providing vehicle manufacturers with the flexibility they need to respond to changing market conditions. Attribute-based 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 attribute-based 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 non-attribute-based CAFE program.

c. 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,*[540] 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. Although the Court found that NHTSA had been arbitrary and capricious in several respects, the Court did not vacate the standards, but instead said it would remand the rule to NHTSA to promulgate new standards consistent with its opinion "as expeditiously as possible and for the earliest model year practicable." 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.

d. 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).

e. NHTSA Proposes CAFE Standards for MYs 2011–2015 (April 2008)

The agency could not 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 could, 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.

f. 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.[541]

g. 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 the MYs 2011–2015 rulemaking.[542] 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

[538] NAS, p. 87.

[539] 71 FR 17566 (Apr. 6, 2006).

[540] 508 F.3d 508.

[541] *See CBD* v. *NHTSA,* 538 F.3d 1172 (9th Cir. 2008).

[542] 73 FR 61859 (Oct. 18, 2008).

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 decision maker 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.

h. 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.[543]

i. 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 National Academy of Sciences assessing automotive technologies that can practicably be used to improve fuel economy.

j. NHTSA Issues Final Rule for MY 2011 (March 2009)

i. Standards

The final rule established footprint-based fuel economy standards for MY 2011 passenger cars and light trucks. 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.[544] 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, for the reasons discussed extensively in that final rule.

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[545] 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

ii. 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.[546] Since its enactment, EPCA has permitted manufacturers to earn credits for exceeding the standards and to apply those credits to compliance obligations

[543] The statement can be found at *http://www.dot.gov/affairs/dot0109.htm* (last accessed March 1, 2010).

[544] 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.

[545] Those numbers set out several paragraphs above.

[546] 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.

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.

2. Energy Policy and Conservation Act, as Amended by the Energy Independence and Security Act

NHTSA establishes CAFE standards for passenger cars and light trucks for each model year under EPCA, as 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.[547]

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." [548] 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 their fleets that employ 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.

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." [549] 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,[550] 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 [551] 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

[547] *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.")

[548] 67 FR 77015, 77021 (Dec. 16, 2002).

[549] *CEI–I,* 793 F.2d 1322, 1352 (DC Cir. 1986).

[550] 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.

[551] 42 FR 63184, 63188 (Dec. 15, 1977). *See* also 42 FR 33534, 33537 (Jun. 30, 1977).

fuel economy capability and thus decrease the level of average fuel economy that the agency can determine to be feasible.

NHTSA also recognizes that in some cases the effect of other motor vehicle standards of the Government on fuel economy may be neutral or positive. For example, to the extent the GHG standards set by EPA and California 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 lower-GHG-producing air conditioners. The agency considered EPA's standards and the harmonization benefits of the National Program in developing its own standards.

(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." [552] 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 [553] 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,[554] 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." [555] 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.[556] In 1988, NHTSA included climate change concepts in its CAFE notices and prepared its first environmental assessment addressing that subject.[557] 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.[558] 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.[559] Under the universal or "flat" CAFE standards that NHTSA was previously authorized to establish, manufacturers were encouraged to 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

[552] 42 FR 63184, 63188 (1977).

[553] 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.

[554] *Center for Auto Safety* v. *NHTSA,* 793 F.2d 1322, 1325 n. 12 (DC Cir. 1986); *Public Citizen* v. *NHTSA,* 848 F.2d 256, 262–3 n. 27 (DC 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).

[555] 42 FR 63184, 63188 (Dec. 15, 1977) (emphasis added).

[556] 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).

[557] 53 FR 33080, 33096 (Aug. 29, 1988).

[558] 53 FR 39275, 39302 (Oct. 6, 1988).

[559] *See, e.g., Center for Auto Safety* v. *NHTSA* (CAS), 793 F. 2d 1322 (DC 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 (DC Cir. 1990).

buy, which resulted in a higher mass differential between the smallest and the largest vehicles, with a correspondingly greater risk to safety. 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, and because all vehicles are required to continue improving their fuel economy.

In addition, the agency considers consumer demand in establishing new standards and in assessing whether already established standards remained feasible. In the 1980s, 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.[560] As noted 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.

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 (DC 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 many 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.

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. NHTSA sought comment in the NPRM 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, but decided against finalizing either option for purposes of this final rule, choosing to defer the matter for now. 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

[560] 49 U.S.C. 32902(h).

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 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.[561] 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 [562] 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.

C. Development and Feasibility of the Final Standards

1. How was the baseline and reference vehicle fleet developed?

a. Why do the agencies establish a baseline and reference vehicle fleet?

As also discussed in Section II.B above, 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 established a baseline vehicle fleet representing those vehicles, based on the best available transparent information. Each agency then developed a separate reference fleet, accounting (via their respective analytical 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 for other relevant comparisons in the rule.

Because NHTSA and EPA have different established practices, the agencies' rulemaking documents (the **Federal Register** notice, Joint Technical Support Document, agency-specific Regulatory Impact Analyses, and NHTSA Environmental Impact Analysis) have some differences in terminology. In connection with its first-ever GHG emissions rule under the CAA, EPA has used the term "baseline fleet" to refer to the MY 2008 fleet (*i.e.,* from EPA certification and fuel economy data for MY 2008) prior to adjustment to reflect projected shifts in market composition. NHTSA, as in recent CAFE rulemakings, refers to the resultant market forecast, as specified in CAFE model input files (and corresponding input files for EPA's OMEGA model), as the "baseline" fleet. EPA refers to this fleet as the "reference fleet." NHTSA refers to the "no action" standards identified in the EIS (that is, the MY 2011 standards carried forward through MY 2016) as defining the "baseline" scenario, and refers to the fleet to which technologies have been added in response to these standards as the "adjusted baseline" fleet.[563] EPA refers to this as the "final reference fleet." These differences in terminology are summarized in the following table:

Fleet description	EPA terminology	NHTSA terminology
MY 2008 Fleet with MY 2008 Production Volumes	Baseline	MY 2008 Fleet
MY 2008 Fleet Adjusted to Reflect Projected Market Shifts	Reference Fleet	Baseline [Market Forecast]
MY 2008 Fleet Adjusted to Reflected Projected Market Shifts and Response to MY 2011 CAFE Standards.	[Final] Reference Fleet	Adjusted Baseline

The agencies have retained this mixed terminology in order to facilitate comparison to past rulemakings. In general, EPA's RIA and the Joint TSD apply EPA's nomenclature, NHTSA's RIA and EIS apply NHTSA's nomenclature, and the joint **Federal Register** notice uses EPA's nomenclature when focusing on GHG emissions standards, and NHTSA's nomenclature when focusing on CAFE standards.

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

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

[562] 49 U.S.C. 30120, Remedies for defects and noncompliance.

[563] Some manufacturers' baseline fleets (as reflected in the agencies' market forecast) do not, without applying additional technology and/or CAFE credits, show compliance with the baseline standards.

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 model year for which final data is currently available from manufacturers. These data were used as the source for MY 2008 production volumes and some vehicle engineering characteristics, such as 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 the 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).[564] 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.[565] This provided the year-by-year percentages of cars and trucks sold by each manufacturer as well as the percentages of each vehicle segment. 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. Noting this, and lacking a credible forecast of company and segment shares after 2015, the agencies assumed 2016 market share and market segments to be the same as for 2015. 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 Joint Technical Support Document accompanying today's final rule.

c. How is this different from NHTSA's historical approach and why is this approach preferable?

As discussed above in Section II.B.4, 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-duty 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 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.

Although manufacturers did not comment on the agency's proposal to rely on public and commercial information rather than manufacturers' confidential product plans when developing a market forecast, those organizations that did comment on this issue supported this change. The California Air Resources Board (CARB) and Center for Biological Diversity (CBD) both commended the resultant increase in transparency. CARB further indicated that the use of public and commercial information should produce a better forecast. On the other hand, as discussed above in Section I, CBD and the Northeast States for Coordinated Air Use Management (NESCAUM) both raised concerns regarding the resultant omission of some new vehicle models, and the inclusion of some vehicles to be discontinued, while CARB suggested that the impact of these inaccuracies should be minor.

As discussed above in Section II.B.4, while a baseline developed using publicly and commercially available sources has both advantages and disadvantages relative to a baseline developed using manufacturers' product plans, NHTSA has concluded for today's rule that the advantages outweigh the disadvantages. Today's approach is much more transparent than the agency's past approach of relying on product plans, and as discussed in Section II.B.4, any inaccuracies related to new or discontinued vehicle models should have only a minor impact on the agency's analysis.

For subsequent rulemakings, NHTSA remains hopeful that manufacturers will agree to make public their plans for model years that are very near, so that this information could be incorporated into analysis available for public review and comment. In any event, because NHTSA is releasing market inputs used in the agency's analysis of this final rule, all interested parties can review these inputs fully, as intended in adopting the transparent approach. More information on the advantages and disadvantages of the current approach and the agencies' decision to follow it is available in Section II.B.4.

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

[564] Available at *http://www.eia.doe.gov/oiaf/aeo/index.html* (last accessed March 15, 2010). Specifically, while the total volume of both cars and trucks was obtained from AEO 2010, the car-truck split was obtained from AEO 2009. The agencies have also used fuel price forecasts from AEO 2010. Both agencies regard AEO a credible source not only of such forecasts, but also of many underlying forecasts, including forecasts of the size of the future light vehicle market.

[565] EPA also considered other sources of similar information, such as J.D. Powers, and concluded that CSM was more appropriate for purposes of this rulemaking analysis.

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. This comparison provides a basis for understanding general characteristics and measures of the difference, in this case, between using publicly (and commercially) available sources and using manufacturers' confidential product plans. The current baseline, while developed using the same methods as the baseline used for MYs 2012–2016 NPRM, reflects updates to the underlying commercially-available forecast of manufacturer and market segment shares of the future light vehicle market. These changes are discussed above in Section II.B.

Estimated vehicle sales:

The sales forecasts, based on the Energy Information Administration's (EIA's) Annual Energy Outlook 2010 (AEO 2010), 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.[566] 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 41 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.

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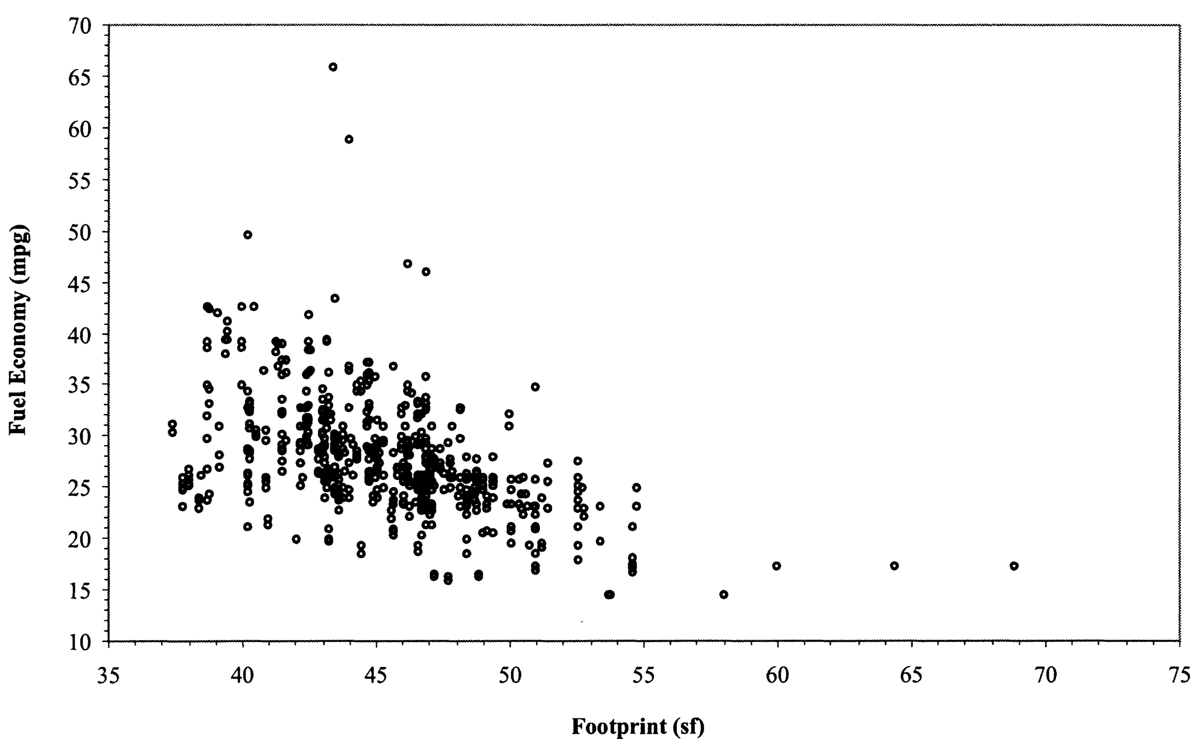
Figure IV.C.1-1 Planned Fuel Economy vs. Footprint, Passenger Cars in Current Baseline



[566] *Please see* Section II.B above and Chapter 1 of the Joint TSD for more discussion on the agencies' use of AEO 2010 to determine the sales forecasts for light vehicles during the model years covered by the rulemaking, as well as the memo available at Docket No. NHTSA–2009–059–0222.

Figure IV.C.1-2 Planned Fuel Economy vs. Footprint, Passenger Cars in MY 2011 Final Rule

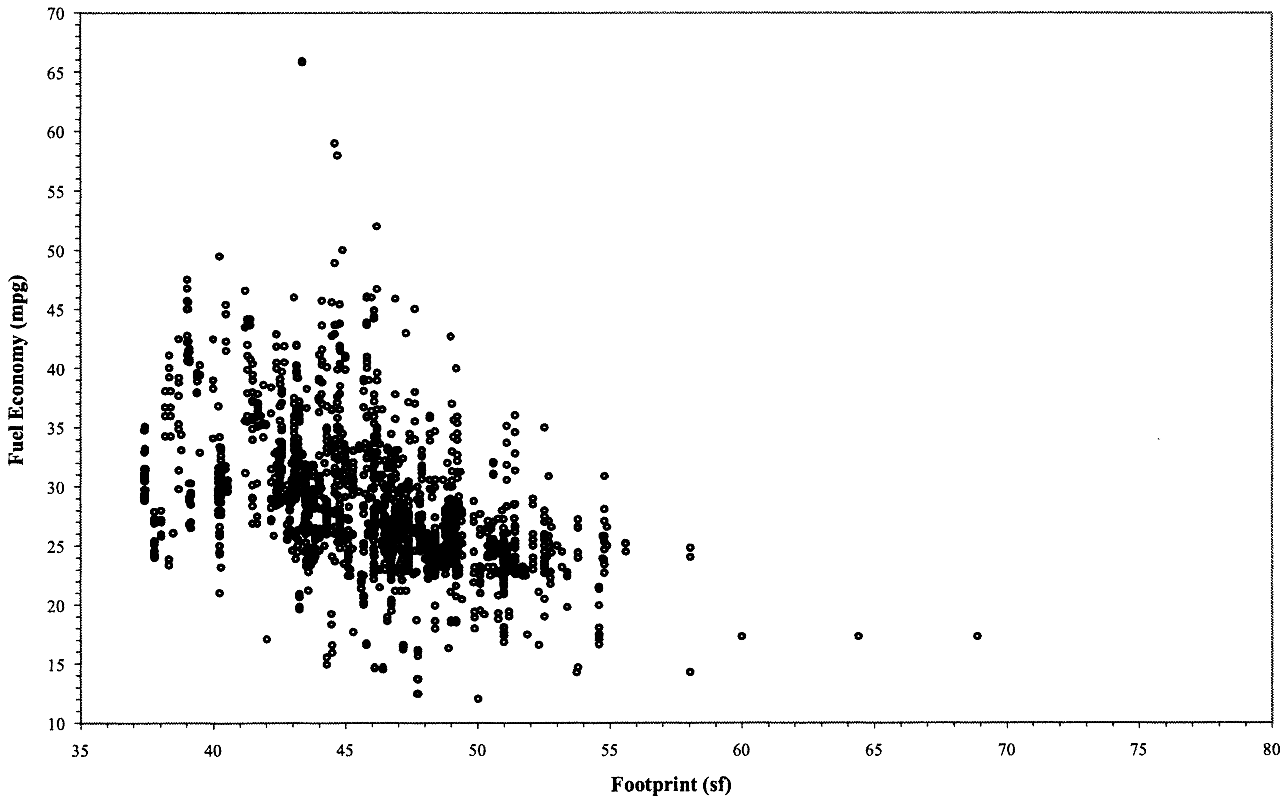


Figure IV.C.1-3 Planned Fuel Economy vs. Footprint, Light Trucks in Current Baseline

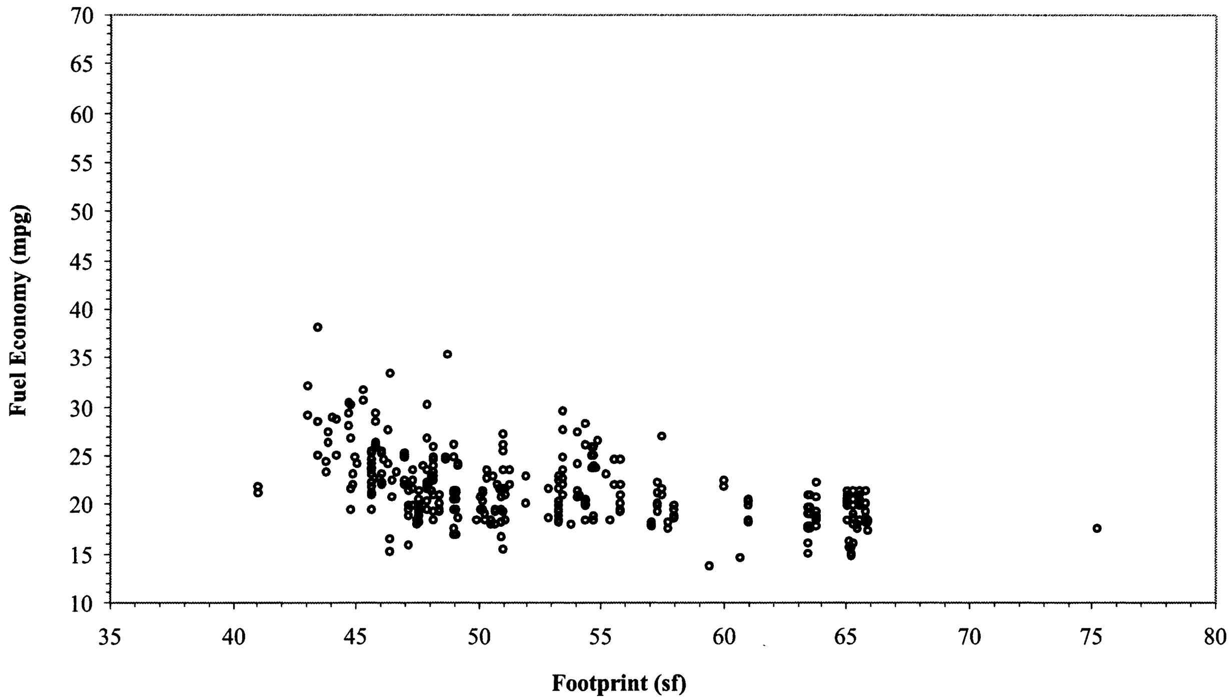
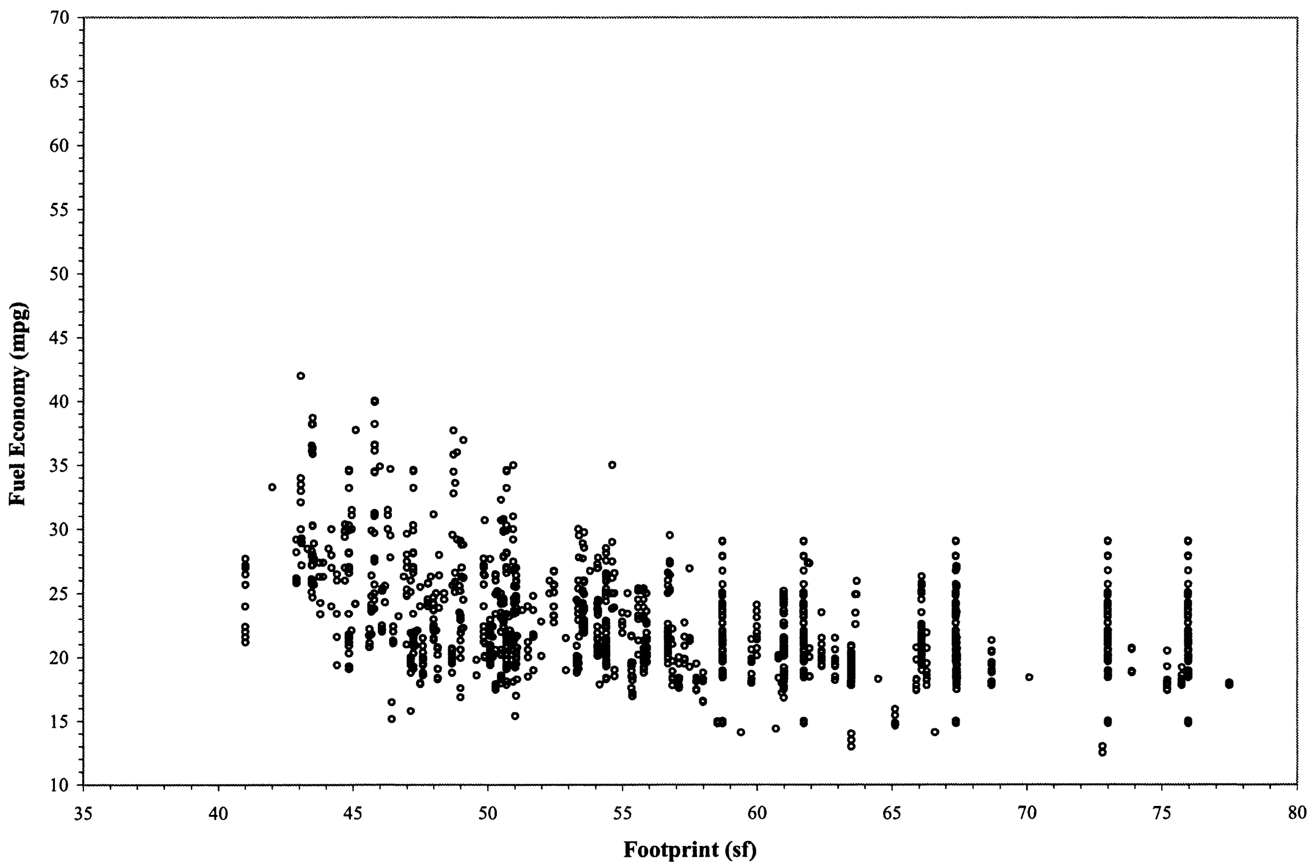


Figure IV.C.1-4 Planned Fuel Economy vs. Footprint, Light Trucks in MY 2011 Final Rule



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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, given that the agency is relying on different sources of material for these assumptions as discussed in Section II.B above and Chapter 1 of the Joint TSD. 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.[567]

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	326	737	707	1,216
Ford	1,344	792	1,615	1,144
General Motors	1,249	1,347	1,700	1,844
Honda	851	585	1,250	470
Hyundai	382	46	655	221
Kia	306	88		
Nissan	612	331	789	479
Toyota	1,356	888	1,405	1,094
Other Asian	664	246	441	191
European	833	396	724	190
Total	7,923	5,458	9,286	6,849

[567] 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.

Dual-fueled vehicles:

Manufacturers have also, during and since MY 2008, indicated to the agency that they intend to sell more dual-fueled or flexible-fuel vehicles (FFVs) in MY 2011 than 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.[568] 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."[569] 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 7 percent for the current baseline, versus 17 percent for the MY 2011 final rule. NHTSA notes that in MY 2008 (the model year providing the vehicle models upon which today's market forecast is based), the three U.S.-based OEMs produced most of the FFVs offered for sale in the U.S., yet these OEMs account are projected to account for a smaller share of the future market in the forecast the agency has used to develop and analyze today's rule than in the forecast the agency used to develop and analyze the MY 2011 standards.

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 lower in MY 2011 than shown in the MY 2011 final rule and the MYs 2012–2016 NPRM. Under the current baseline, average fuel economy for MY 2011 is 26.4 mpg, versus 26.5 mpg under the baseline in the MY 2011 final rule, and 26.7 mpg under the baseline in the MYs 2012–2016 NPRM. The 0.3 mpg change relative to the MYs 2012–2016 baseline is the result of changes in manufacturer and market segment shares of the MY 2011 market.

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 Volkswagen is essentially the same under both, Toyota and Nissan show increased combined CAFE levels under the current baseline (by 1.9 and 0.7 mpg respectively), while Chrysler, Ford, and GM show decreased combined CAFE levels under the current baseline (by 1.4, 1.1, and 0.8 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	23.0	27.0	23.0
Chrysler	27.8	21.8	28.2	23.1
Ford	28.0	21.0	29.3	22.5
Subaru	29.2	26.1	28.6	28.6
General Motors	28.2	21.2	30.3	21.4
Honda	33.5	25.0	32.3	25.2
Hyundai	32.5	24.3	31.7	26.0
Tata	24.6	19.6	24.7	23.9
Kia[570]	31.7	23.7		
Mazda[571]	30.6	26.0		
Daimler	26.4	21.0	25.2	20.6
Mitsubishi	29.4	23.6	29.3	26.7
Nissan	31.7	21.7	31.3	21.4
Porsche	26.2	20.0	27.2	20.0
Ferrari[572]			16.2	
Maserati[573]			18.2	
Suzuki	30.9	23.3	28.7	24.0
Toyota	35.1	23.7	33.2	22.7
Volkswagen	29.1	20.2	28.5	20.1
Total/Average	30.3	22.2	30.4	22.6

[568] *See* 49 U.S.C. 32905 and 32906.

[569] 49 U.S.C. 32902(h).

[570] 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).

[571] 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.

[572] 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.

[573] 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	25.0	26.0
Chrysler	23.3	24.7
Ford	24.9	26.0
Subaru	27.9	28.6
General Motors	24.1	24.9
Honda	29.5	30.0
Hyundai	31.3	30.0
Tata	21.4	24.4
Kia	29.5	
Mazda	29.8	
Daimler	24.4	23.6
Mitsubishi	27.4	29.1
Nissan	27.3	26.6
Porsche	23.7	22.0
Ferrari		16.2
Maserati		18.2
Suzuki	29.7	27.8
Toyota	29.5	27.6
Volkswagen	27.0	27.1
Total/Average	26.4	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 used in that rulemaking, 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	49.9	47.5
Chrysler	46.8	52.8	50.9
Daimler	47.1	53.3	49.0
Ford	46.3	56.1	49.9
General Motors	46.4	58.2	52.5
Honda	44.3	49.1	46.3
Hyundai	44.4	48.7	44.8
Kia	45.2	51.0	46.5
Mazda	44.4	47.3	44.9
Mitsubishi	43.8	46.5	44.6
Nissan	45.3	53.9	48.3
Porsche	38.6	51.0	42.8
Subaru	43.1	46.2	44.3
Suzuki	40.8	47.2	41.6
Tata	50.3	47.8	48.8
Toyota	44.0	53.0	47.6
Volkswagen	43.5	52.6	45.1
Industry Average	45.2	53.5	48.6

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	50.4	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

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	4,648	4,055
Chrysler	3,572	4,469	4,194
Daimler	3,583	5,127	4,063
Ford	3,526	4,472	3,877
General Motors	3,528	4,978	4,281
Honda	3,040	4,054	3,453
Hyundai	3,014	4,078	3,129
Kia	3,035	4,007	3,252
Mazda	3,258	3,803	3,348
Mitsubishi	3,298	3,860	3,468
Nissan	3,251	4,499	3,689
Porsche	3,159	4,906	3,760
Subaru	3,176	3,470	3,391
Suzuki	2,842	3,843	2,965
Tata	3,906	5,171	4,627
Toyota	3,109	4,321	3,589
Volkswagen	3,445	5,672	3,839
Industry Average	3,313	4,499	3,797

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	0.067
Chrysler	0.055	0.052	0.053
Daimler	0.068	0.056	0.064
Ford	0.058	0.054	0.056
General Motors	0.057	0.056	0.056
Honda	0.056	0.054	0.056
Hyundai	0.052	0.055	0.052
Kia	0.050	0.056	0.051
Mazda	0.052	0.055	0.052
Mitsubishi	0.053	0.056	0.054
Nissan	0.059	0.057	0.058
Porsche	0.105	0.073	0.094
Subaru	0.060	0.056	0.058
Suzuki	0.049	0.062	0.051
Tata	0.077	0.057	0.065
Toyota	0.053	0.062	0.056
Volkswagen	0.057	0.052	0.056
Industry Average	0.057	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 (percent)	LT (percent)	Avg. (percent)
BMW	32	37	34
Chrysler	0	13	9
Daimler	0	0	0
Ford	12	8	11
General Motors	17	3	9
Honda	29	26	28
Hyundai	26	0	23
Kia	38	83	48
Mazda	0	0	0
Mitsubishi	0	59	18
Nissan	5	25	12
Porsche	0	100	34
Subaru	0	42	16
Suzuki	4	21	6
Tata	28	100	69
Toyota	5	15	9
Volkswagen	16	0	13
Industry Average	13	15	14

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
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 IV.C.1–8 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 IV.C.1–8 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 rule?

As discussed in Section II.B.5 above, while the agencies received updated product plans in Spring and Fall 2009 in response to NHTSA's requests, the baseline data used in this final rule is not informed by these product plans, except with respect to specific engineering characteristics (*e.g.,* GVWR) of some MY 2008 vehicle models, because these product plans contain confidential business information that the agencies are legally required to protect from disclosure, and because the agencies have concluded that, for purposes of this final rule, a transparent baseline is preferable.

For the NPRM, NHTSA conducted a separate analysis that did make use of these product plans. NHTSA performed this separate analysis for purposes of comparison only. For today's final rule NHTSA used the publicly available baseline for all analysis related to the development and evaluation of the new CAFE standards. As discussed above in Section II.B.4, while a baseline developed using publicly and commercially available sources has both advantages and disadvantages relative to a baseline developed using manufacturers' product plans, NHTSA has concluded for today's rule that the advantages outweigh the disadvantages. NHTSA plans to consider these advantages and disadvantages further in connection with future rulemakings, taking into account changes in the market, changes in the scope and quality of publicly and commercially available data, and any changes in manufacturers' willingness to make some product planning information publicly available.

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, as well as the comments received to the NPRM for this rule. In addition, the agencies supplemented their review with updated information from the FEV tear-down studies contracted by EPA, 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 final rule above in Section II.E, in Chapter 3 of the Joint TSD, and in Section V of NHTSA's FRIA.

a. What technologies does NHTSA consider?

Section I*I.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,[574] 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.[575] 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 FRIA.

[574] 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–2009–0059–0156 and on NHTSA's Web site.

[575] 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

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
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	DEACD	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 final rule 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. 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 final standards. However, some refinements were made as discussed in the NPRM.[576] Additionally, the following refinements were made for purposes of the final rule.

Specific to its modeling, NHTSA has revised two technologies used in the final rule analysis from those considered in the NPRM. These revisions were based on comments received in response to the NPRM and the identification of area to improve accuracy. In the NPRM, a diesel engine option (DSLT or DSLC) was not available for small vehicles because it did not appear to be a cost-effective option. However, based on comments received in response to the NPRM, the agency added a diesel engine option for small vehicles. Additionally, in the NPRM, the mass reduction/material substitution technology, MS1, assumed engine downsizing. However, for purposes of the final rule, engine downsizing is no longer assumed for MS1, thus slightly lowering the effectiveness estimate to better reflect how manufacturers might implement small amounts of mass reduction/ material substitution. Chapter 3 of the Joint TSD and Section V of NHTSA's FRIA provide a more detailed explanation of these revisions.

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 EPA's 2008 Staff Technical Report,[577] the agencies took a fresh look at technology cost and effectiveness values and incorporated additional FEV tear-down study results for purposes of this final rule. This joint work is reflected in Chapter 3 of the Joint TSD and in Section II of this preamble, as 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 FRIA. NHTSA and EPA are confident that the thorough review conducted for purposes of this final rule led to the best available conclusions regarding technology costs and effectiveness estimates for the current rulemaking and resulted in excellent consistency between the agencies' respective analyses for

[576] 74 FR at 49655–56 (Sept. 28, 2009).

[577] 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. *Available at* Docket No. NHTSA–2009–0059–0027.

developing the CAFE and CO_2 standards.

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 for purposes of the NRPM: mild and strong hybrids, diesels, SGDI, and Valve Train Lift Technologies. In addition, based on FEV tear-down studies, the costs for turbocharging/downsizing, 6-, 7-, 8-speed automatic transmissions, and dual clutch transmissions were revised for this final rule. These revisions are discussed at length in the Joint TSD and in NHTSA's FRIA.

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 the agencies apply technologies to vehicles in their respective models, we report the ranges for the effectiveness values used in each model. For purposes of the final rule analysis, NHTSA made only a couple of changes to the effectiveness estimates. Specifically, in reviewing the NPRM effectiveness estimates for this final rule NHTSA discovered that the DCTAM effectiveness value for Subcompact and Compact subclasses was incorrect; the (lower) wet clutch effectiveness estimate had been used instead of the intended (higher) dry clutch estimate for these vehicle classes.[578] Thus, NHTSA corrected these effectiveness estimates. Additionally, as discussed above, the effectiveness estimate for MS1 was revised (lowered) to better represent the impact of reducing mass at a refresh. 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 FRIA.

As a general matter, NHTSA received relatively few comments related to technology cost and effectiveness estimates as compared to the number received on these issues in previous CAFE rulemakings. The California Air Resources Board (CARB) generally agreed with cost estimates used in the NPRM analysis. NHTSA also received comments from the Aluminum Association, General Motors, Honeywell, International Council on Clean Transportation (ICCT), Manufacturers of Emission Controls Association (MECA), Motor and Equipment Manufacturers Association (MEMA) and the New Jersey Department of Environmental Protection related to cost and effectiveness estimates for specific technologies, including but not limited to hybrids, diesels, turbocharging and downsizing, and mass reduction/material substitution. A detailed description of these comments and NHTSA's responses can be found in Section V of NHTSA's FRIA.

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. NHTSA sought comment on the extent to which commenters believed that the agencies have been successful in holding constant these elements of vehicle performance and utility in developing the technology cost and effectiveness estimates, but received relatively little in response. NHTSA thus concludes that commenters had no significant issues with its approach for purposes of this rulemaking, but the agency will continue to analyze this issue going forward.

Additionally, NHTSA notes that the technology costs included in this final rule take into account only those associated with the initial build of the vehicle. The agencies sought comment 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, but received no responses. The agency will continue to examine this issue closely for subsequent rulemakings, particularly as manufacturers turn increasingly to even more advanced technologies in the future that may have more significant lifetime costs.

The tables below provide examples of the incremental cost and effectiveness estimates employed by the agency in developing this final rule, according to the decision trees used in the Volpe modeling analysis. Thus, the effectiveness and cost estimates are not absolute to a single reference vehicle, but are incremental to the technology or technologies that precede it.

TABLE IV.C.2–2—TECHNOLOGY EFFECTIVENESS ESTIMATES EMPLOYED IN THE VOLPE MODEL FOR CERTAIN TECHNOLOGIES

	Subcomp. 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
VEHICLE TECHNOLOGY INCREMENTAL FUEL CONSUMPTION REDUCTION (−%)												
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

[578] "Dry clutch" DCTAMs and "wet clutch" DCTAMs have different characteristics and different uses. A dry clutch DCTAM is more efficient and less expensive than a wet clutch DCTAM, which requires a wet-clutch-type hydraulic system to cool the clutches. However, without a cooling system, a dry clutch DCTAM has a lower torque capacity. Dry clutch DCTAMs are thus ideal for smaller vehicles with lower torque ratings, like those in the Subcompact and Compact classes, while wet clutch DCTAMs would be more appropriate for, *e.g.,* larger trucks. Thus, it is appropriate to distinguish accordingly in DCTAM effectiveness between subclasses.

TABLE IV.C.2–2—TECHNOLOGY EFFECTIVENESS ESTIMATES EMPLOYED IN THE VOLPE MODEL FOR CERTAIN TECHNOLOGIES—Continued

	Subcomp. 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
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	4.2–4.8	4.2–4.8	4.2–4.8	1.8–1.9	4.2–4.8	1.8–1.9	1.8–1.9	1.8–1.9	1.8–1.9	4.2–4.8	1.8–1.9	1.8–1.9
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	8.7–8.9	8.6–8.9	8.7–8.9	8.7–8.9	8.7–8.9	8.7–8.9	8.6–8.9	8.7–8.9	14.1–16.3
Power Split Hybrid	6.3–12.4	6.3–12.4	6.3–12.4	6.3–12.4	6.3–12.4	6.3–12.4	6.3–12.4	6.3–12.4	6.3–12.4	6.3–12.4	6.3–12.4	n.a.
Aero Drag Reduction	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

TABLE IV.C.2–3—TECHNOLOGY COST ESTIMATES EMPLOYED IN THE VOLPE MODEL FOR CERTAIN TECHNOLOGIES

	Subcomp. 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
VEHICLE TECHNOLOGY ICM COSTS PER VEHICLE ($)												
Nominal baseline engine (for cost purpose)	(*)	(*)	(*)	V6	(*)	V6	V6	V8	V6	(*)	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	82	38	82	82	82	82	38	82	82
Discrete Variable Valve Lift (DVVL) on DOHC	142	142	142	206	142	206	206	294	206	142	206	294
Cylinder Deactivation on OHV	n.a.	n.a.	n.a.	168	n.a.	168	168	192	168	n.a.	168	192
Stoichiometric Gasoline Direct Injection (GDI)	236	236	236	342	236	342	342	392	342	236	342	392
Turbocharging and Downsizing	445	445	445	325	445	325	325	919	325	445	325	919
6/7/8-Speed Auto. Trans with Improved Internals	112	112	112	112	112–214	112–214	112–214	112–214	112–214	112	112–214	112–214
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	337	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	3,149	3,141	3,611	5,124
Power Split Hybrid	1,600	2,133	2,742	3,261	3,661	4,018	5,287	6,723	4,018	2,337	3,462	n.a.
Aero Drag Reduction	48	48	48	48	48	48	48	48	48	48	48	48

* Inline 4.

c. How does NHTSA use these assumptions in its modeling analysis?

NHTSA relies on several inputs and data files to conduct the compliance analysis using the Volpe model, as discussed further below and in Section V of the FRIA. For the purposes of applying technologies, the Volpe model primarily uses two data files, one that contains data on the vehicles expected to be manufactured in the model years covered by the rulemaking and 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 final 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 standards, which cover MYs 2012–2016, the light-duty 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—previous analyses would count a vehicle as "new" in any year when significant technology differences are made, such as at a redesign.[579] 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-duty vehicle fuel economy.[580]

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 estimated 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 likely be applied to vehicles equipped with manual transmissions during the rulemaking timeframe, due primarily to the cylinder deactivation system not being able to anticipate gear shifts. 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.

In response to the NPRM, NHTSA received comments from GM that included a description of technical considerations, concerns, limitations and risks that need to be considered when implementing turbocharging and downsizing technologies on full size trucks. These include concerns related to engine knock, drivability, control of boost pressure, packaging complexity, enhanced cooling for vehicles that are designed for towing or hauling, and noise, vibration and harshness. NHTSA judges that the expressed technical considerations, concerns, limitations and risks are well recognized within the industry and it is standard industry practice to address each during the design and development phases of applying turbocharging and downsizing technologies. Cost and effectiveness estimates used in the final rule are based on analysis that assumes each of these factors is addressed prior to production implementation of the technologies. In comments related to full size trucks, GM commented that potential to address knock limit concerns through various alternatives, which include use of higher octane premium fuel and/or the addition of a supplemental ethanol injection system. For this rulemaking, NHTSA has not assumed that either of these approaches is implemented to address knock limit concerns, and these technologies are not included in assessment of turbocharging and downsizing feasibility, cost or effectiveness.[581] In addition, NHTSA has received confidential business information from a manufacturer that supports that turbocharging and downsizing is feasible on a full size truck product during the rulemaking period.

[579] The market file for the MY 2011 final rule, which included data for MYs 2011–2015, had 5500 vehicles, about 5 times what we are using in this analysis of the MY 2008 certification data.

[580] 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 the fleets that 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.

[581] Note that for one of the teardown analysis cost studies of turbocharging and downsizing conducted by FEV, in which a 2.4L I4 DOHC naturally aspirated engine was replaced by a 1.6L I4 DOHC SGDI turbocharged engine, the particular 1.6L turbocharged engine chosen for the study was a premium octane fuel engine. For this rulemaking, NHTSA intends that a turbocharged and downsized engine achieve comparable performance to a baseline engine without requiring premium octane fuel. For the FEV study of the 1.6L turbocharged engine, this could be achieved through the specification of an engine with a displacement of slightly greater than 1.6L. NHTSA judges that a slightly larger engine would have small effect on the overall cost analysis used in this rulemaking. For all other teardown studies conducted by FEV, both the naturally aspirated engine and the replacement turbocharged and downsized engine were specified to use regular octane fuel.

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.[582]

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 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 FRIA and in Chapter 3 of the TSD.

NHTSA received comments from the Center for Biological Diversity (CBD) and Ferrari regarding redesign cycles. CBD stated that manufacturers do not necessarily adhere to the agencies' assumed five-year redesign cycle, and may add significant technologies by redesigning vehicles at more frequent intervals, albeit at higher costs. CBD argued that NHTSA should analyze the costs and benefits of manufacturers choosing to redesign vehicles more frequently than a 5-year average. Conversely, Ferrari agreed with the agencies that major technology changes are introduced at vehicle redesigns, rather than at vehicle freshenings, stating further that as compared to full-line manufacturers, small-volume manufacturers in fact may have 7 to 8-year redesign cycles. In response, NHTSA recognizes that not all manufacturers follow a precise five-year redesign cycle for every vehicle they produce,[583] but continues to believe that the five-year redesign cycle assumption is a reasonable estimate of how often manufacturers can make major technological changes for purposes of its modeling analysis.[584] NHTSA has considered attempting to quantify the increased cost impacts of setting standards that rise in stringency so rapidly that manufacturers are forced to apply "usual redesign" technologies at non-redesign intervals, but such an analysis would be exceedingly complex and is beyond the scope of this rulemaking given the timeframe and the current condition of the industry. NHTSA emphatically disagrees that the redesign cycle is a barrier to increasing penetration of technologies as CBD suggests, but we also believe that standards so stringent that they would require manufacturers to abandon redesign cycles entirely would be beyond the realm of economic practicability and technological feasibility, particularly in this rulemaking timeframe given lead time and capital constraints. Manufacturers can and will accomplish much improvement in fuel economy and GHG reductions while applying technology consistent with their redesign schedules.

Once the model indicates 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

[582] 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 a vehicle's braking characteristics or how it performs in crash avoidance tests.

[583] In prior NHTSA rulemakings, the agency was able to account for shorter redesign cycles on some models (*e.g.,* some sedans), and longer redesign cycles on others (*e.g.,* cargo vans), but has standardized the redesign cycle in this analysis using the transparent baseline.

[584] In the MY 2011 final rule, NHTSA noted that the CAR report submitted by the Alliance, prepared by the Center for Automotive Research and EDF, stated that "For a given vehicle line, the time from conception to first production may span two and one-half to five years," but that "The time from first production ("Job#1") to the last vehicle off the line ("Balance Out") may span from four to five years to eight to ten years or more, depending on the dynamics of the market segment," The CAR report then stated that "At the point of final production of the current vehicle line, a new model with the same badge and similar characteristics may be ready to take its place, continuing the cycle, or the old model may be dropped in favor of a different product." *See* NHTSA–2008–0089–0170.1, Attachment 16, at 8 (393 of pdf). NHTSA explained that this description, which states that a vehicle model will be redesigned or dropped after 4–10 years, was consistent with other characterizations of the redesign and freshening process, and supported the 5-year redesign and 2–3 year refresh cycle assumptions used in the MY 2011 final rule. See *id.,* at 9 (394 of pdf). Given that the situation faced by the auto industry today is not so wholly different from that in March 2009, when the MY 2011 final rule was published, and given that the commenters did not present information to suggest that these assumptions are unreasonable (but rather simply that different manufacturers may redesign their vehicles more or less frequently, as the range of cycles above indicates), NHTSA believes that the assumptions remain reasonable for purposes of this final rule analysis. *See also* "Car Wars 2009–2012, The U.S. automotive product pipeline," John Murphy, Research Analyst, Merrill Lynch research paper, May 14, 2008 and "Car Wars 2010–2013, The U.S. automotive product pipeline," John Murphy, Research Analyst, Bank of America/Merrill Lynch research paper, July 15, 2009. *Available at http://www.autonews.com/assets/PDF/CA66116716.PDF* (last accessed March 15, 2010).

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 car classes and 6 truck classes),[585] 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 "like" 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 final rule as for the NPRM, 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 final rule for MYs 2012–2016. No comments were received on the vehicle subclasses employed in the agency's NPRM analysis, and NHTSA has retained the subclasses and the methodology for dividing vehicles among them for the final rule analysis. Vehicle subclasses are discussed in more detail in Section V of the FRIA 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, Hyundai Accent.
Subcompact Performance	Mazda MX–5, BMW Z4.
Compact	Chevy Cobalt, Nissan Sentra and Altima.
Compact Performance	Audi S4, Mazda RX–8.
Midsize	Chevy Impala, 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.
Small SUV/Pickup/Van	Ford Escape & Ranger, Nissan Rogue.
Midsize SUV/Pickup/Van	Chevy Colorado, Jeep Wrangler, Toyota Tacoma.
Large SUV/Pickup/Van	Chevy Silverado, Ford E-Series, 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.

585 The NAS classes included subcompact cars, compact cars, midsize cars, large cars, small SUVs, midsize SUVs, large SUVs, small pickups, large pickups, and minivans.

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 add 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 final rule, 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 and in the MY 2012–2016 NPRM.

In general, and as described in great detail in the MY 2011 final rule and in Section V of the current FRIA, 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 FRIA. Expanded decision trees are available in the docket for this final rule.

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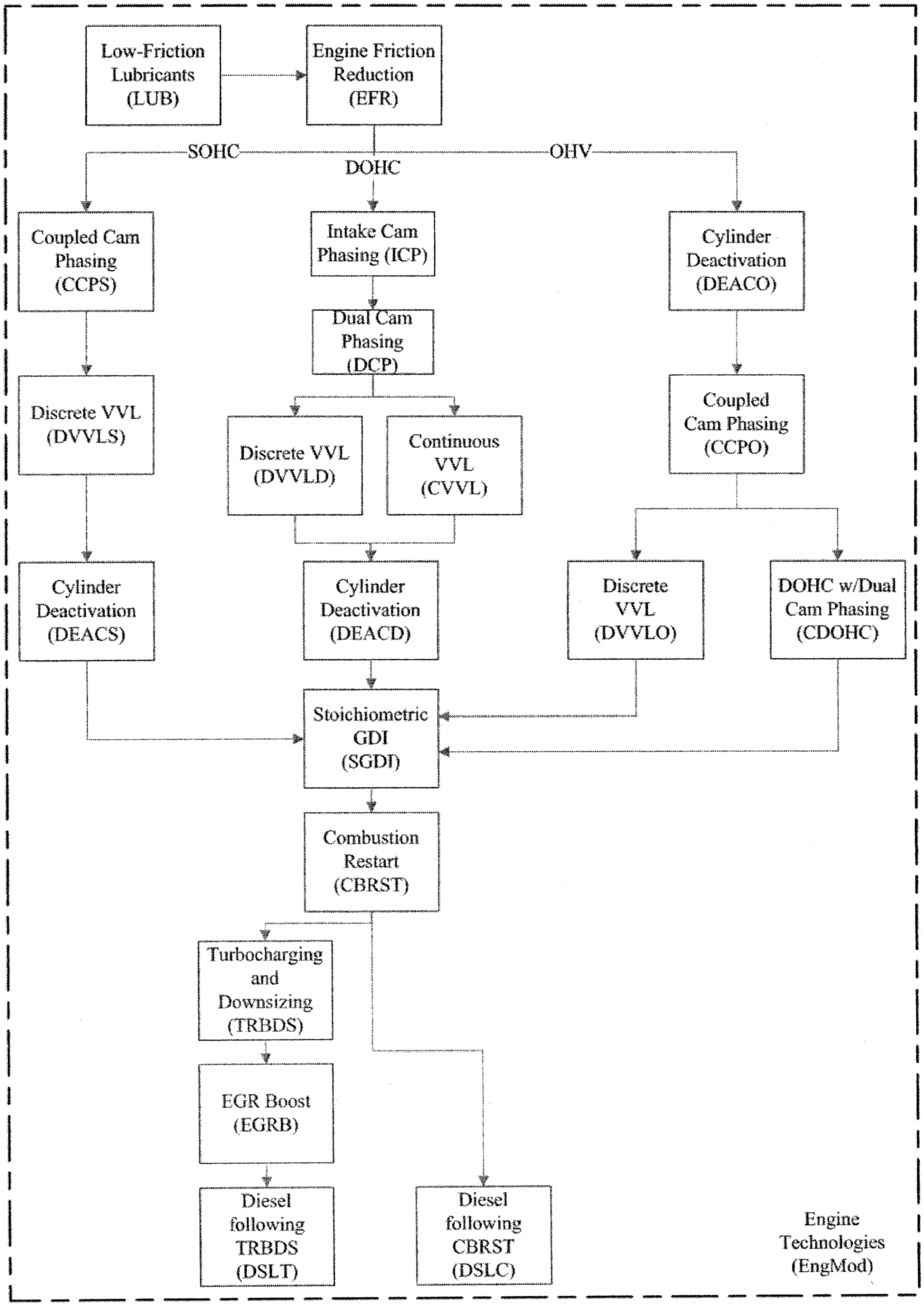
Figure IV.C.2-1 Engine Technology (EngMod) Decision Tree



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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 FRIA). 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 this and 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 that have been offered for the agencies' consideration 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 final rule.[586] To the extent that the decision trees have changed for purposes of the NPRM and this final rule, 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 did not receive any comments related to the use or ordering of the decision trees, and the agency continued to use the decision trees as they were proposed in the NPRM.

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 (albeit in varying degrees) in the model years covered by this rule. 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.

CBD commented that because many of the technologies considered in the NPRM are currently available, manufacturers should be able to attain mpg levels equivalent to the MY 2016 standards in MY 2009. In response, as discussed above, technology "availability" is not determined based simply on whether the technology exists, but depends also on whether the technology has achieved a level of technical viability that makes it appropriate for widespread application. This depends in turn on component supplier constraints, capital investment and engineering constraints, and manufacturer product cycles, among other things. Moreover, even if a technology is available for application, it may not be available for every vehicle. Some technologies may have considerable fuel economy benefits, but cannot be applied to some vehicles due to technological constraints—for example, cylinder deactivation cannot be applied to vehicles with current 4-cylinder engines (because not enough cylinders are present to deactivate some and continue moving the vehicle) or on vehicles with manual transmissions within the rulemaking timeframe. The agencies have provided for increases over time to reach the mpg level of the MY 2016 standards precisely because of these types of constraints, because they have a real effect on how quickly manufacturers can apply technology to vehicles in their fleets.

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.[587] 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 for purposes of the agency's modeling analysis over the course of the last several CAFE rulemakings, as discussed in greater detail in the MY 2011 final rule,[588] and in Section V of the FRIA 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.[589]

[586] *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.

[587] 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.

[588] 74 FR 14268–14271 (Mar. 30, 2009).

[589] *See* 74 FR at 14269 (Mar. 20, 2009).

For purposes of this final rule 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.[590] 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 this final rule, 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 this final rule 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 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 analysis underlying this final rule.

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 final rule 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.

NHTSA received comments from the Alliance and ICCT relating to phase-in caps. The Alliance commented that the higher phase-in caps in the NPRM analysis (as compared to the MY 2011 final rule) "ignore OEM engine architecture differences/limitations," arguing that the agency must consider manufacturing investment and lead time implications when defining phase-in caps. ICCT did not raise the issue of phase-in caps directly, but commented that the agencies had not provided information in the proposal documents explaining when each manufacturer can implement the different technologies and how long it will take the technologies to spread across the fleet. ICCT argued that this information was crucial to considering how quickly the stringency of the standards could be increased, and at what cost.

In response to the Alliance comments, the phase-in cap constraint is, in fact, exactly intended to account for manufacturing investment and lead time implications, as discussed above: phase-in caps are intended to reflect a manufacturer's overall resource capacity available for implementing new technologies (such as engineering and development personnel and financial resources), to help ensure that resource capacity is accounted for in the modeling process. Although the phase-in caps for the analysis supporting these standards are higher than the phase-in caps employed in the MY 2011 final rule, as stated in the NPRM, the agencies considered the fact that manufacturers, as part of the agreements supporting the National Program, appear to be anticipating higher technology application rates during the rulemaking timeframe—indicating that the values selected for the phase-in caps are more likely within the range of practicability. Additionally, the agencies did not receive any comments from manufacturers indicating a direct concern with the proposed application rates, which they were able to review in the detailed manufacturer level model outputs. The agencies believe that as manufacturers focus their resources (*i.e.,* engineering, capital investment, etc.) on fuel economy-improving technologies, many of which have been in production for many years, the application rates being modeled are appropriate for the timeframe being analyzed.

In response to ICCT's comments, the combination of phase-in caps, refresh/redesign cycles, engineering constraints, etc., are intended to simulate manufacturers' technology application decisions, and ultimately define the technology application/implementation rates for each manufacturer. NHTSA has used the best public data available to define refresh and redesign schedules to define technology implementation, which allows us to apply technologies at the specific times each manufacturer is planning. There was full notice of not just the phase-in caps themselves, but their specific application as well. NHTSA notes that the PRIA and the FRIA do contain manufacturer-specific application/implementation rates for prominent technologies, and that manufacturer-specific technology application as employed in the agency's analysis is available in full in the Volpe model outputs available on NHTSA's Web site. The model outputs present the resultant application of technologies at the industry, manufacturer, and vehicle levels.

Theoretically, significantly higher phase-in caps, such as those used in the current proposal and final rule as compared to those used in the MY 2011 final rule, should 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 final standards.[591] NHTSA believes that this is due to the interaction of the various changes in methodology for this final rule—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 the modeling analysis for this final rule as compared to prior rulemakings. Other revisions that could impact modeled application rates include the use of transparent CAFE certification data in baseline fleet formulation and the use of other data for projecting it forward,[592] 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 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 the analysis underlying these final

[590] *See* 74 FR at 14270 (Mar. 30, 2009) for further discussion and examples.

[591] The modeling output for the analysis underlying these final standards is available on NHTSA's Web site.

[592] 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 projected net application of technology.

standards, achieving a suitable level of stringency without requiring unrealistic or unachievable penetration rates.

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 rule, 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 the proposed standards, NHTSA and EPA reviewed both types of learning factors, and the thresholds (300,000) and reduction rates (20 percent for volume, 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 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 was applied to the higher complexity hybrid technologies, while no learning was 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.

ICCT and Ferrari commented on learning curves. ICCT stated the agencies could improve the accuracy of the learning curve assumptions if they used a more dynamic or continuous learning curve that is more technology-specific, rather than using step decreases as the current time- and volume-based learning curves appear to do. ICCT also commented on the appropriate application of volume- versus time-based learning, and stated further that worldwide production volumes should be taken into account when developing learning curves. Ferrari commented that is more difficult for small-volume manufacturers to negotiate cost decreases from things like cost learning effects with their suppliers, implying that learning effects may not be applicable equally for all manufacturers.

NHTSA agrees that a continuous curve, if implemented correctly, could potentially improve the accuracy of modeling cost-learning effects, although the agency cannot estimate at this time how significant the improvement would be. To implement a continuous curve, however, NHTSA would need to develop a learning curve cost model to be integrated into the agency's existing model for CAFE analysis. Due to time constraints the agencies were not able to investigate fully the use of a continuous cost-learning effects curve for each technology, but we will investigate the applicability of this approach for future rulemakings. For purposes of the final rule analysis, however, NHTSA believes that while more detailed cost learning approaches may eventually be possible, the approach taken for this final rule is valid.

Additionally, while the agencies agree that worldwide production volumes can impact learning curves, the agencies do not forecast worldwide vehicle production volumes in addition to the already complex task of forecasting the U.S. market. That said, the agencies do consider current and projected worldwide technology proliferation when determining the maturity of a particular technology used to determine the appropriateness of applying time- or volume-based learning, which helps to account for the effect of globalized production.

With regard to ICCT's comments on the appropriate application of volume- versus time-based learning, however, it seems as though ICCT is referencing a study that defines volume- and time-based learning in a different manner than the current definitions used by the agencies, and so is not directly relevant. The agencies use "volume-based" learning for non-mature technologies that have the potential for significant cost reductions through learning, while "time-based" learning is used for mature technologies that have already had significant cost reductions and only have the potential for smaller cost reductions. For "time-based" learning, the agencies chose to emulate the small year-over-year cost reductions manufacturers realize through defined cost reductions, approximately 3 percent per year, negotiated into contracts with suppliers. A more detailed description of how the agencies define volume- and time-based learning can be found in NHTSA's PRIA.

And finally, in response to Ferrari's comment, NHTSA recognizes that cost negotiations can be different for different manufacturers, but believes that on balance, cost learning at the supplier level will generally impact costs to all purchasers. Thus, if cost reductions are realized for a particular technology, all entities that purchase the technology will benefit from these cost reductions.

Is the technology more or less effective due to synergistic effects?

When two or more technologies are added to a particular vehicle model to 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.[593] 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.[594] 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 that 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 FRIA.

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).[595] 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 FRIA) 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 received only one comment regarding synergies, from MEMA, who commented that NHTSA's Volpe model adequately addressed synergistic effects. Having received no information to the contrary, NHTSA finalized the synergy approach and values for the final rule.

d. Where can readers find more detailed information about NHTSA's technology analysis?

Much more detailed information is provided in Section V of the FRIA, and a discussion of how NHTSA and EPA jointly reviewed and updated technology assumptions for purposes of this final rule 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 final rule, Docket No. NHTSA–2009–0059, and on NHTSA's

[593] 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 percent (*i.e.,* 0.1) and 20 percent (*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 percent rather than the 30 percent obtained by adding 10 percent to 20 percent. The "synergy factors" discussed in this section further adjust these multiplicatively combined effectiveness values.

[594] 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. *Available at* Docket No. NHTSA–2009–0059–0027.

[595] 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 March 15, 2010).

Web site. And finally, because much of NHTSA's technology analysis for purposes of this final rule 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 growing experience with this type of analysis.[596]

3. How did NHTSA develop its economic assumptions?

NHTSA's analysis of alternative CAFE standards for the model years covered by this rulemaking relies on a range of forecast variables, economic assumptions, and parameter values. This section describes the sources of these forecasts, the rationale underlying each assumption, and the agency's choices of specific parameter values. These 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 final rule, NHTSA reconsidered previous comments it had received and comments received to the NPRM, as well as reviewed newly available literature. As a consequence, the agency elected to revise some of its economic assumptions and parameter estimates from previous rulemakings at the NPRM stage, 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 FRIA, 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 comments the agency received and its responses are discussed in detail below, as well as in the TSD and FRIA. For the reader's reference, Table IV.C.3–1 below summarizes the values used to calculate the economic benefits from each alternative.

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
Average percentage of tank refilled per refueling	55%
Percent of drivers refueling in response to low fuel level	100%
Annual growth in average vehicle use	1.15%
Fuel Prices (2012–50 average, $/gallon)	
Retail gasoline price	$3.66
Pre-tax gasoline price	$3.29
Economic Benefits from Reducing Oil Imports ($/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)	$1,300
Nitrogen oxides (NO_x)—vehicle use	$5,300
Nitrogen oxides (NO_x)—fuel production and distribution	$5,100
Particulate matter ($PM_{2.5}$)—vehicle use	$290,000
Particulate matter ($PM_{2.5}$)—fuel production and distribution	$240,000
Sulfur dioxide (SO_2)	$31,000
Carbon dioxide (CO_2)	$21 [597]
Annual Increase in CO_2 Damage Cost	Varies by year.
External Costs from Additional Automobile Use ($/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%, 7%

[596] 74 FR 14233–308 (Mar. 30, 2009).

[597] The $21 value is for CO_2 emissions in 2010, which rises to $45/ton in 2050, at an average discount rate of 3 percent.

a. Costs of Fuel Economy-Improving Technologies

NHTSA and EPA previously developed detailed estimates of the costs of applying fuel economy-improving technologies to vehicle models for use in analyzing the impacts of alternative standards considered in the proposed rulemaking, including varying cost estimates for applying certain fuel economy technologies to vehicles of different sizes and body styles. These estimates were modified for purposes of this analysis as a result of extensive consultations among engineers from NHTSA, EPA, and the Volpe Center. Building on NHTSA's estimates developed for the MY 2011 CAFE final rule and EPA's Advanced Notice of Proposed Rulemaking, which relied on EPA's 2008 Staff Technical Report, the two agencies took a fresh look at technology cost and effectiveness values and incorporated FEV tear-down study results for purposes of this joint final rule under the National Program.

While NHTSA generally found that much of the cost information used in the 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 the component costs of several major technologies including: turbocharging/downsizing, mild and strong hybrids, diesels, SGDI, and Valve Train Lift Technologies for purposes of the NPRM. In addition, based on FEV tear-down studies, the costs for turbocharging/downsizing, 6-, 7-, 8-speed automatic transmissions, and dual clutch transmissions were revised for this final rule.

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 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.[598] 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 and EPA received far fewer specific comments on technology cost estimates than in previous CAFE rulemakings, which suggests that most, although not all, stakeholders generally agreed with the agencies' assumptions. Several commenters supported the agencies' use of tear-down studies for developing some of the technology costs, largely citing the agencies' own reasons in support of that methodology. Some specific comments were received with regard to hybrid and other technology costs, to which the agencies are responding directly in Chapter 3 of the Joint TSD and in the agencies' respective FRIAs. Generally speaking, however, to the extent that commenters disagreed with the agencies' cost estimates, often the disagreement stemmed from assumptions about the technology's maturity, which the agencies have tried to account for in the analysis. These issues are discussed further in Chapter 3 of the TSD. Additionally, we note that technology costs will also be addressed in the upcoming revised NAS report.

With regard to the indirect cost multiplier approach, commenters also generally supported the higher level of specificity provided by the ICM approach compared to the RPE approach, although some commenters suggested specific refinements to the measurement of ICMs. For example, while the automotive dealer organization NADA argued that all dealer costs of sales should be included in "dealer profit," another commenter noted expressly that the ICM does not include profits. Comments from ICCT also argued in favor of revising the "technology complexity" component of the ICM to account for the complexity of integrating a new technology into a vehicle, rather than for only the complexity of producing the technology itself. These comments and others on the ICM are addressed in Chapter 3 of the Joint TSD and in the agencies' respective FRIAs. NHTSA notes that profits were not included in the indirect cost estimates of this rule, and also that NHTSA's sensitivity analysis, presented in Chapter X of the FRIA, indicates that using the 1.5 RPE multiplier would result in higher costs compared to today's final rule costs incorporating the ICM multiplier, although even with those higher costs the 1.5 RPE analysis still resulted in significant net benefits for the rulemaking as a whole. NHTSA continues to study this issue and may employ a different approach in future rulemakings.

b. Potential Opportunity Costs of Improved Fuel Economy

An important concern is whether achieving the fuel economy improvements required by alternative CAFE standards might result in manufacturers compromising 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. (This possibility is addressed in detail in Section IV.G.6.) Although 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 varying combinations of these characteristics clearly demonstrate that changes in these attributes affect the utility and economic value that vehicles offer to potential buyers.[599]

[598] NHTSA notes that in addition to the technology cost analysis employing this "ICM" approach, the FRIA contains a sensitivity analysis using a technology cost multiplier of 1.5.

[599] *See, e.g.,* 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–2009–0472–0015); Berry, Steven, James Levinsohn, and Ariel Pakes, 1995. "Automobile Prices in Market Equilibrium," Econometrica 63(4): 841–940 (Docket NHTSA–2009–0059–0031); McCarthy, Patrick S., 1996.

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 cost estimates for fuel economy-improving technologies include adequate provision for accompanying outlays that are necessary to prevent any significant degradation in other attributes that vehicle owners value, 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 omitting these will cause the agency's estimated technology costs to underestimate the true economic costs of improving fuel economy.

Recognizing this possibility, it would be desirable 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. Although the agency has been unable to develop a procedure for doing so as part of this rulemaking, Section IV.G.6. below includes a detailed analysis and discussion of how omitting possible changes in vehicle attributes other than their prices and fuel economy might affect its estimates of benefits and costs resulting from the standards this rule establishes.

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.[600]

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 savings resulting from alternative CAFE standards evaluated in the MY 2011 final rule.

For purposes of this final rule, 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 rated 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 vehicle fleet *would have achieved* from 2000 through 2006 if cars and light trucks of each model year achieved the same fuel economy levels in actual on-road driving as they did under test conditions when new.

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.[601] 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.

NHTSA received no comments on this issue in response to the NPRM. Accordingly, it has not revised its estimate of the on-road fuel economy gap from the 20 percent figure used previously.

d. Fuel Prices and the Value of Saving Fuel

Projected future fuel prices are a critical input into the 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 2010 Early Release (December 2009) 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.[602] This forecast is

"Market Price and Income Elasticities of New Vehicle Demands." Review of Economics and Statistics 78: 543–547 (Docket NHTSA–2009–0059–0039); and 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–2009–0472–0017).

[600] 71 FR 77871 (Dec. 27, 2006).

[601] 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 March 1, 2010).

[602] Energy Information Administration, Annual Energy Outlook 2010 Early Release, Reference Case (December 2009), Table A12. *Available at http://www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf, p. 25* (last accessed March 1, 2010). These forecasts reflect 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 lead to a decline in its future price, there is some concern about whether the AEO 2010 forecast of fuel prices 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 agency

Continued

somewhat lower than the AEO 2009 Reference Case forecast the agency relied upon in the analysis it conducted for the NPRM. Over the period from 2010 to 2030, the AEO 2010 Early Release Reference Case forecast of retail gasoline prices used in this analysis averages $3.18 per gallon (in 2007 dollars), in contrast to the $3.38 per gallon average price for that same period forecast in the earlier AEO 2009 Reference Case and used in the NPRM analysis.

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. We also anticipated that the Reference Case forecasts would be significantly higher in subsequent editions of AEO, and that in future rulemaking analyses the agency would be likely to rely on the Reference Case rather than High Price Case forecasts. In fact, both EIA's AEO 2009 Reference Case and its subsequent AEO 2010 Early Release Reference Case forecasts project *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 2010 Early Release Reference Case is an appropriate forecast for projected future fuel prices.

NHTSA and EPA received relatively few comments on the fuel prices used in the NPRM analysis, compared to previous CAFE rulemakings. Two commenters, CARB and NADA, supported the use of AEO's Reference Case for use in the agencies' analysis, although they disagreed on the agencies' use of the High and Low Price Cases for sensitivities. Both commenters emphasized the sensitivity of the market and the agencies' analysis to higher and lower gas prices, and on that basis, CARB supported the use of the High and Low Price Cases in sensitivity analysis but urged the agencies to caveat the "Reference Case" results more explicitly. In contrast, NADA argued that the agencies should not use the High and Low Price Cases, because EIA does not assign specific probabilities to either of them. Only one commenter, James Adcock, argued that the agencies should use forecasts of future fuel prices other than those reported in AEO; Adcock stated that future fuel prices should be assumed to be higher than current pump prices.

Measured in constant 2007 dollars, the AEO 2010 Early Release Reference Case forecast of retail gasoline prices during calendar year 2010 is $2.44 per gallon, and rises gradually to $3.83 by the year 2035 (these values include Federal, State and local taxes). However, the agency's analysis of the value of fuel savings over the lifetimes of MY 2012–2016 cars and light trucks requires forecasts extending through calendar year 2050, approximately the last year during which a significant number of MY 2016 vehicles will remain in service. To obtain fuel price forecasts for the years 2036 through 2050, the agency assumes that retail fuel prices will continue to increase after 2035 at the average annual rates projected for 2025 through 2035 in the AEO 2010 Early Release Reference Case.[603] This assumption results in a projected retail price of gasoline that reaches $4.49 in 2007 dollars during 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. The agency has updated the estimates of gasoline taxes it employed in the NPRM using the recent data on State fuel tax rates; expressed in 2007 dollars, Federal gasoline taxes are currently $0.178, while State and local gasoline taxes together average $0.231 per gallon, for a total tax burden of $0.401 per gallon. 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, NHTSA deducts their value from retail fuel prices to determine the true value of fuel savings resulting from more stringent CAFE standards to the U.S. economy.

NHTSA follows the assumptions used by EIA in AEO 2010 Early Release that State and local gasoline taxes will keep pace with inflation in nominal terms, and thus remain constant when expressed in constant 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 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 rather than an *ad valorem* 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 to determine the economic value of each gallon of fuel saved during that year as a result of improved fuel economy. Subtracting fuel taxes from the retail prices forecast in AEO 2010 Early Release results in a projected value for saving gasoline of $2.04 per gallon during 2010, rising to $3.48 per gallon by the year 2035,and averaging $2.91 over this 25-year period.

Although the Early Release of AEO 2010 contains only the Reference Case forecast, EIA includes "High Price Case" and "Low Price Case" forecasts in each year's complete AEO, which reflect uncertainties regarding future levels of oil production and demand. For this final rule, NHTSA has continued to use the most recent "High Price Case" and "Low Price Case" forecasts available, which are those from AEO 2009. While NHTSA recognizes that these forecasts are not probabilistic, as NADA commented, we continue to believe that using them for sensitivity analyses provides valuable information for agency decision-makers, because it illustrates the sensitivity of the rule's primary economic benefit resulting from uncertainty about future growth in world demand for petroleum energy and the strategic behavior of oil suppliers.

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 (all figures in 2007 dollars). 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 $1.66 to $5.09 per gallon in 2030 (again, all figures are in constant 2007 dollars). In conducting the 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. Detailed

notes 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 then recently-passed EISA legislation. The fuel price forecasts reported in EIA's Revised Release of AEO 2008 differed by less than one cent per gallon throughout the entire forecast period (2008–2030) 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 2010 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.

[603] 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.

results and discussion of this sensitivity analysis can be found in the FRIA. Generally, however, this analysis confirmed that as several commenters suggested, the primary economic benefit resulting from the rule—the value of fuel savings—is quite sensitive to forecast fuel prices.

e. Consumer Valuation of Fuel Economy and Payback Period

In estimating the impacts on vehicle sales that would result from alternative CAFE standards to potential vehicle buyers, NHTSA assumes, as in the MY 2011 final rule, that potential vehicle 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 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.

One commenter, NADA, supported the agency's assumption of a five-year period for buyers' valuation of fuel economy, on the basis that the considerable majority of consumers seek to recoup costs quickly. However, NADA also encouraged the agencies to ensure that purchaser finance costs, opportunity costs of vehicle ownership, and increased maintenance costs were accounted for. Another commenter, James Adcock, argued that the assumption of a five-year period was irrational, because it did not account for the fact that first purchasers will be able to sell a higher-mpg vehicle for more money than a lower-mpg vehicle.

In response to these comments, the agency notes that it 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 the shorter 5-year "payback period" we assume that manufacturers employ to represent the preferences of vehicle buyers. The 5-year payback period is only utilized to identify the likely sequence of improvements in fuel economy that manufacturers are likely to make to their different vehicle models. The procedure the agency uses for calculating lifetime fuel savings is discussed in detail in the following section, while alternative assumptions about the time horizon over which potential buyers consider fuel savings in their vehicle purchasing decisions are analyzed and discussed in detail in Section IV.G.6 below.

Valuing fuel savings over vehicles' entire lifetimes in effect recognizes the gains that future vehicle owners will receive, even if initial purchasers of higher-mpg models are not able to recover the entire remaining value of fuel savings when they re-sell those vehicles. The agency acknowledges, however, that it has not accounted for any effects of increased financing costs for purchasing vehicles with higher fuel economy or increased expenses for maintaining them on benefits to vehicle owners, over either the short-run payback period or the full lifetimes of vehicles.

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.[604] 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."

As discussed in more detail in Section II.B.3 above and in Chapter 1 of the TSD, 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 and NHTSA used projected car and truck volumes for this period from Energy Information Administration's (EIA's) Annual Energy Outlook (AEO) 2009 in the NPRM analysis.[605] For the analysis supporting this final rule, NHTSA substituted the revised forecasts of total volume reported in EIA's Annual Energy Outlook 2010 Early Release. However, Annual Energy Outlook forecasts only total car and light truck sales, rather than sales at the manufacturer and model-specific level, which the agencies require in order to estimate the effects new standards will have on individual manufacturers.[606]

To estimate sales of individual car and light truck models produced by each manufacturer, EPA purchased data from CSM Worldwide and used its projections of the number of vehicles of each type (car or truck) that will be produced and sold by manufacturers in model years 2011 through 2015.[607] This provided year-by-year estimates of the percentage of cars and trucks sold by each manufacturer, as well as the sales percentages accounted for by each vehicle market segment. (The distributions of car and truck sales by manufacturer and by market segment for the 2016 model year and beyond were assumed to be the same as CSM's forecast for the 2015 calendar year.) Normalizing these percentages to the

[604] 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 March 1, 2010).

[605] *Available at http://www.eia.doe.gov/oiaf/aeo/index.html* (last accessed March 15, 2010). 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.

[606] 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.

[607] 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.

total car and light truck sales volumes projected for 2012 through 2016 in AEO 2009 provided manufacturer-specific market share and model-specific sales estimates for those model years. The volumes were then scaled to AEO 2010 total volume for each year.

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.[608]

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).[609] 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 FRIA and Chapter 4 of the 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 2010 Early Release Reference Case.[610] 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 1.15 percent per year 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.[611]

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.[612]

NHTSA and EPA received no comments on their respective NPRMs indicating that these assumptions should be updated or reconsidered. Thus the agencies have continued to employ them in the analysis supporting this final rule.

g. Accounting for the Fuel Economy 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 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.[613] 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 the NPRM.[614] 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

[608] 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 March 1, 2010). These updated survival rates suggest that the expected lifetimes of recent-model passenger cars and light trucks are 13.8 and 14.5 years.

[609] For a description of the Survey, *See http://nhts.ornl.gov/quickStart.shtml* (last accessed March 1, 2010).

[610] 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.

[611] 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.

[612] 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).

[613] 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.

[614] 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.

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.[615] 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 used a 10 percent rebound effect in its analysis of fuel savings and other benefits from higher CAFE standards for the NPRM. The agency also sought comment on other alternatives for estimating the rebound effect, such as 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.

[615] 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.

NHTSA and EPA received far fewer comments on the rebound effect than were previously received to CAFE rulemakings. Only one commenter, NJ DEP, expressly supported the agencies' assumption of 10 percent for the rebound effect; other commenters (CARB, CBD, ICCT) argued that 10 percent should be the absolute maximum value and that the rebound effect assumed by the agencies should be lower, and would also be expected to decline over time. ICCT added that the price elasticity of gasoline demand could be a useful comparison for the rebound effect, but should not be used to derive it. Other commenters argued that a rebound effect either was unlikely to occur (James Hyde), or was unlikely to produce a uniform increase in use of all vehicles with improved fuel economy (Missouri DNR). NADA argued, in contrast, that the agencies had not provided sufficient justification for lowering the rebound effect to 10 percent from the "historically justified" range of 15 to 30 percent.

The agency's interpretation of historical and recent evidence on the magnitude of the rebound effect is that a significant fuel economy rebound effect exists, and commenters did not provide any additional data or analysis to justify revising our initial estimates of the rebound effect. Therefore, the data available at this time do not justify using a rebound effect below the 10 percent figure employed in its NPRM analysis. NHTSA believes that projections of a *continued* decline in the magnitude of the rebound effect are unrealistic because they assume the rate at which it declines in response to increasing incomes remain constant, and in some cases imply that the rebound effect will become negative in the near future. In addition, the continued increases in fuel prices used in this analysis will tend to increase the magnitude of the rebound effect, thus offsetting part of the effect of rising incomes. As the preceding discussion indicates, there is a wide range of estimates for both the historical magnitude of the rebound effect and its projected future value, and there is some evidence that the magnitude of the rebound effect appears to be declining over time. Nevertheless, NHTSA requires a single point estimate for the rebound effect as an input to its analysis, although a range of estimates can be used to test the sensitivity to uncertainty about its exact magnitude. For the final rule, NHTSA chose to use 10 percent as its primary estimate of the rebound effect, with a range of 5–15 percent for use in sensitivity testing.

The 10 percent figure is well below those reported in almost all previous research, and it is also below most estimates of the historical and current magnitude of the rebound effect developed by NHTSA. However, other recent research—particularly that conducted by Small and Van Dender and by Greene—reports persuasive evidence that the magnitude of the rebound effect is likely to be declining over time, and the forecasts developed by NHTSA also suggest that this is likely to be the case. As a consequence, NHTSA concluded that a value below the historical estimates reported here is likely to provide a more reliable estimate of its magnitude during the future period spanned by NHTSA's analysis of the impacts of this rule. The 10 percent estimate meets this condition, since it lies below the 15–30 percent range of estimates for the historical rebound effect reported in most previous research, and at the upper end of the 5–10 percent range of estimates for the future rebound effect reported in the recent studies by Small and Van Dender and by Greene. It also lies within the 3–16 percent range of forecasts of the future magnitude of the rebound effect developed by NHTSA in its recent research. In summary, the 10 percent value was not derived from a single point estimate from a particular study, but instead represents a reasonable compromise between the historical estimates and the projected future estimates. NHTSA will continue to review this estimate of the rebound effect in future rulemakings, but the agency has continued to use the 10 percent rebound effect over the entire future period spanned by the analysis it conducted for this final rule.

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.[616] 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. Because no comments addressed this issue of benefits from increased vehicle use or the procedure used to estimate them, the agencies have finalized their proposed assumptions for purposes of the final rule analysis.

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.[617] 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.[618]

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 × 24 mpg) to 225 miles (= 9 gallons × 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).[619]Assuming that locating a station and filling up requires a total of five minutes, the annual value of time saved as a result of less frequent refueling amounts to $4.72 (calculated as 5/60 × 2.3 × $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.

Although the agencies received no public comments on the procedures they used to estimate the benefits from less frequent refueling or the magnitude of those benefits, we note also that the estimated value of less frequent refueling events is subject to a number of uncertainties which we discuss in detail in Chapter 4.1.11 of the Joint TSD, and the actual value could be higher or lower than the value presented here. Specifically, the analysis makes three assumptions: (a) That manufacturers will not adjust fuel tank capacities downward (from the current average of 19.3 gallons) when they improve the fuel economy of their vehicle models. (b) that the average fuel purchase (55 percent of fuel tank capacity) is the typical fuel purchase. (c) that 100 percent of all refueling is demand-based; *i.e.,* that every gallon of fuel which is saved would reduce the need to return to the refueling station. NHTSA has planned a new research project which will include a detailed study of refueling events, and which is expected to improve upon these assumptions. These assumptions and the upcoming research project are discussed in detail in Joint TSD Chapter 4.2.10, as well as in Chapter VIII of NHTSA's FRIA.

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.[620] NHTSA employed these estimates previously in its analysis accompanying the MY 2011 final rule, and after reviewing the procedures used by FHWA to develop them and considering other available estimates of these values, continues to find them appropriate for use in this final rule. 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.

One commenter, Inrix, Inc., stated that "deeply connected vehicles," *i.e.,* those with built-in computer systems to help drivers identify alternative routes to avoid congestion, are better able to avoid congestion than conventional vehicles. The commenter argued that increased use of these models may be less likely to contribute to increased congestion, and urged the agencies to consider the impact of this on their estimates of fuel use and GHG emissions. NHTSA notes that the number of such vehicles is extremely small at present, and is likely to remain modest for the model years affected by this rule, and has thus continued to employ the estimates of congestion costs from additional rebound-effect vehicle use that it utilized in the NPRM analysis. The agency recognizes that these vehicles may become sufficiently common in the future that their effect on the fuel economy drivers actually experience could become significant, but notes that to the extent this occurs,

[616] 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.

[617] If manufacturers respond to improved fuel economy by reducing the size of fuel tanks to maintain a constant driving range, the resulting cost saving will presumably be reflected in lower vehicle sales prices.

[618] 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 March 1, 2010); update *available at http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2-11-03.pdf* (last accessed March 1, 2010).

[619] 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.

[620] 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 March 1, 2010).

it would be reflected in the gap between test and on-road fuel economy. NHTSA will continue to monitor the production of such vehicles and their representation in the vehicle fleet in its future rulemakings.

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.[621]

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 final 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.[622] 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.[623] The updated ORNL study was subjected to a detailed peer review comissioned by EPA, and ORNL's estimates of the value of oil import externalities were subsequently revised to reflect their comments and recommendations of the peer reviewers.[624] Finally, 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, as well as 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 increase in payments from U.S. oil purchasers to foreign oil suppliers *beyond* the increased purchase price of petroleum itself that results when increased U.S. import demand raises the world price of petroleum.[625] However, the monopsony premium represents a financial transfer from consumers of petroleum products to oil producers, which does not entail the consumption of real economic resources. Thus reducing the magnitude of the monopsony premium produces no savings in real economic resources globally or domestically, although it does reduce the value of the financial transfer from U.S. consumers of petroleum products to foreign suppliers of petroleum. Accordingly, NHTSA's analysis of the benefits from adopting proposed CAFE standards for MY 2012–2016 cars and light trucks excluded the reduced value of monopsony payments by U.S. oil consumers that might result from lower fuel consumption by these vehicles. The agency sought comment on whether it would be reasonable to include 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.

Commenters from NYU School of Law argued that monopsony payments should be treated as a distributional effect, not a standard efficiency benefit. An individual commenter, A.G. Fraas, also supported the agencies' exclusion of the monopsony benefit, arguing that it represents a pecuniary externality that should not be considered in benefit-cost analyses of governmental actions—again, in essence, that it represents a distributional effect. These comments support the agency's decision to exclude any reduction in monopsony premium payments that results from lower U.S. petroleum imports from its accounting of benefits from reduced fuel consumption. Thus the agency continues to exclude any reduction in monopsony premium payments from its estimates of benefits for the stricter CAFE standards this final rule establishes.

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 to the U.S. economy by $0.169 per gallon (in 2007$). In contrast to reduced monopsony premium payments, 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 analysis of the economic benefits from adopting higher CAFE standards for MY 2012–2016 cars and light trucks.

A.G. Fraas commented on this proposed rule and felt that that magnitude of the economic disruption portion of the energy security benefit may be too high. He cites a recent paper written by Stephen P.A. Brown and Hillard G. Huntington, entitled "Estimating U.S. Oil Security Premiums" (September 2009). He commented that the Brown and Huntington premium associated with replacing oil imports by increased domestic oil production while keeping U.S. oil consumption unchanged (*i.e.,* "the cost of displacing a barrel of domestic oil with a barrel of imported oil") ranges from $2.17 per barrel in 2015 to $2.37 per barrel in 2030 (2007$), or $0.052 to $0.056 per gallon.

In contrast, this rule is not a domestic oil supply initiative, but is one intended to reduce domestic oil consumption and thereby also to a significant extent reduce U.S. oil imports. When NHTSA

[621] 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 (Docket NHTSA–2009–0062–24); and Toman, M.A. (1993). "The Economics of Energy Security: Theory, Evidence, Policy," in A.V. Kneese and J.L. Sweeney, eds. (1993) (Docket NHTSA–2009–0062–23). Handbook of Natural Resource and Energy Economics, Vol. III. Amsterdam: North-Holland, pp. 1167–1218.

[622] 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 March 1, 2010).

[623] 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 March 1, 2010).

[624] *Peer Review Report Summary: Estimating the Energy Security Benefits of Reduced U.S. Oil Imports,* ICF, Inc., September 2007. *Available at* Docket No. NHTSA–2009–0059–0160.

[625] 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.

used the ORNL Energy Security Premium Analysis to calculate the energy security premium for this rule, it based the energy security premium on decreased demand for oil and oil products. The agency estimated that most of the decreased demand for oil and oil products would come from decreased imports of oil, given the inelasticity of U.S. supply and the modest estimated change in world oil price. The Brown and Huntington estimates for this change, considering the disruption component alone, are much in line with the ORNL estimates. For a reduction in U.S. consumption that largely leads to a reduction in imports, Brown and Huntington estimate a midpoint premium of $4.98 per barrel in 2015 rising to $6.82 per barrel by 2030 (2007$). The 2015 disruption premium estimate has an uncertainty range of $1.10 to $14.35 (2007$). The corresponding 2030 estimate from ORNL is only about 19 percent higher ($8.12/bbl), with an uncertainty range—$3.90 to $13.04—completely enclosed by that of Brown and Huntington. Thus, we conclude that the ORNL disruption security premium estimates for this rule is roughly consistent with the Brown and Huntington results.

Commenters from the NYU School of Law agreed that reduced disruption costs should be counted as a benefit, but stated that the agencies should disaggregate and exclude any reduction in wealth transfers that occur during oil shocks from their calculation of this benefit. NHTSA acknowledges that for consistency with its exclusion of reductions in monopsony premium payments from the benefits of reduced fuel consumption and petroleum imports, it may be necessary to exclude reductions in the wealth transfer component of macroeconomic disruption costs from the benefits of reducing U.S. petroleum imports. In future rulemakings, the agency will assess the arguments for excluding the wealth transfer component of disruption costs from its accounting of benefits from reducing domestic fuel consumption and U.S. petroleum imports, and explore whether it is practical to estimate its value separately and exclude it from the benefits calculations.

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.[626] 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.

Commenters from the NYU School of Law stated that the agencies were justified in not including a value for military security, as long as the agencies incorporate the increased protection value of the SPR into their calculation of disruption effects. CBD and James Adcock disagreed, and stated that the agencies should, in fact, include a value for military security—CBD cited several studies, and Mr. Adcock presented his own value of $0.275 per gallon. CARB stated simply that the agencies should include a sensitivity analysis for military security at $0.15 per gallon, in addition to the $0.05 per gallon already evaluated. EDF also cited studies claiming a benefit for increased national security.

In response to the comments from CBD and Mr. Adcock, NHTSA's examination of the historical record indicates that while costs for U.S. military security may vary over time in response to long-term changes in the level of oil imports into the U.S., these costs are unlikely to decline in response to the small reductions in U.S. oil imports (relative to total oil imports) that are typically projected to result from raising CAFE standards for light-duty vehicles. U.S. military activities in regions that represent vital sources of oil imports also serve a broader range of security and foreign policy objectives than simply protecting oil supplies, and as a consequence are unlikely to vary significantly in response to the modest changes in the level of oil imports likely to be prompted by higher CAFE standards.

The agency does not find evidence in the historical record that Congress or the Executive Branch has ever attempted to calibrate U.S. military expenditures, overall force levels, or specific deployments to any measure of global oil market activity or U.S. reliance on petroleum imports, or to any calculation of the projected economic consequences of hostilities arising in the Persian Gulf. Instead, changes in U.S. force levels, deployments, and thus military spending in that region have been largely governed by political events, emerging threats, and other military and political considerations, rather than by shifts in U.S. oil consumption or imports. NHTSA thus concludes that the levels of U.S. military activity and expenditures are likely to remain unaffected by even relatively large changes in light duty vehicle fuel consumption, and has continued to exclude any reduction in these outlays from its estimates of the economic benefits resulting from lower U.S. fuel consumption and petroleum imports.

In response to the comments from the NYU School of Law, NHTSA will explore how it might estimate the contribution of the SPR to reducing potential macroeconomic costs from oil supply disruptions, although the agency notes that to some extent the existence of the SPR may already be reflected in the magnitude of price elasticities of the supplies of foreign oil available for import to the U.S. However, the agency notes that the size of the SPR has not appeared to change significantly in response to historical variation in U.S. petroleum consumption or imports, suggesting that its effect on the magnitude of potential macroeconomic costs from disruptions in petroleum imports may be limited.

Finally, in response to the comment from EDF, the agency notes that the value of $0.05 per gallon for the reduction in military security outlays that is used for sensitivity analysis assumes that the *entire* reduction in U.S. petroleum imports resulting from higher CAFE standards would reflect lower imports from Persian Gulf suppliers, that the estimate of annual U.S. military costs for securing Persian Gulf oil supplies reported by Delucchi and Murphy is correct, and that Congress would reduce *half* of these outlays in proportion to any decline in U.S. oil imports from the region. The $0.15 per gallon estimate recommended by CARB would thus require that U.S. military outlays to protect Persian Gulf oil supplies are three times as large as Delucchi and Murphy estimate, or that Congress would reduce military spending in that region more than in proportion to any reduction in U.S. petroleum imports originating there. Because it views these possibilities as unrealistic, NHTSA has continued to use the $0.05 figure in its sensitivity analysis, rather than the higher figure suggested.

Based on a detailed analysis of differences in fuel consumption,

[626] 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.

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 estimated 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 reduce domestic fuel refining.[627] 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.[628] 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.[629]

NHTSA employed this estimate in the analysis presented in the NPRM, and received no comments on the assumptions or data used to develop it. Hence the agency has continued to assume that each 100 gallons of fuel saved as a consequence of the CAFE standards established by this final rule will reduce total U.S. imports of crude petroleum or refined fuel by 95 gallons. NHTSA has applied the estimates of economic benefits from lower U.S. petroleum imports to the resulting estimate of reductions in imports of crude petroleum and refined fuel.

l. Air Pollutant Emissions

i. Changes in 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 (MOVES 2010).[630] 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.[631] 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.[632] 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.[633] 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 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.[634]

[627] 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.

[628] 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.

[629] This figure is calculated as 50 gallons + 50 gallons*90% = 50 gallons + 45 gallons = 95 gallons.

[630] 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.

[631] 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.

[632] 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 March 15, 2010).

[633] 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.

[634] 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. We note that while assuming that all changes in upstream emissions result from a decrease in petroleum production and

Continued

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.[635] 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.[636] 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.

NHTSA and EPA received no comments on the procedures they employed to estimate the reductions in emissions of criteria air pollutants reported in their respective NPRMs, or on the unit economic values the agencies applied to those reductions to calculate their total value. Thus the agencies have continued to employ these procedures and values in the analysis reported in this final rule. However, the agencies have made some minor changes in the emission factors used to calculate changes in emissions resulting from increased vehicle use; these revisions are detailed in Chapter 4 of the Final Technical Support Document accompanying this rule.

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 alternative CAFE standards and in assessing the economic benefits of each alternative that was considered. Since direct estimates of the economic benefits from reducing CO_2 or other 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. Thus the benefits from reducing CO_2 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 increased carbon dioxide (CO_2) emissions, including losses in agricultural productivity, the economic damages caused by adverse effects on human health, property losses and damages resulting from sea level rise, and changes in the value of ecosystem services. The SCC is usually expressed in dollars per additional metric ton of CO_2 emissions occurring during a specified year, and is higher for more distant future years because the damages caused by an additional ton of emissions increase with larger existing concentrations of CO_2 in the earth's atmosphere. Marginal reductions in CO_2 emissions that are projected to result from lower fuel consumption, refining, and distribution during each future year are multiplied by the estimated SCC appropriate for that year, which is used

transport, our analysis of downstream criteria pollutant impacts assumes no change in the composition of the gasoline fuel supply.

[635] 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.

[636] 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.

to represent the value of eliminating each ton of CO_2 emissions, to determine the total economic benefit from reduced emissions during that year. These benefits are then discounted to their present value as usual, using a discount rate that is consistent with that used to develop the estimate of the SCC itself.

The agency's NPRM incorporated the Federal interagency working group's interim guidance on appropriate SCC values for estimating economic benefits from reductions in CO_2 emissions. NHTSA specifically asked for comment on the procedures employed by the group to develop its recommended values, as well as on the reasonableness and correct interpretation of those values. Comments the agency received address several different issues, including (1) the interagency group's procedures for selecting SCC estimates to incorporate in its recommended values; (2) the appropriateness of the procedures the agency used to combine and summarize these estimates; (3) the parameter values and input assumptions used by different researchers to develop their estimates of the SCC; (4) the choice between global and domestic estimates of the SCC for use in Federal regulatory analysis, (5) the discount rates used to derive estimates of the SCC; and (6) the overall level of the agency's SCC estimates.

NHTSA's Procedures for Selecting SCC Estimates

Many of the comments NHTSA received concerned the group's procedures for selecting published estimates and aggregating them to arrive at its range of recommended values. CARB asked for a clearer explanation of why mean SCC estimates from only two of the three major climate models were included in the average values reported in the interim guidance, and whether the arithmetic mean of reported values is the appropriate measure of their central tendency. Students from the University of California at Santa Barbara (UCSB) noted that the interagency group often selected only a single SCC estimate from studies reporting multiple estimates or a range of values to include in developing its summary values, and objected that this procedure caused the group to understate the degree of uncertainty surrounding its recommended values.

Steven Rose also noted that the interagency group's "filtering" of published estimates of the SCC on the basis of their vintage and input assumptions tended to restrict the included estimates to a relatively narrow band that excluded most potentially catastrophic climate changes, and thus was not representative of the wide uncertainty surrounding the "true" SCC. If the purpose of incorporating the SCC into regulatory analysis was effectively to price CO_2 emissions so that emitters would account for climate damages caused by their actions, he reasoned, then the estimate to be used should incorporate the wide range of uncertainty surrounding the magnitude of potential damages.

Rose also noted that many of the more recent studies reporting estimates of the SCC were designed to explore the influence of different factors on the extent and timing of climate damages, rather than to estimate the SCC specifically, and thus that these more recent estimates were not necessarily more informative than SCC estimates reported in some older studies. Rose argued that because there has been little change in major climate models since about 2001, all estimates published after that date should be considered in order to expand the size of the sample represented by average values, rather than limiting it by including only the most recently-reported estimates.

James Adcock objected to the interagency group's reliance on Tol's survey of published estimates of the SCC, since many of the estimates it included were developed by Tol himself. In contrast, Steven Rose argued that the Tol survey offered a useful way to summarize and represent variation among published estimates of the SCC, and thus to indicate the uncertainty surrounding its true value.

Procedures for Summarizing Published SCC Estimates

Steven Rose argued that combining SCC estimates generated using different discount rates was inappropriate, and urged the interagency group instead to select one or more discount rates and then to average only SCC estimates developed using the same discount rate. Rose also noted that the interagency group's explanation of how it applied the procedure developed by Newell and Pizer to incorporate uncertainty in the discount rate was inadequately detailed, and in any case it may not be appropriate for use in combining SCC estimates that were based on different discount rates. UCS also questioned NHTSA's use of averaging to combine estimates of the SCC relying on different discount rates, as well as the agency's equal weighting of upper- and lower-bound SCC estimates reported in published studies.

NESCAUM commented that the interagency group's basis for deriving the $20 SCC estimate from its summary of published values was not adequately clear, and that the group's guidance should clarify the origin of this value. NESCAUM also urged the interagency group to identify a representative range of alternative SCC estimates for use in assessing benefits from reduced emissions, rather than a single value.

Ford commented that the interagency group's methodology for developing an estimate of the SCC was acceptable, but argued that NHTSA agency should rely on the costs of reducing CO_2 emissions in other sectors of the U.S. economy to evaluate economic benefits from reducing motor vehicle emission. Ford asserted that this represented a more reliable estimate of the benefits from reducing emissions than the potential climate damages avoided by reducing vehicle emissions, since lowering vehicle emissions reduces the need to control emissions from other economic sectors.

Parameter Values and Input Assumptions Underlying SCC Estimates

CARB also noted that some of the wide variation in published SCC estimates relied upon by the interagency group could be attributed to authors' differing assumptions about future GHG emissions scenarios and choices of discount rates. Steven Rose noted that SCC estimates derived using future emissions scenarios that assumed significant reductions in emissions were probably inappropriate for use in Federal regulatory analysis, since Federal regulations must be adopted individually and are each likely to lead to only marginal reductions in emissions, so it is unreasonable to assume that their collective effect on future emissions will be large.

CARB also emphasized that SCC estimates were not available over the same range of discount rates for all major climate models, thus making averages of available results less reliable as indicators of any central tendency in estimates of the SCC. To remedy this shortcoming, the Pew Center on Climate Change urged the interagency group to analyze the sensitivity of SCC estimates to systematic variation in uncertain model parameters and input scenarios as a means of identifying the range of uncertainty in the SCC itself, as well as to include a risk premium in its SCC estimates as a means of compensating for climate models' omission of potential economic damages from catastrophic climate changes.

CBD commented that the interim nature of the interagency group's guidance made it impossible for decision-makers to determine whether the agency's proposed CAFE standards were sufficiently stringent. CBD also argued that economic models' exclusion of some potential climate impacts caused them to underestimate the "true" SCC, and that the interagency group's procedure of averaging published estimates failed to convey important information about variation in estimates of the SCC to decision makers. In a related comment, the Pew Center on Climate Change cautioned against use of the interagency group's interim SCC estimates for analyzing benefits from NHTSA's final rule, on the grounds that some older estimates of the SCC surveyed for the interim guidance implausibly suggested that there could be positive net benefits from climate change, while more recent research suggests uniformly negative economic impacts.

James Adcock presented his own estimate of the value of reducing CO_2 emissions, which he derived by assuming that climate change would completely eliminate the economic value of all services provided by the local natural environment within a 50-year time frame. In addition, Adcock urged that Federal agencies use a consistent estimate of the SCC in their regulatory analyses, and that this estimate be updated regularly to reflect new knowledge; he also asserted that the SCC should be above the per-ton price of CO_2 emissions permits under a cap-and-trade system.

Global vs. Domestic SCC Values

NADA argued that NHTSA should employ an estimate of the domestic value of reducing CO_2 emissions for purposes of estimating their aggregate economic benefits, since the agency includes only the domestic value of benefits stemming from reductions in other environmental and energy security externalities. In contrast, both the Pew Center on Climate Change and students from the University of California at Santa Barbara (UCSB) asserted that a global value of the SCC was appropriate for use even in analyzing benefits from U.S. domestic environmental regulations such as CAFE, and Steven Rose added that it was difficult to identify any proper role for a domestic estimate of the SCC. James Adcock commented that the agency's derivation of the fraction of the global SCC it employed (6 percent) to obtain a domestic value was not clearly explained.

Discount Rates Used To Derive SCC Estimates

NRDC also cited the effect of positive discount rates on damages occurring in the distant future, which reduce the present value of those damages to misleadingly low levels. Similarly, Steven Rose argued that the interagency group should have used discount rates below the 3 percent lower bound the group selected, and that the discount rate should also have been allowed to vary over time to account for uncertainty in its true value. The Pew Center also urged NHTSA to account explicitly for uncertainty surrounding the correct discount rate, but did not indicate how the agency should do so.

CARB echoed the recommendation for including SCC values reflecting discount rates below 3 percent, since EPA had previously used lower rates in previously proposed rules to discount benefits that were not expected to occur until the distant future, and thus to be experienced mainly by future generations. The New Jersey Department of Environmental Protection noted that giving nearly equal weight to future generations would imply a discount rate of less than 3 percent—probably in the neighborhood of 2 percent—and endorsed the interagency group's use of the procedure developed by Newell and Pizer to account for uncertainty surrounding the correct discount rate.

The Pew Center urged the agency to ignore SCC estimates derived using discount rates above 5 percent, and instead to use the lowest possible rates, even including the possibility of negative values. Similarly, NRDC asserted that both the 3 percent and 5 percent discount rates selected by the interagency group are inappropriately high, but did not recommend a specific alternative rate. Students from UCSB observed that the interagency group's equal weighting of the 3 percent and 5 percent rates appeared to be inconsistent with the more frequent use of 3 percent in published estimates of the SCC, as well as with OMB's guidance that the 3 percent rate was appropriate for discounting future impacts on consumption. The group urged NHTSA to consider a wider range of discount rates in its revised estimates of the SCC, including some below 3 percent. CBD argued that the discount rate should increase over the future to reflect the potential for catastrophic climate impacts.

CBD asserted that because the potential consequences of climate change are so extreme, that future economic impacts of climate change should not be discounted (*i.e.,* a 0 percent discount rate should be used). James Adcock echoed this view.

Overall Level of SCC Estimates

NRDC argued that the SCC estimate recommended by the interagency group was likely to be too low, because of most models' omission of some important climate impacts, particularly including potential catastrophic impacts resulting from non-incremental changes in climate conditions. CARB argued that it seemed prudent to include SCC values as high as $200 per ton, to reflect the possibility of low-probability but catastrophic changes in the global climate and the resulting economic damages.

The New Jersey Department of Environmental Protection pointed out that SCC estimates reviewed by the IPCC ranged as high as $95/ton, and that the Stern Report's estimate was $85/ton, suggesting the possibility that the interagency group may have inappropriately filtered out the highest estimates of the SCC. Other commenters including NACAA, NESCAUM, NRDC, and UCS urged NHTSA to employ higher SCC values than it used in the NPRM analysis, but did not recommend specific values. CARB urged the agency to use higher values of the SCC than it employed in its NPRM analysis, and recommended a value of $25/ton, growing at 2.4 percent annually, or alternatively, a fixed value of $50/ton.

Steven Rose cautioned against applying a uniform 3 percent annual growth rate to all of the provisional SCC estimates recommended by the interagency group, and noted that the base year where such growth is assumed to begin should be determined carefully for each estimate.

Finally, the Institute for Energy Research commented that NHTSA had probably overstated the reductions in CO_2 emissions that would result from the proposed standards—and thus their economic value—because of the potential for compensating increases in emissions, such as those cause by increased retention and use of older, less fuel-efficient vehicles in the fleet.

After carefully considering comments received to the NPRM, for purposes of this final rule, NHTSA has relied on estimates of the SCC developed by the Federal interagency working group convened for the specific purpose of developing new estimates to be used by U.S. Federal agencies in regulatory evaluations. Under Executive Order 12866, Federal agencies are required, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The group's purpose in developing new estimates of the SCC was to allow

Federal agencies to incorporate the social benefits of reducing carbon dioxide (CO_2) emissions into cost-benefit analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions, as most Federal regulatory actions can be expected to have.

The interagency group convened on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key inputs and assumptions in order to generate SCC estimates. Agencies that actively participated in the interagency process included the Environmental Protection Agency and the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury. This process was convened by the Council of Economic Advisers and the Office of Management and Budget, with active participation and regular input from the Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions that are grounded in the existing literature. In this way, key uncertainties and model differences can more transparently and consistently inform the range of SCC estimates used in the rulemaking process.

The interagency group developed its estimates of the SCC estimates while clearly acknowledging the many uncertainties involved, and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts. Technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literature. In this way, key uncertainties and model differences transparently and consistently can inform the range of SCC estimates used in the rulemaking process.

The group ultimately selected four SCC values for use in regulatory analyses. Three values are based on the average SCC from three integrated assessment models, using discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95th percentile SCC estimate across all three models at a 3 percent discount rate, is included to represent the possibility of higher-than-expected impacts from temperature change that lie further out in the tails of the distribution of SCC estimates. Table IV.C.3–2 summarizes the interagency group's estimates of the SCC during various future years. The SCC estimates reported in the table assume that the marginal damages from increased emissions are constant for small departures from the baseline emissions path, an approximation that is reasonable for policies that have effects on emissions that are small relative to cumulative global carbon dioxide emissions.

TABLE IV.C.3–2—SOCIAL COST OF CO_2 EMISSIONS, 2010–2050

[2007 dollars]

Discount rate	5%	3%	2.5%	3%
Source	Average of estimates			95th Percentile estimate
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

As Table IV.C.3–2 shows, the four SCC estimates selected by the interagency group for use in regulatory analyses are $5, $21, $35, and $65 (in 2007 dollars) for emissions occurring in the year 2010. The first three estimates are based on the average SCC across models and socio-economic and emissions scenarios at the 5, 3, and 2.5 percent discount rates, respectively. The fourth value is included to represent the higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. For this purpose, the group elected to use the SCC value for the 95th percentile at a 3 percent discount rate.

The central value identified by the interagency group is the average SCC across models at the 3 percent discount rate, or $21 per metric ton in 2010. To capture the uncertainties involved in regulatory impact analysis, however, the group emphasized the importance of considering the full range of estimated SCC values. As the table also shows, the SCC estimates also rise over time; for example, the central value increases to $24 per ton of CO_2 in 2015 and $26 per ton of CO_2 in 2020.

The interagency group is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. Specifically, the group has set a preliminary goal of revisiting the SCC values within two years or at such time as substantially updated models become available, and to continue to support research in this area. U.S. Federal agencies will periodically review and reconsider estimates of the SCC used for cost-benefit analyses to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.

Details of the process used by the interagency group to develop its SCC estimates, complete results including year-by-year estimates of each of the four values, and a thorough discussion of their intended use and limitations is provided in the document *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,* Interagency Working Group on Social Cost of Carbon, United States Government, February 2010.[637]

[637] This document is available in the docket for this rulemaking (NHTSA–2009–0059).

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 proposed increases in CAFE standards for MY 2012–2016 passenger cars and light trucks, NHTSA employed a discount rate of 3 percent per year, but also presents these benefit and cost estimates at a 7 percent discount rate.

While both discount rates are presented, NHTSA believes that 3 percent is the most appropriate rate for discounting future benefits from increased CAFE standards because most or all of vehicle manufacturers' costs for complying with higher CAFE standards will ultimately be reflected in higher sales prices for their new vehicle models. By increasing sales prices for new cars and light trucks, CAFE regulations 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 consumers' rate of time preference.[638]

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 consumers' rate of time preference, NHTSA believes that 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 is more appropriate than 7 percent, but presents both.[639] One commenter, NRDC, supported the agencies' use of a 3 percent discount rate as consistent with DOE practice in energy efficiency-related rulemakings and OMB guidance. OMB guidance actually requires that benefits and costs be presented at both a 3 and a 7 percent discount rate.

Because there is some remaining uncertainty about whether vehicle manufacturers will completely recover their costs for complying with higher CAFE standards by increasing vehicle sales prices, however, NHTSA also presents these benefit and cost estimates using a higher 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 OMB estimates that this rate currently averages about 7 percent.[640] Thus the agency has also examined its benefit and cost estimates for alternative MY 2012–2016 CAFE standards using a 7 percent real discount rate.

In its proposed rule, NHTSA sought comment on whether it should evaluate CAFE standards using a discount rate of 3 percent, 7 percent, or an alternative value. NRDC not only opposed the agency's use of a 7 percent discount rate, but also opposed conducting even sensitivity analyses with discount rates higher than 3 percent. In contrast, two other commenters, NADA and the Institute for Energy Research, advised that the agencies should use discount rates of 7 percent or higher. NADA argued that the most appropriate discount rate would be one closer to historical financing rates on motor vehicle loans (which currently average about 6.5 percent), while the Institute for Energy Research argued that consumers may have much higher discount rates than the agencies assumed, perhaps even as high as 25 percent.

After carefully considering these comments, NHTSA has elected to use discount rates of both 3 and 7 percent in the analysis supporting this final rule. As indicated above, the agency believes that vehicle manufacturers will recover most or all of their added costs for complying with the CAFE standards this rule establishes by raising sales prices for some or all vehicle models. As a consequence, this regulation will thus primarily affect vehicle purchases and related consumption decisions, which suggests that its future benefits and costs should be discounted at the rate of time preference vehicle buyers reveal in their consumption and savings behavior. OMB's 3 percent figure appears to be a conservative (*i.e.,* low) estimate of this rate, because it assumes in effect that vehicle buyers face little risk about the value of future fuel savings and other benefits from the rule; nevertheless, in the current economic environment it appears to represent a reasonable estimate of consumers' rate of time preference. Thus NHTSA has mainly relied upon 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

One important exception to the 3 percent discount rate is the rates used to discount benefits from reducing CO_2 emissions from the years in which reduced emissions occur, which span the lifetimes of MY 2012–2016 cars and light trucks, to their present values. In order to ensure consistency in the derivation and use of the interagency group's estimates of the unit values of reducing CO_2 emissions, the benefits from reducing those emissions during each future year are discounted using the same "intergenerational" discount rates that were used to derive each of the alternative unit values of reducing CO_2 emissions. As indicate in Table IV.C.3–2 above, these rates are 2.5 percent, 3 percent, and 5 percent depending on which estimate of the SCC is being considered.[641]

n. Accounting for Uncertainty in Benefits and Costs

In analyzing the uncertainty surrounding its estimates of benefits and costs from alternative CAFE standards, 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, 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

[638] *Id.*

[639] 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).

[640] *Id.*

[641] The fact that the 3 percent discount rate used by the interagency group to derive its central estimate of the SCC is identical to the 3 percent short-term or "intra-generational" discount rate used by NHTSA to discount future benefits other than reductions in CO_2 emissions is coincidental, and should not be interpreted as a required condition that must be satisfied in future rulemakings.

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 FRIA, and a discussion of how NHTSA and EPA jointly reviewed and updated economic assumptions for purposes of this final rule is available in Chapter 4 of the Joint 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 final rule, NHTSA–2009–0059, and on NHTSA's Web site.[642] Finally, because much of NHTSA's economic analysis for purposes of this final rule 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.[643]

4. How does NHTSA use the assumptions in its modeling analysis?

In developing today's final 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 final rule, as are inputs for and outputs from analysis of today's final CAFE standards.

a. How does the model operate?

As discussed above, the agency uses the Volpe model to estimate how 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 and reference market forecast discussed above in Section IV.C.1 and Chapter 1 of the TSD, (b) technology-related estimates discussed above in Section IV.C.2 and Chapter 3 of the TSD, (c) economic inputs discussed above in Section IV.C.3 and Chapter 4 of the TSD, and (d) inputs defining baseline and 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.[644] 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"[645] 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.[646]

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. This is designed to simulate a manufacturer's decision to plan for CAFE obligations several years in advance, which NHTSA believes better replicates manufacturers' actual behavior as compared to the year-by-year evaluation which EPCA would otherwise require.

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 stringency and then set the standard at

[642] *See http://www.nhtsa.dot.gov* (click on "Fuel Economy Standards (CAFE)," click on "Related Links: CAFE Compliance and Effects Modeling System: The Volpe Model").

[643] 74 FR 14308–14358 (Mar. 30, 2009).

[644] NHTSA does its best to remain scrupulously neutral in the application of technologies through the modeling analysis, to avoid picking technology "winners." The technology application methodology has been reviewed by the agency over the course of several rulemakings, and commenters have been generally supportive of the agency's approach. See, *e.g.,* 74 FR 14238–14246 (Mar. 30, 2009).

[645] 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.

[646] 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. NHTSA thus includes the possibility of manufacturers choosing to pay fines in its modeling analysis in order to achieve what the agency believes is a more realistic simulation of manufacturer decision-making. Unlike flex-fuel and other credits, NHTSA is not barred by statute from considering fine-payment in determining maximum feasible standards under EPCA/EISA. 49 U.S.C. 32902(h).

that level, while ensuring ratable increases in average fuel economy.[647] The multi-year planning capability mentioned above increases the model's ability to simulate manufacturers' real-world behavior, accounting for the fact that manufacturers will seek out compliance paths for several model years at a time, while accommodating the year-by-year requirement.

The model also calculates the costs, effects, and benefits of technologies that it estimates could be added in response to a given CAFE standard.[648] 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 today's final standards, the agency did not use the Volpe model's curve fitting routines; rather, as discussed above in Section II, the agency fitted curves outside the model (as for the NPRM) but elected to retain the curve shapes defining the proposed standards. 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.[649] Also, although some observers have criticized analyses the agency has conducted using the Volpe model, those criticisms have largely concerned inputs to the model (such as fuel prices and the estimated economic cost of CO_2 emissions), not the model itself. In comments on the NPRM preceding today's final rule, one of these observers, the Center for Biological Diversity (CBD), suggested that the revisions to such inputs have produced an unbiased cost-benefit analysis.

One commenter, the International Council on Clean Transportation (ICCT) suggested that the Volpe model is excessively complex and insufficiently transparent. However, in NHTSA's view, the complexity of the Volpe model has evolved in response to the complex analytical demands surrounding very significant regulations impacting a large and important sector of the economy, and ICCT's own comments illustrate some of the potential pitfalls of model simplification. Furthermore, ICCT's assertions regarding model transparency relate to the use of confidential business information, not to the Volpe model itself; as discussed elsewhere in this final rule, NHTSA and the Volpe Center have taken pains to make the Volpe model transparent by releasing the model and supporting documentation, along with the underlying source code and accompanying model inputs and outputs. Therefore, the agency disagrees with these ICCT comments.

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 that would be "maximum feasible" for that year.[650] 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. 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

[647] 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.

[648] 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 February 21, 2010).

[649] 74 FR 14372 (Mar. 30, 2009).

[650] 49 U.S.C. 32902(a).

(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 to 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 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 final CAFE standards for passenger cars, the CAFE model estimated that manufacturers could apply turbocharged SGDI engines mated with dual-clutch AMTs to 2.4 million passenger cars in MY 2016, about 22 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 final 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?

As discussed in the NPRM preceding today's final rule, the Volpe model has been 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.[651] 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 conducting analysis to support the NPRM and in analyzing the standards finalized today. Consequently, this new capability 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.

[651] 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.

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 FRIA. 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.

In the NPRM preceding today's final rule, NHTSA sought comment on ways to improve on this earlier work and develop this capability effectively. Some comments implied that the agency should continue work to do so, without providing specific recommendations. The Alliance of Automobile Manufacturers identified consumer choice as one of several factors outside the industry's control yet influential with respect to the agencies' analysis. Also, the University of Pennsylvania Environmental Law Project suggested that the rule would change consumers' vehicle purchasing decisions, and the California Air Resources Board expressed support for continued consideration of consumer choice modeling. On the other hand, citing concerns regarding model calibration, handling of advanced technologies, and applicability to the future light vehicle market, ACEEE, ICCT, UCS, and NRDC all expressed opposition to the possibility of using consumer choice models in estimating the costs and benefits of new standards. Notwithstanding comments on this issue, NHTSA has been unable to further develop this capability in time to include it in the analysis supporting decisions regarding final CAFE standards. The agency will, however, continue efforts to develop and make use of this capability in future rulemakings, taking into account comments received in connection with today's final rule.

d. Does the model set the standards?

Since NHTSA began using the Volpe model in CAFE analysis, some commenters have interpreted the agency's use of the model as the way by which the agency chooses the maximum feasible fuel economy standards. This is incorrect. 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, it was not the model's decision to seek that level of stringency, it was the agency's, as it is always the agency's decision what level of CAFE stringency is appropriate. Ultimately, NHTSA's selection of appropriate CAFE standards 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 final standards, based on the agency's determinations and assumptions. Others assess alternative standards, some of which exceed the final standards and/or the point at which net benefits are maximized.[652] 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)[653] 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 or 2007 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 final rule are available in the public docket. With the model and these input files, anyone is capable of independently

[652] *See* Section IV.F below for a discussion of the regulatory alternatives considered in this rulemaking.

[653] 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.

running the model to repeat, evaluate, and/or modify the agency's analysis.

NHTSA is aware of two attempts by commenters to install and use the Volpe model in connection with the NPRM. James Adcock, an individual reviewer, reported difficulties installing the model on a computer with Microsoft® Office 2003 installed. Also, students from the University of California at Santa Barbara, though successful in installing and running the model, reported being unable to reproduce NHTSA's results underlying the development of the shapes of the passenger car and light truck curves.

Regarding the difficulties Mr. Adcock reported encountering, NHTSA staff is aware of no attempts to contact the agency for assistance locating supporting material related to the MYs 2012–2016 CAFE rulemaking. Further, the model documentation provides specific minimum hardware requirements and also indicates operating environment requirements, both of which have remained materially unchanged for more than a year. Volpe Center staff members routinely install and run the model successfully on new laptops, desktops, and servers as part of normal equipment refreshes and interagency support activities. We believe, therefore, that if the minimum hardware and operating environment requirements are met, installing and running the model should be straightforward and successful. The model documentation notes that some of the development and operating environment used by the Volpe model (*e.g.,* the software environment rather than the hardware on which that software environment operates), particularly the version of Microsoft® Excel used by the model, is Microsoft® Office 2003. We recognize that some users may have more recent versions of Microsoft® Office. However, as in the case of other large organizations, software licensing decisions, including the version of Microsoft® Office, is centralized in the Office of the Chief Information Officer. Nonetheless, the Volpe Model is proven on both Microsoft® Office version 2003 and the newer 2007 version.

As discussed in Section II.C, considering comments by the UC Santa Barbara students regarding difficulties reproducing NHTSA's analysis, NHTSA reexamined its analysis, and discovered some erroneous entries in model inputs underlying the analysis used to develop the curves proposed in the NPRM. These errors are discussed in the FRIA and have since been corrected. Updated inputs and outputs have been posted to NHTSA's Web site, and should enable outside replication of the analysis documented in today's notice.

5. How did NHTSA develop the shape of the target curves for the final standards?

In developing the shape of the target curves for today's final 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 final 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. Given comments received in response to the NPRM preceding this final rule, it appears that the constrained linear function developed here significantly mitigates prior steepness concerns, and appropriately balances, for purposes of this rulemaking, the objectives of (1) discouraging vehicle downsizing that could compromise highway safety and (2) avoiding an overly strong incentive to increase vehicle sizes in ways that could compromise energy and environmental benefits.

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.[654] Like the MY 2011 standards, the MY 2012–2016 passenger car and light truck standards are attribute-based and defined by a mathematical function.[655] 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. 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

[654] 49 U.S.C. 32902(a)(3)(A).

[655] As discussed in Chapter 2 of the TSD, EPA is also setting 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.

ways harmful to safety.[656] 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.[657] 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 universal 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 finalized 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. Section II discusses the reasons that the agency does not believe that fuel savings and emissions reductions will be significantly lower than anticipated such as to warrant additional backstop measures beyond the one mandated by EISA, but the agency will monitor the situation and consider further rulemaking solutions if necessary and as lead time permits. *See* also Section IV.E.3 below for further discussion of NHTSA's backstop authority.

b. What attribute does NHTSA use, and why?

Consistent with the MY 2011 CAFE standards, NHTSA is using 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 Section IV.D.1.a.ii below, 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. NHTSA's research indicates that reductions in vehicle mass tend to compromise vehicle safety if applied on an equal basis across the entire light duty vehicle fleet, however if greater mass reduction is applied to the higher mass vehicles (the larger light trucks), an improvement in aggregate fleet safety is possible. Footprint-based standards provide an incentive to use advanced lightweight materials and structures that, if carefully designed and validated, should minimize impacts on safety, although that will be better proven as these vehicles become more prevalent in the future.

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.

As discussed above in Section II.C, NHTSA and EPA sought comment on whether the agencies should consider setting standards for the final rule based on another attribute or another combination of attributes. Although NHTSA specifically requested that the commenters address the concerns raised 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, commenters raising the issue largely reiterated comments submitted in prior CAFE rulemakings, which the agency answered in the MY 2011 final rule.[658] As a result, and as discussed further in Section II, the agencies finalized target curve standards based on footprint for MYs 2012–2016.

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:

$$TARGET = \frac{1}{\frac{1}{a} + \left(\frac{1}{b} - \frac{1}{a}\right)\frac{e^{(FOOTPRINT-c)/d}}{1+e^{(FOOTPRINT-c)/d}}}$$

[656] 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.

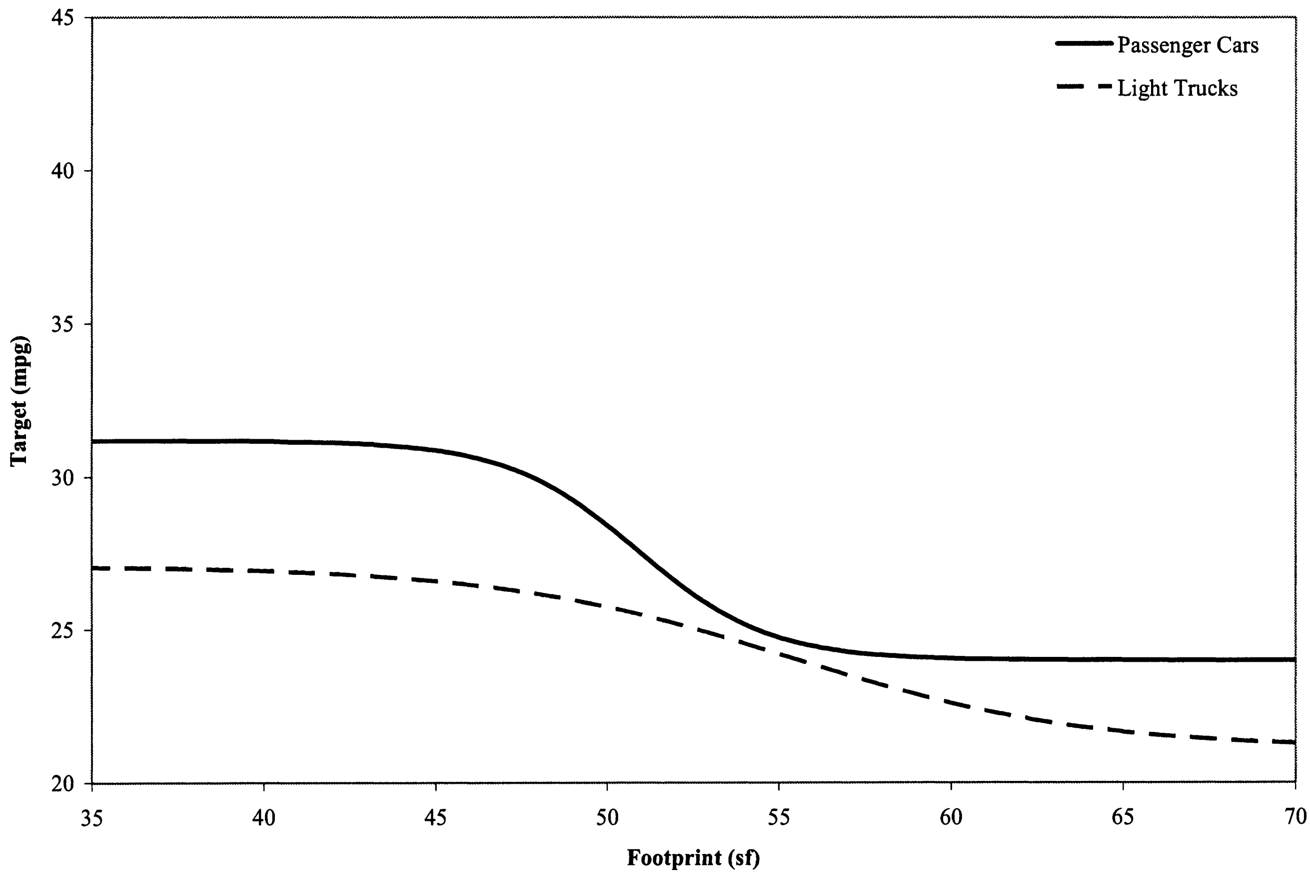
[657] *Id.* at 4–5, finding 10.

[658] *See* 74 FR at 14358–59 (Mar. 30, 2009).

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,[659] *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.5-1 MY 2011 CAFE Standards for Passenger Cars and Light Trucks



d. What mathematical function is NHTSA using for the MYs 2012–2016 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 for the final CAFE standards.

In revisiting this question, NHTSA found that the final MY 2011 CAFE standard for passenger cars, though less steep than the MY 2011 standard NHTSA final 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 discussed above in Section II.C, NHTSA and EPA have considered comments by students from UC Santa Barbara indicating that the passenger car and light truck curves should be flatter. The agencies conclude that flatter curves would reduce the incentives intended in shifting from

[659] *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.

"flat" CAFE standards to attribute-based CAFE and GHG standards—those being the incentive to respond to attribute-based standards in ways that minimize compromises in vehicle safety, and the incentive for more manufacturers (than primarily those selling a wider range of vehicles) across the range of the attribute to have to increase the application of fuel-saving technologies.

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 at that time, 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 final standards, and considered comments discussed above in Section II, NHTSA, with EPA, concludes that for both passenger cars and light trucks, the constrained linear functions finalized today remain 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 functions finalized today are not so steeply sloped that they 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, today's final CAFE standards 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.

e. How did NHTSA fit the coefficients that determine the shape of the final curves?

For purposes of this final rule and the preceding NPRM, and for EPA's use in developing new CO_2 emissions standards, potential curve shapes were fitted 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 FRIA and Chapter 3 of the Joint TSD [660] 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.

However, while this approach produced curves that the agencies' judged appropriate for the NPRM, it did not do so for the final rule. Corrections to some engineering inputs in NHTSA's market forecast, while leading to a light truck curve nearly identical to that derived for the NPRM, yielded a considerably steeper passenger car curve. As discussed above in Section II, NHTSA and EPA are concerned about the incentives that would result from a significantly steeper curve. Considering this, and considering that the updated analysis—in terms of the error measure applied by the agency—supports the curve from the NPRM nearly as well as it supports the steeper curve, NHTSA and EPA are promulgating final standards based on the curves proposed in the NPRM.

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. Section II.C also discusses comments NHTSA and EPA received on this process, and on the outcomes thereof.

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.[661] 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.[662] Second, as discussed above and at length in the March 2009 final rule establishing the MY 2011 CAFE standards, EPCA requires that the 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, based on a balancing of

[660] 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 final standards. NHTSA and EPA did include diesel engines and strong hybrid vehicle technologies in all other portions of their analyses.

[661] EISA added the following additional requirements: (1) Standards must be attribute-based and expressed in the form of a mathematical function. 49 U.S.C. 32902(b)(3)(A). (2) Standards for MYs 2011–2020 must "increase ratably" in each model year. 49 U.S.C. 32902(b)(2)(C). This requirement does not have a precise mathematical meaning, particularly because it must be interpreted in conjunction 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. Generally speaking, the requirement for ratable increases means that the annual increases should not be disproportionately large or small in relation to each other.

[662] 49 U.S.C. 32902(b)(2)(A).

express statutory and other factors.[663] The implication of this second requirement is that it calls for setting a standard that exceeds 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. The ultimate determination of what standards can be considered maximum feasible involves a weighing and balancing of these factors. NHTSA received a number of comments on how the agency interprets its statutory requirements, and will respond to them in this section.

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.

Commenters appear to have generally agreed with the agency's interpretation of technological feasibility. NESCAUM commented that the proposed standards were technologically feasible and cost-effective in the rulemaking timeframe. CBD and the UCSB students focused their comments more on the technology-forcing aspects of the definition of technological feasibility. CBD commented that the standards must be below the level of all that is technologically feasible if all the technology necessary to meet them is available today. The UCSB students similarly commented that the agencies should not base regulations for MY 2016 solely on technologies available today, that they should also consider technologies still in the research phase for the later years of the rulemaking timeframe.

While NHTSA agrees that the technological feasibility factor can include a degree of technology forcing, and that this could certainly be appropriate given EPCA's overarching purpose of energy conservation, we note that determining what levels of technology to require in the rulemaking timeframe requires a balancing of all relevant factors. Technologies that are still in the research phase now may be sufficiently advanced to become available for commercial application in, for example, MY 2016. However, given the rate at which the standards already require average mpg to rise, and given the current state of the industry, NHTSA does not believe that it would be reasonable to set standards mandating that manufacturers devote substantial resources to bringing these technologies to market immediately rather than to simply improving the fuel economy of their fleets by applying more of the technologies on the market today. As will be discussed further in Section IV.F below, technological feasibility is one of four factors that the agency balances in determining what standards would be maximum feasible for each model year. As the balancing may vary depending on the circumstances at hand for the model years in which the standards are set, the extent to which technological feasibility is simply met or plays a more dynamic role may also shift.

(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." [664] In an attempt to ensure the standards' economic practicability, the agency considers a variety of factors, including the annual rate at which manufacturers can increase the percentage of the 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." [665] 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 factor must be considered in the context of the competing concerns associated with different levels of standards. Prior to the MY 2005–2007 rulemaking, the agency generally 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 should 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.

Besides the many commenters raising economic practicability as an issue in the context of the stringency of the proposed standards, some commenters also directly addressed the agency's interpretation of economic practicability. AIAM commented that NHTSA has wide discretion to consider economic practicability concerns as long as EPCA's overarching purpose of energy conservation is met, and that it would be within NHTSA's statutory discretion to set standards at levels

[663] 49 U.S.C. 32902(a).

[664] 67 FR 77015, 77021 (Dec. 16, 2002).

[665] *CEI–I,* 793 F.2d 1322, 1352 (DC Cir. 1986).

below those at which net benefits are maximized due to economic practicability. GM and Mitsubishi both commented that consideration of economic practicability should include more focus on individual manufacturers: GM stated that NHTSA must consider sales and employment impacts on individual manufacturers and not just industry in the aggregate, while Mitsubishi emphasized the difficulties of limited-line manufacturers in meeting standards that might be economically practicable for full-line manufacturers. CBD commented that a determination of economic practicability should not be tied to "differences between incremental improvements" that "fail to consider all relevant costs and benefits and fail to analyze the overall impact of the proposed standards." CBD pointed to the three-to-one benefit-cost ratio of the proposed standards to argue that much more stringent standards would still be economically practicable. ACEEE also commented that standards set at the level at which net benefits are maximized should be considered a "lower bound" for determining economic practicability.

While NHTSA agrees with AIAM in general that the agency has wide discretion to consider economic practicability concerns, we do not believe that economic practicability will always counsel setting standards lower than the point at which net benefits are maximized, given that it must be considered in the context of the overall balancing and EPCA's overarching purpose of energy conservation. Depending on the conditions of the industry and the assumptions used in the agency's analysis of alternative stringencies, NHTSA could well find that standards that maximize net benefits, or even higher standards, could be economically practicable. To that end, however, given the current conditions faced by the industry, which is perhaps just now passing the nadir of the economy-wide downturn and looking at a challenging road to recovery, and the relatively limited amount of lead time for MYs 2012–2016, we disagree with CBD's comment that the benefit-cost ratio of the final standards indicates that more stringent standards would be economically practicable during the rulemaking timeframe and with ACEEE's comment that standards higher than those that would maximize net benefits would be economically practicable at this time. These comments overlook the fact that nearly all manufacturers are capital-constrained at this time and may be for the next couple of model years; access to capital in a down market is crucial to making the investments in technology that the final standards will require, and requiring more technology will require significantly more capital, to which manufacturers would not likely have access. Moreover, economic practicability depends as well on manufacturers' ability to sell the vehicles that the standards require them to produce. If per-vehicle costs increase too much too soon, consumers may defer new vehicle purchases, which defeats the object of raising CAFE standards to get vehicles with better mileage on the road sooner and meet the need of the Nation to conserve energy. *See* Section IV.F below for further discussion of these issues.

As for GM's and Mitsubishi's comments, while the agency does consider carefully the impacts on individual manufacturers in the agency's analysis, as shown in the FRIA, we reiterate that economic practicability is not keyed to any single manufacturer. One of the main benefits of attribute-based standards is greater regulatory fairness—for all the manufacturers who build vehicles of a particular footprint, the target for that footprint is the same, yet each manufacturer has their own individual compliance obligation depending on the mix of vehicles they produce for sale. More manufacturers are required to improve their fuel economy, yet in a fairer way. And while some manufacturers may face difficulties under a given CAFE standard, others will find opportunities. The agency's consideration of economic practicability recognizes these difficulties and opportunities in the context of the industry as a whole, and in the context of balancing against the other statutory factors, as discussed further below.

(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,[666] 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[667] 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 has said that it 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."[668] 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.[669] 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.

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

[666] 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.

[667] 42 FR 63184, 63188 (Dec. 15, 1977). *See* also 42 FR 33534, 33537 (Jun. 30, 1977).

[668] 42 FR 33534, 33537 (Jun. 30, 1977).

[669] That provision was deleted as obsolete when EPCA was codified in 1994.

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 endangerment finding, its granting of a waiver to California for its motor vehicle GHG standards, and its own GHG standards for light-duty vehicles, 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.

In the NPRM, NHTSA tentatively concluded that the effects of the EPA and California standards are neither positive nor negative because the proposed rule resulted in consistent standards among all components of the National Program, but sought comment 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. NHTSA stated that it had already considered EPA's proposal and the harmonization benefits of the National Program in developing its own proposed maximum feasible standards.

The Alliance commented that the extent to which the consideration of other motor vehicle standards of the government should affect NHTSA's standard-setting process was entirely within the agency's discretion. The Alliance agreed with NHTSA that the original intent of the factor was to ensure that NHTSA accounted for other government standards that might reduce fuel economy or inhibit fuel economy improvements, but stated that since GHG standards set by EPA and California overlap CAFE standards so extensively, and are thus functionally equivalent to CAFE standards (plus air conditioning), those standards should be "basically irrelevant to NHTSA's mission to set fuel economy standards, unless some specific aspect of the GHG standards actually makes it harder for mfrs to improve fuel economy." The Alliance stated further that NHTSA must still determine what levels of CAFE standards would be maximum feasible regardless of the findings or standards set by EPA and California. Thus, the Alliance stated, for purposes of the MYs 2012–2016 CAFE standards, EPA's GHG standards could be sufficiently considered by NHTSA given the agency's decision to harmonize as part of the National Program,[670] while California's GHG standards need not be considered because of the state's agreement under the National Program that compliance with EPA's standards would constitute compliance with its own. Ford concurred individually with the Alliance comments. NADA, in contrast, commented that EPA's GHG standards should not be considered as an "other vehicle standard" for purposes of this statutory factor, and argued that NHTSA need not and should not consider California's GHG standards due to preemption under EPCA.

Commenters from the state of California (the Attorney General and the Air Resources Board), in contrast, stated that NHTSA must consider the effects of the California GHG standards on fuel economy as a baseline for NHTSA's analysis, to give credit to the state's leadership role in achieving the levels required by the National Program. CBD seconded this comment.[671] The California Attorney General further stated that Congress discussed both positive and negative impacts of other standards on fuel economy in the 1975 Conference Reports preceding EPCA's enactment.[672] CARB and the University of Pennsylvania Environmental Law Project both cited the *Green Mountain Chrysler*[673] and *Central Valley Chrysler*[674] cases as supporting NHTSA's consideration of CARB's GHG standards pursuant to this factor.

NHTSA believes that these comments generally support the agency's interpretation of this factor as stated in the NPRM. While the agency may consider both positive and negative effects of other motor vehicle standards of the Government on fuel economy in determining what level of CAFE standards would be maximum feasible, given the fact that the final rule results in consistent standards among all components of the National Program, and given that NHTSA considered the harmonization benefits of the National Program in developing its own standards, the agency's obligation to balance this factor with the others may be considered accounted for.

(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."[675] 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.

While a number of commenters cited the need of the nation to conserve energy in calling for the agency to set more stringent CAFE standards, none disagreed with the agency's interpretation of this factor and its influence on the statutory balancing required by EPCA. CBD, for example, commented that "Increasing mileage standards for this vehicle fleet is the single most effective and quickest available step the U.S. can take to conserve energy and to reduce the U.S. dependence on foreign oil, and also has an immediate and highly significant effect on total U.S. GHG emissions," and that accordingly, NHTSA should consider the need of the nation to conserve energy as counseling the agency to raise standards at a faster rate. NHTSA agrees that this factor tends to influence stringency upwards, but reiterates that the need of the nation to conserve energy is still but one of four factors that must be balanced, as discussed below.

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 FR 33534, 33551 (June 30, 1977)). The courts have consistently upheld NHTSA's implementation of EPCA in this manner. *See, e.g., Competitive*

[670] The University of Pennsylvania Environmental Law Project offered a similar comment.

[671] NHTSA answered similar comments in the FEIS. See FEIS Section 10.2.4.2 for the agency's response.

[672] *Citing* HR Rep 94–340 at 86–87, 89–91 (1975 USCCAN 1762, 1848–49, 1851–53).

[673] *Green Mountain Chrysler Plymouth Dodge Jeep* v. *Crombie,* 508 F.Supp.2d 295 (D.Vt. 2007).

[674] *Central Valley Chrysler Jeep, Inc.* v. *Goldstene,* 529 F.Supp.2d 1151 (E.D. Cal. 2007).

[675] 42 FR 63184, 63188 (1977).

Enterprise Institute v. *NHTSA,* 956 F.2d 321, 322 (DC 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 (DC 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, manufacturers were encouraged to 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, which resulted in a higher mass differential between the smallest and the largest vehicles, with a correspondingly greater risk to safety. Under the attribute-based standards being finalized 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, and because all vehicles are required to continue improving their fuel economy. In prior rulemakings, NHTSA limited the application of mass reduction/material substitution in our modeling analysis to vehicles over 5,000 lbs GVWR,[676] but for purposes of today's final standards, NHTSA has revised its modeling analysis to allow some application of mass reduction/ material substitution for all vehicles, although it is concentrated in the largest and heaviest vehicles, 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 Joint TSD and in Section V of the FRIA; and the estimated safety impacts that may be due to the final 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.[677] 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 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."[678] 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 broad 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,[679] and as long as that balancing reasonably accommodates "conflicting policies that were committed to the agency's care by the statute."[680] 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.[681] 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, as noted above, 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.

v. Other Standards—Minimum Domestic Passenger Car Standard

The minimum domestic passenger car standard was added to the CAFE

[676] *See* 74 FR 14396–14407 (Mar. 30, 2009).

[677] 49 U.S.C. 32902(h).

[678] *Center for Auto Safety v. NHTSA,* 793 F.2d 1322, 1341 (C.A.D.C. 1986).

[679] *Center for Biological Diversity* v. *NHTSA,* 538 F.3d 1172, 1195 (9th Cir. 2008).

[680] *CAS*, 1338 (quoting *Chevron U.S.A., Inc.* v. *Natural Resources Defense Council, Inc.,* 467 U.S. 837, 845).

[681] *CBD* v. *NHTSA,* 538 F.3d 1172, 1198 (9th Cir. 2008).

program through EISA, when Congress gave NHTSA explicit authority to set universal standards for domestically-manufactured passenger cars at the level of 27.5 mpg or 92 percent of the average fuel economy of the combined domestic and import passenger car fleets in that model year, whichever was greater.[682] This minimum standard was intended to act as a "backstop," ensuring that domestically-manufactured passenger cars reached a given mpg level even if the market shifted in ways likely to reduce overall fleet mpg. Congress was silent as to whether the agency could or should develop similar backstop standards for imported passenger cars and light trucks. NHTSA has struggled with this question since EISA was enacted.

In the MY 2011 final rule, facing comments split fairly evenly between support and opposition to additional backstop standards, NHTSA noted Congress' silence and "accept[ed] at least the possibility that * * * [it] could be reasonably interpreted as permissive rather than restrictive," but concluded based on the record for that rulemaking as a whole that additional backstop standards were not necessary for MY 2011, given the lack of leadtime for manufacturers to change their MY 2011 vehicles, the apparently-growing public preference for smaller vehicles, and the anti-backsliding characteristics of the footprint-based curves.[683] NHTSA stated, however, that it would continue to monitor manufacturers' product plans and compliance, and would revisit the backstop issue if it became necessary in future rulemakings.[684]

Thus, in the MYs 2012–2016 NPRM, NHTSA again sought comment on the issue of additional backstop standards, recognizing the possibility that low fuel prices during the years that the MYs 2012–2016 vehicles are in service might lead to less than anticipated fuel savings.[685] NHTSA asked commenters, in addressing this issue, to consider reviewing the agency's discussion in the MY 2011 final rule, which the agency described as concluding that its authority was likely limited by Congress' silence to setting only the backstop that Congress expressly provided for.[686] EPA also sought comment on whether it should set backstop standards under the CAA for MYs 2012–2016.

As discussed above in Section II, many commenters addressed the backstop issue, and again comments were fairly evenly split between support and opposition to additional backstop standards. While commenters opposed to additional backstops, such as the Alliance, largely reiterated NHTSA's previous statements with regard to its backstop authority, some commenters in favor of additional backstops provided more detailed legal arguments than have been previously presented for the agency's consideration. Section II provides NHTSA's and EPA's general response to comments on the backstop issue; this section provides NHTSA's specific response to the legal arguments by Sierra Club *et al.*[687] on the agency's authority to set additional backstop standards.

The Sierra Club *et al.* commented that a more permissive reading of Congress' silence in EISA was appropriate given the context of the statute, the 9th Circuit's revised opinion in *CBD* v. *NHTSA*, and the assumptions employed in the NPRM analysis. The commenters stated that given that EISA includes the 35-in-2020 and ratable increase requirements, and given that CAFE standards were only just starting to rise for light trucks at the time of EISA's enactment and had remained at the statutory level of 27.5 mpg for passenger cars for many years, it appears that Congress' intent in EISA was to raise CAFE standards as rapidly as possible. Thus, the commenters stated, if the purpose of EISA was to promote the maximum feasible increase in fuel economy with ratable increases, then there was no reason to think that backstop standards would be inconsistent with that purpose—if they were inconsistent, Congress would not have included one for domestic passenger cars. Similarly, Congress could not have thought that additional backstops were inconsistent with attribute-based standards, or it would not have included one for domestic passenger cars.[688] The commenters also cited D.C. Circuit case law stating that congressional silence leaves room for agency discretion; specifically, that "[w]hen interpreting statutes that govern agency action, [the courts] have consistently recognized that a congressional mandate in one section and silence in another often 'suggests not a prohibition but simply a decision not to mandate any solution in the second context, *i.e.,* to leave the question to agency discretion.' "[689]

The Sierra Club *et al.* also commented that it appeared that the 9th Circuit's revised opinion in *CBD* v. *NHTSA* supported the agency's discretion to set additional backstops, since it was revised after the passage of EISA and did not change its earlier holding (pertaining to the original EPCA language) that backstop standards were within the agency's discretion.[690]

And finally, the commenters stated that NHTSA's rationale for not adopting additional backstops in the MY 2011 final rule should not be relied on for MYs 2012–2016, namely, that the agency's belief that backstop standards were unnecessary to ensure the expected levels of fuel savings given the short lead time between the promulgation of the final standards and the beginning of MY 2011, the apparent growing consumer preference for smaller vehicles, and the existing anti-backsliding measures in the attribute-based curves. As described above in Section II, these commenters (and many others) expressed concern about the agencies' fleet mix assumptions and their potential effect on estimated fuel savings.

In response, and given DC Circuit precedent as cited above, NHTSA agrees that whether to adopt additional minimum standards for imported passenger cars and light trucks is squarely within the agency's discretion, and that such discretion should be exercised as necessary to avoid undue losses in fuel savings due to market shifts or other forces while still respecting the statutorily-mandated manufacturer need for lead time in establishing CAFE standards. However, as discussed above in Section II.C, NHTSA remains confident that the projections of the future fleet mix are reliable, and that future changes in the fleet mix of footprints and sales are not likely to lead to more than modest changes in projected emissions reductions or fuel savings. There are only a relatively few model years at issue, and market trends today are consistent with the agencies' estimates, showing shifts from light trucks to passenger cars and increased emphasis on fuel economy from all vehicles. The shapes of the curves also tend to avoid

682 49 U.S.C. 32902(b)(4).

683 74 FR at 14412 (Mar. 30, 2009).

684 *Id.*

685 74 FR at 49685 (Sept. 28, 2009).

686 *Id.* at 49637, 49685 (Sept. 28, 2009).

687 NHTSA refers to these commenters by the shorthand "Sierra Club *et al.*," but the group consists of the Sierra Club, the Safe Climate Campaign, the Coalition for Clean Air, the Alliance for Climate Protection, and Environment America. Their comments may be found at Docket No. EPA–HQ–OAR–2009–0472–7278.1.

688 The commenters also suggested that NHTSA could set attribute-based backstop standards if it was concerned that Congress' mandate to set attribute-based standards generally precluded additional flat backstops.

689 *Citing Catawba County, N.C.* v. *EPA,* 571 F.3d 20, 36 (DC Cir. 2009) (quoting *Cheney R. Co.* v. *ICC,* 902 F.2d 66, 69 (DC Cir. 1990)).

690 *Citing CBD* v. *NHTSA,* 538 F.3d at 1204–06 (9th Cir. 2008).

or minimize regulatory incentives for manufacturers to upsize their fleet to change their compliance burden, and the risk of vehicle upsizing or changing vehicle offerings to "game" the passenger car and light truck definitions to which commenters refer is not so great for the model years in question, because the changes that commenters suggest manufacturers might make are neither so simple nor so likely to be accepted by consumers, as discussed above.

Thus, NHTSA is confident that the anticipated increases in average fuel economy and reductions in average CO_2 emission rates can be achieved without backstops under EISA, as noted above. Nevertheless, we acknowledge that the MY 2016 fuel economy goal of 34.1 mpg is an estimate and not a standard,[691] and that changes in fuel prices, consumer preferences, and/or vehicle survival and mileage accumulation rates could result in either smaller or larger oil savings. However, as explained above and elsewhere in the rule, NHTSA believes that the possibility of not meeting (or, alternatively, exceeding) fuel economy goals exists, but is not likely to lead to more than modest changes in the currently-projected levels of fuel and GHG savings. NHTSA plans to conduct retrospective analysis to monitor progress, and has the authority to revise standards if warranted, as long as sufficient lead time is provided. Given this, and given the potential complexities in designing an appropriate backstop, NHTSA believes that the balance here points to not adopting additional backstops at this time for the MYs 2012–2016 standards other than NHTSA's issuing the ones required by EPCA/EISA for domestic passenger cars. If, during the timeframe of this rule, NHTSA observes a significant shift in the manufacturer's product mix resulting in a relaxation of their estimated targets, NHTSA and EPA will reconsider options, both for MYs 2012–2016 and future rulemakings.

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."[692]

The APA also requires that agencies provide notice and comment to the public when proposing regulations.[693] Two commenters, the American Chemistry Council and the American Petroleum Institute, argued that the agreements by auto manufacturers and California to support the National Program indicated that a "deal" had been struck between the agencies and these parties, which was not available as part of the administrative record and which the public had not been given the opportunity to comment on. The commenters argued that this violated the APA.

In response, under the APA, agencies "must justify their rulemakings solely on the basis of the record [they] compile[] and make[] public."[694] Any informal contacts that occurred prior to the release of the NPRM may have been informative for the agencies and other parties involved in developing the NPRM, but they did not release the agencies of their obligation consider and respond to public comments on the NPRM and to justify the final standards based on the public record. The agencies believe that the record fully justifies the final standards, demonstrating analytically that they are the maximum feasible and reasonable for the model years covered. Thus, we disagree that there has been any violation of the APA.

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 both a draft and a final 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

[691] The MYs 2012–2016 passenger car and light truck curves are the actual standards.

[692] *Ibid.,* 1181.

[693] 5 U.S.C. 553.

[694] *Sierra Club* v. *Costle,* 657 F.2d 298, 401 (DC Cir. 1981).

U.S. 332, 350, 109 S.Ct. 1835, 104 L.Ed.2d 351 (1989).

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.

This final rule also constitutes a Record of Decision for NHTSA under NEPA. Section IV.K below provides much more information on the agency's NEPA analysis for this rulemaking, and on how this final rule constitutes a Record of Decision.

E. What are the final CAFE standards?

1. Form of the Standards

Each of the CAFE standards that NHTSA is finalizing 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.[695]

As discussed above in Section II.C, NHTSA has determined 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.

In the NPRM preceding today's final rule (as under the recently-promulgated MY 2011 standards), NHTSA proposed that the CAFE level required of any given manufacturer 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, *SALESi* 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.

However, comments by Honda and Toyota indicate that the defined variables used in the equations could be interpreted differently by vehicle manufacturers. The term "footprint of a vehicle model" could be interpreted to mean that a manufacturer only has to use one representative footprint within a model type or that it is necessary to use all the unique footprints and corresponding fuel economy target standards within a model type when determining a fleet target standard.

In the same NPRM, EPA proposed new regulations which also include the calculation of standards based on the attribute of footprint. The EPA regulation text is specific and states that standards will be derived using the target values "for each unique combination of model type and footprint value" (proposed regulation text 40 CFR 86.1818–12(c)(2)(ii)(B) for passenger automobiles and (c)(3)(ii)(B) for light trucks). Also, in an EPA final rule issued November 25, 2009, the manufacturers are required to provide in their final model year reports to EPA data for "each unique footprint within each model type" used to calculate the new CAFE program fuel economy levels (40 CFR 600.512–08(c)(8) and (9)). Using this term would be more definitive than using terms such as "footprint of a vehicle model" and would more fully harmonize the NHTSA and EPA regulations. Therefore, under the final CAFE standards promulgated today, a manufacturer's "fleet target standard" will be derived from the summation of the targets for all and every unique footprint within each model type for all model types that make up a fleet of vehicles. Also, to provide greater clarity, the equation will use the variable name *PRODUCTION* rather than *SALES* to refer to production of vehicles for sale in the United States. Otherwise, for purposes of the final rule the same equation will apply:

[695] 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 established today.

$$CAFE_{required} = \frac{\sum_i PRODUCTION_i}{\sum_i \frac{PRODUCTION_i}{TARGET_i}}$$

However, $PRODUCTION_i$ is the number of units produced for sale in the United States of each i^{th} unique footprint within each model type, produced for sale in the United States, and $TARGET_i$ is the corresponding fuel economy target (according to the equation shown in Chapter II and based on the corresponding footprint), and the summations in the numerator and denominator are both performed over all unique footprint and model type combinations in the fleet in question. The equations and terms specified for calculating the required CAFE fleet values in Part 531.5(b) and (c) for MYs 2012–2016, and Part 533.5(g), (h) and (i) for MYs 2008–2016 will be updated accordingly. Although the agency is not changing the equations for the MY 2011 standards, we would expect manufacturers to follow the same procedures for calculating their required levels for that model year. Also, the Appendices in each of these parts will also be updated to provide corresponding examples of calculating the fleet standards.

Corresponding changes to regulatory text defining CAFE standards are discussed below in Section IV.I.

The final 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 proposed CAFE standards defined by the following coefficients during MYs 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

After updating inputs to its analysis, and revisiting the form and stringency of both passenger cars and light truck standards, as discussed in Section II, NHTSA is finalizing passenger car CAFE standards defined by the following coefficients during MYs 2012–2016:

TABLE IV.E.2–2—COEFFICIENTS DEFINING FINAL MY 2012–2016 FUEL ECONOMY TARGETS FOR PASSENGER CARS

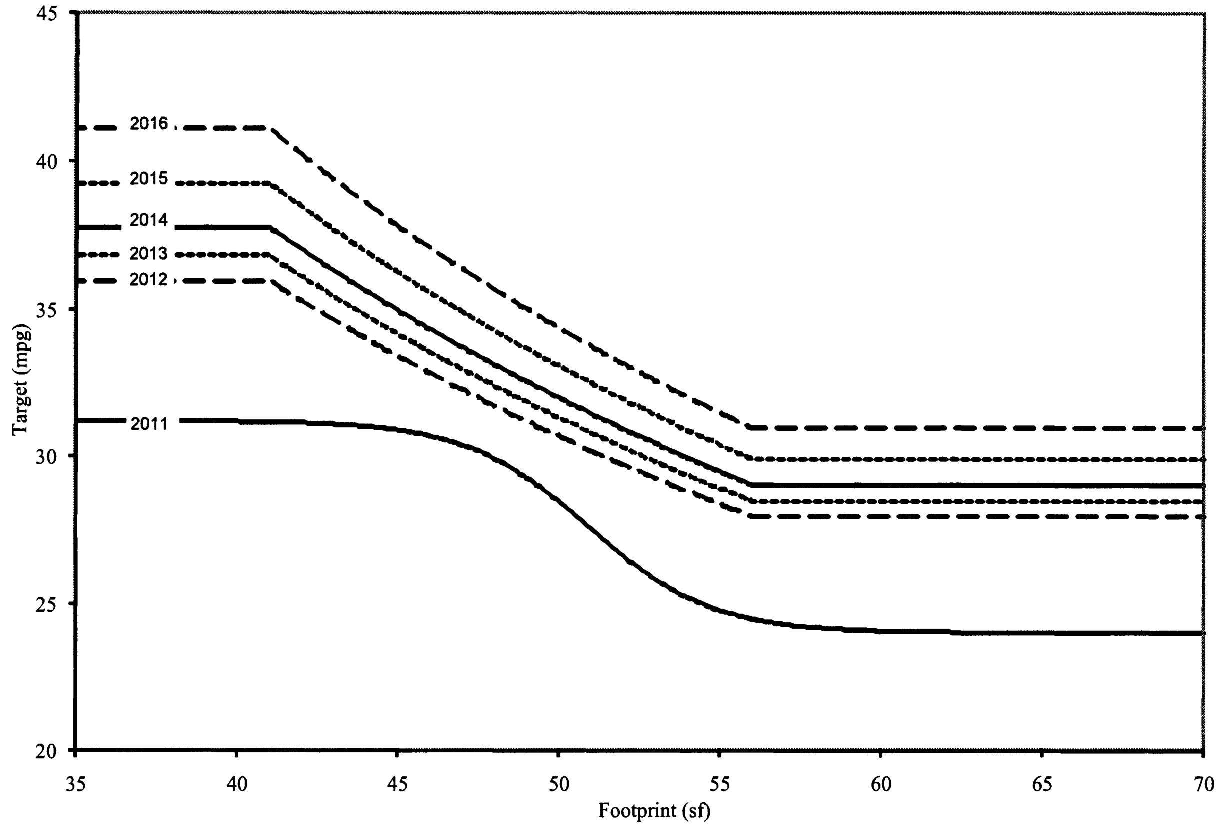
Coefficient	2012	2013	2014	2015	2016
a (mpg)	35.95	36.80	37.75	39.24	41.09
b (mpg)	27.95	28.46	29.03	29.90	30.96
c (gpm/sf)	0.0005308	0.0005308	0.0005308	0.0005308	0.0005308
d (gpm)	0.006057	0.005410	0.004725	0.003719	0.002573

These coefficients reflect the agency's decision, discussed above in Section II, to leave the shapes of both the passenger car and light truck curves unchanged. They also reflect the agency's reevaluation of the "gap" in stringency between the passenger car and light truck standard, also discussed in Section II.

These coefficients result in the 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.

Figure IV.E.2-1 Final MY 2011 and Final 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 final 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): [696]

TABLE IV.E.2–3—ESTIMATED AVERAGE FUEL ECONOMY REQUIRED UNDER FINAL MY 2011 AND FINAL MY 2012–2016 CAFE STANDARDS FOR PASSENGER CARS

Manufacturer	MY 2011	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	30.2	33.0	33.7	34.5	35.7	37.3
Chrysler	29.4	32.6	33.3	34.1	35.2	36.7
Daimler	29.2	32.0	32.7	33.3	34.4	35.8
Ford	29.7	32.9	33.7	34.4	35.6	37.1
General Motors	30.3	32.7	33.5	34.2	35.4	36.9
Honda	30.8	33.8	34.6	35.4	36.7	38.3
Hyundai	30.9	33.8	34.3	35.1	36.6	38.2
Kia	30.6	33.4	34.2	35.0	36.3	37.9
Mazda	30.6	33.8	34.6	35.5	36.8	38.4
Mitsubishi	31.0	34.2	35.0	35.8	37.1	38.7
Nissan	30.7	33.3	34.1	34.9	36.1	37.7

[696] 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 30.4 mpg in MY 2011. This does not mean that the agency is making the standards more stringent for that model year, or that any manufacturer will necessarily face a more difficult CAFE standard, it simply reflects the change in assumptions about what vehicles will be produced for sale in that model year. The target curve remains the same, and each manufacturer's compliance obligation will still be determined at the end of the model year.

TABLE IV.E.2–3—ESTIMATED AVERAGE FUEL ECONOMY REQUIRED UNDER FINAL MY 2011 AND FINAL MY 2012–2016 CAFE STANDARDS FOR PASSENGER CARS—Continued

Manufacturer	MY 2011	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Porsche	31.2	35.9	36.8	37.8	39.2	41.1
Subaru	31.0	34.6	35.5	36.3	37.7	39.4
Suzuki	31.2	35.8	36.6	37.5	39.0	40.8
Tata	28.0	30.7	31.4	32.1	33.3	34.7
Toyota	30.8	33.9	34.7	35.5	36.8	38.4
Volkswagen	30.8	34.3	35.0	35.9	37.2	38.8
Average	30.4	33.3	34.2	34.9	36.2	37.8

Because a manufacturer's required average fuel economy level for a model year under the final standards will be based on its actual production numbers in that model year, its official required fuel economy level will not be known until the end of that model year. However, because the targets for each vehicle footprint will 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.

As published in the MY 2011 final rule, the domestic minimum passenger car standard for MY 2011 was set at 27.8 mpg, which represented 92 percent of the final projected passenger car standards promulgated for that model year.[697] NHTSA stated at the time that "The final calculated minimum standards will be updated to reflect any changes in the projected passenger car standards."[698] Subsequently, in the NPRM proposing the MYs 2012–2016 standards, NHTSA noted that given changes in the projected estimated required passenger car standard for MY 2011,[699] 92 percent of that standard would be 28.0 mpg, not 27.8 mpg, and proposed to raise the minimum domestic passenger car standard accordingly.

The Alliance commented to the NPRM that the minimum domestic passenger car standard is subject to the 18-month lead time rule for standards per 49 U.S.C. per 49 U.S.C. 32902(a), and that NHTSA therefore cannot revise it at this time. Toyota individually offered identical comments.

49 U.S.C. 32902(b)(4)(B) does state that the minimum domestic passenger car standard shall be 92 percent of the projected average fuel economy for the passenger car fleet, "which projection shall be published in the **Federal Register** when the standard for that model year is promulgated in accordance with this section." In reviewing the statute, the agency concurs that the minimum domestic passenger car standard should be based on the agency's fleet assumptions when the passenger car standard for that year is promulgated, which would make it inappropriate to change the minimum standard for MY 2011 at this time. However, we note that we do not read this language to preclude any change in the minimum standard after it is first promulgated for a model year. As long as the 18-month lead-time requirement of 49 U.S.C. 32902(a) is respected, NHTSA believes that the language of the statute suggests that the 92 percent should be determined anew any time the passenger car standards are revised.

The Alliance also commented that the minimum domestic passenger car standard should be based on the projected "actual" (NHTSA refers to this as "estimated achieved") mpg level for the combined passenger car fleet, rather than based on the projected "target" mpg level (NHTSA refers to this as "estimated required") for the combined fleet. The Alliance argued that the plain language of the statute states that 92 percent should be taken of the "average fuel economy projected * * * for the combined * * * fleets," which is different than the average fuel economy *standard* projected. The Alliance further argued that using the "estimated achieved" value to determine the 92 percent will avoid inadvertently "considering" FFV credits in setting the minimum standard, since the "estimated achieved" value is determined by ignoring FFV credits. Toyota individually offered identical comments.

NHTSA disagrees that the minimum standard should be based on the estimated achieved levels rather than the estimated required levels. NHTSA interprets Congress' reference in the second clause of 32902(b)(4)(B) to the standard promulgated in that model year as indicating that Congress intended "projected average fuel economy" in the first clause to pertain to the estimated required level, not the estimated achieved level. The Alliance's concern that a minimum standard based on the estimated required level "inadvertently considers" FFV credits is misplaced, because NHTSA is statutorily prohibited from considering FFV credits in setting maximum feasible standards. Thus, NHTSA has continued to determine the minimum domestic passenger car standard based on the estimated required mpg levels projected for the model years covered by the rulemaking.

Based on NHTSA's current market forecast, the agency's estimates of these minimum standards under the final MY 2012–2016 CAFE standards (and, for comparison, the final MY 2011 minimum domestic passenger car standard) are summarized below in Table IV.E.3–1.

[697] *See* 74 FR at 14410 (Mar. 30, 3009).

[698] *Id.*

[699] Readers should remember, of course, that the "estimated required standard" is not necessarily the ultimate mpg level with which manufacturers will have to comply, because the ultimate mpg level for each manufacturer is determined at the end of the model year based on the target curves and the mix of vehicles that each manufacturer has produced for sale. The mpg level designated as "estimated required' is exactly that, an estimate.

TABLE IV.E.3–1—ESTIMATED MINIMUM STANDARD FOR DOMESTICALLY MANUFACTURED PASSENGER CARS UNDER FINAL MY 2011 AND FINAL MY 2012–2016 CAFE STANDARDS FOR PASSENGER CARS

2011	2012	2013	2014	2015	2016
27.8	30.7	31.4	32.1	33.3	34.7

4. Light Truck Standards

For light trucks, NHTSA proposed 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

After updating inputs to its analysis, and revisiting the form and stringency of both passenger cars and light truck standards, as discussed in Section II, NHTSA is finalizing light truck CAFE standards defined by the following coefficients during MYs 2012–2016:

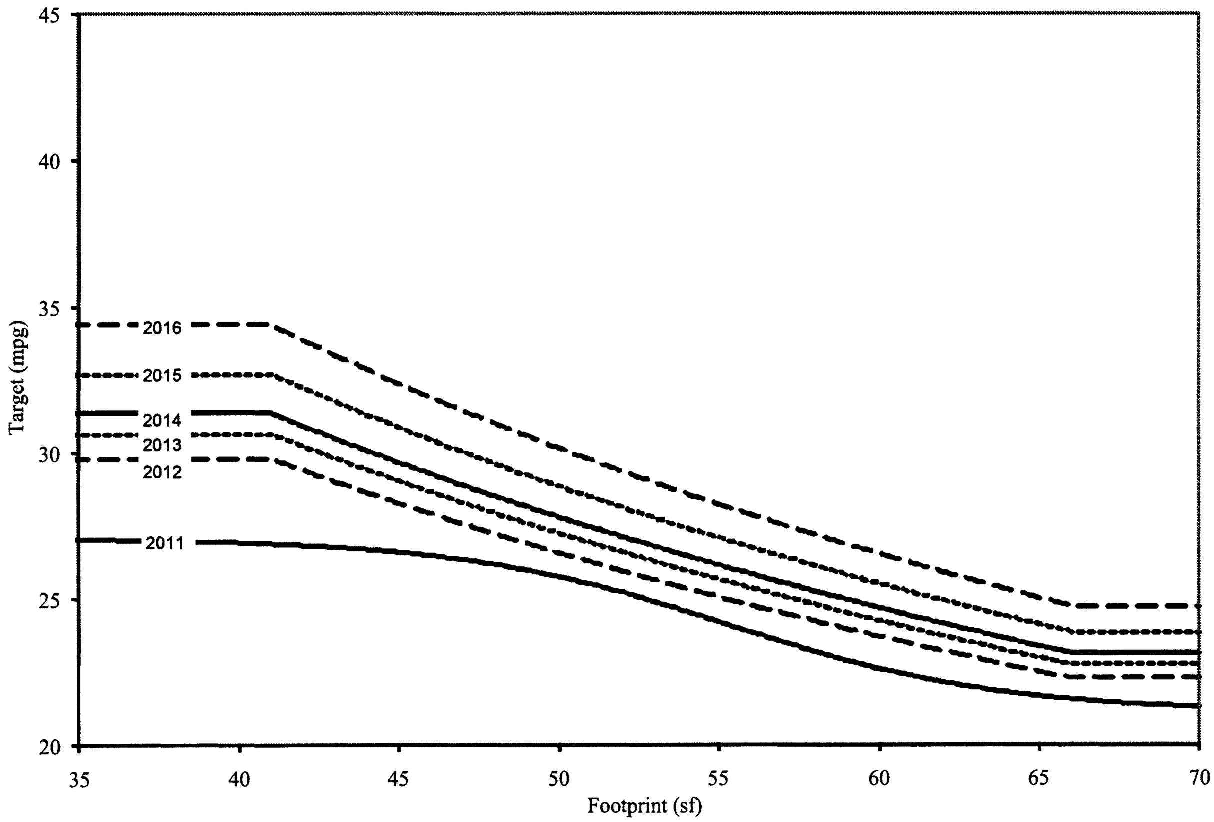
TABLE IV.E.4–2—COEFFICIENTS DEFINING FINAL MY 2012–2016 FUEL ECONOMY TARGETS FOR LIGHT TRUCKS

Coefficient	2012	2013	2014	2015	2016
a (mpg)	29.82	30.67	31.38	32.72	34.42
b (mpg)	22.27	22.74	23.13	23.85	24.74
c (gpm/sf)	0.0004546	0.0004546	0.0004546	0.0004546	0.0004546
d (gpm)	0.014900	0.013968	0.013225	0.011920	0.010413

As for passenger cars, these coefficients reflect the agency's decision, discussed above in Section II, to leave the shapes of both the passenger car and light truck curves unchanged. They also reflect the agency's reevaluation of the "gap" in stringency between the passenger car and light truck standard, also discussed in Section II.

These coefficients result in the 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.

Figure IV.E.4-1 Final MY 2011 and Final MY 2012-2016 Fuel Economy Targets for Light Trucks



Again, 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 final 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): [700]

TABLE IV.E.4–3—ESTIMATED AVERAGE FUEL ECONOMY REQUIRED UNDER FINAL MY 2011 AND FINAL MY 2012–2016 CAFE STANDARDS FOR LIGHT TRUCKS

Manufacturer	MY 2011	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	25.6	26.6	27.3	27.9	28.9	30.2
Chrysler	24.5	25.7	26.2	26.8	27.8	29.0
Daimler	24.7	25.6	26.3	26.9	27.8	29.1
Ford	23.7	24.8	25.4	26.0	27.0	28.1
General Motors	23.3	24.2	24.8	25.2	26.1	27.2
Honda	25.7	26.9	27.5	28.0	29.1	30.4
Hyundai	25.9	27.0	27.6	28.2	29.3	30.7
Kia	25.2	26.2	26.7	27.3	28.3	29.5
Mazda	26.2	27.6	28.4	28.9	30.1	31.5
Mitsubishi	26.4	27.8	28.5	29.1	30.2	31.7
Nissan	24.5	25.6	26.2	26.8	27.8	29.1
Porsche	25.5	26.3	26.9	27.5	28.5	29.8
Subaru	26.5	27.9	28.6	29.2	30.4	31.9
Suzuki	26.3	27.5	28.2	28.8	29.9	31.4
Tata	26.2	27.4	28.2	28.8	29.9	31.3
Toyota	24.6	25.7	26.2	26.8	27.8	29.1

[700] 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 24.4 mpg in MY 2011. The increase in the estimate reflects a decrease in the size of the average light truck.

TABLE IV.E.4–3—ESTIMATED AVERAGE FUEL ECONOMY REQUIRED UNDER FINAL MY 2011 AND FINAL MY 2012–2016 CAFE STANDARDS FOR LIGHT TRUCKS—Continued

Manufacturer	MY 2011	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Volkswagen	25.0	25.8	26.4	27.0	28.0	29.2
Average	24.4	25.4	26.0	26.6	27.5	28.8

As discussed above with respect to the final passenger cars standards, we note that a manufacturer's required fuel economy level for a model year under the final standards will be based on its actual production numbers in that model year.

F. How do the final standards fulfill NHTSA's statutory obligations?

In developing the proposed MY 2012–16 standards, the agency developed and considered a wide variety of alternatives. 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%.[701] That same approach has been carried over to this final rule and to the accompanying FEIS and FRIA. Thus, 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 clearly communicates the level of stringency of each alternative and allows us to identify alternatives that represent different ways to balance NHTSA's statutory requirements under EPCA/EISA.

In the NPRM, we noted that each of the listed alternatives represents, in part, a different way in which NHTSA could conceivably balance different policies and considerations in setting the standards. We were mindful that the agency needs to weigh and balance many factors, such as technological feasibility, economic practicability, including lead time considerations for the introduction of technologies and impacts on the auto industry, the impacts of the standards on fuel savings and CO_2 emissions, and fuel savings by consumers, as well as other relevant factors such as safety. For example, the 7% 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. We also recognized that some technologies (*e.g.,* PHEVs and EVs) will not be available for more than limited commercial use through MY 2016, and that even those technologies that could be more widely commercialized through MY 2016 cannot all be deployed on every vehicle model in MY 2012 but require a realistic schedule for more widespread commercialization to be within the realm of economically practicability.

In addition to the alternatives that increase evenly at annual rates ranging from 3% to 7%, NHTSA also included alternatives developed using benefit-cost criteria. The agency emphasized benefit-cost-related alternatives in its rulemakings for MY 2008–2011 and, subsequently, MY 2011 standards. By including such alternatives in its current analysis, the agency is providing a degree of analytical continuity between the two approaches to defining alternatives in an effort to illustrate the similarities and dissimilarities. To that end, we included and analyzed two additional alternatives, one that sets standards at the point where net benefits are maximized (labeled "MNB" in the table below), and another that sets standards at the point at which total costs are most nearly equal to total benefits (labeled "TCTB" in the table below).[702] 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, NHTSA used the Volpe model extensively to assess the technologies that the manufacturers could apply in order to comply with each of the alternatives. This allowed us to assess the variety, amount and cost of the technologies that could be used 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, reduce fuel consumption, and reduce CO_2 emissions.

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 other relevant goals and priorities. Those priorities and goals include maximizing energy conservation and achieving a nationally harmonized and coordinated program for regulating fuel economy and GHG emissions.

Part of that assessment of alternatives 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 a national attribute-based GHG emissions standard would need to be set to achieve the same emission reductions in California as the California GHG program. This was done by evaluating a nationwide Clean Air Act standard for MY 2016 that would apply across the country and require the levels of emissions reduction which California standards would require for the subset

[701] Notice of intent to prepare an EIS, 74 FR 14857, 14859–60, April 1, 2009.

[702] 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 FRIA, 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.

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 national new vehicle fleet-wide CO_2 performance standards for model year 2016 which would result in the new light-duty 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 were met exclusively by fuel economy improvements—and the overall result is the model year 2016 goals of the National Program.

However, the level of stringency for the National Program goal of 250 g/mi CO_2 can be met with both fuel economy "tailpipe" improvements as well as other GHG-reduction related improvements, such as A/C refrigerant leakage reductions. CAFE standards, as discussed elsewhere in this final rule, cannot be met by improvements that cannot be accounted for on the FTP/HFET tests. Thus, setting CAFE standards at 35.5 mpg would require more tailpipe technology (at more expense to manufacturers) than would be required under such a CAA standard. To obtain an equivalent CAFE standard, we determined how much tailpipe technology would be necessary in order to meet an mpg level of 35.5 if manufacturers also employed what EPA deemed to be an average amount of A/C "credits" (leakage and efficiency) to reach the 250 g/mi equivalent. This results in a figure of 34.1 mpg as the appropriate counterpart CAFE standard. This differential gives manufacturers the opportunity to reach 35.5 mpg equivalent 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.

Thus, as part of the process of considering all of the factors relevant under EPCA for setting standards, in a context where achieving a harmonized National Program is important, for the proposal 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 alternatives presented above, represents a unique balancing of the statutory factors and other relevant considerations. For the reader's reference, the estimated required levels of stringency for each alternative in each model year are presented below:

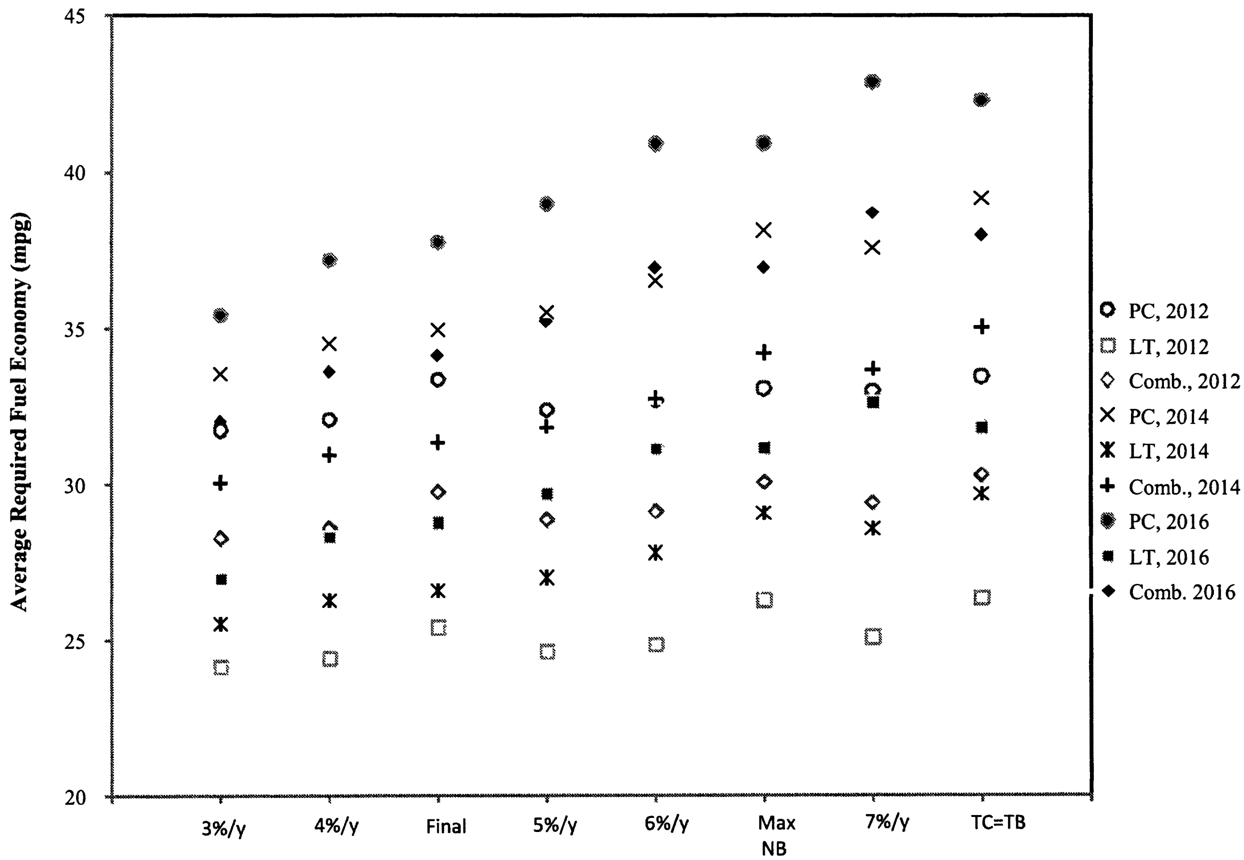
TABLE IV.F–1—ESTIMATED REQUIRED FUEL ECONOMY LEVEL FOR REGULATORY ALTERNATIVES [703]

	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
	No action	3%/year increase	4%/year increase	~4.3%/year increase	5%/year increase	~6.0%/year increase MNB	6%/year increase	7%/year increase	~6.6%/year increase TCTB
2012:									
Passenger Cars	30.5	31.7	32.1	33.3	32.4	33.0	32.7	33.0	33.4
Light Trucks	24.4	24.1	24.4	25.4	24.6	26.3	24.9	25.1	26.3
Combined	27.8	28.3	28.6	29.7	28.8	30.0	29.1	29.4	30.3
2013:									
Passenger Cars	30.5	32.6	33.3	34.2	33.9	36.1	34.5	35.2	36.7
Light Trucks	24.4	24.8	25.3	26.0	25.8	27.7	26.3	26.8	28.0
Combined	27.8	29.1	29.7	30.5	30.3	32.3	30.8	31.4	32.8
2014:									
Passenger Cars	30.5	33.5	34.5	34.9	35.5	38.1	36.5	37.6	39.2
Light Trucks	24.5	25.5	26.3	26.6	27.0	29.1	27.8	28.6	29.7
Combined	28.0	30.0	30.9	31.3	31.8	34.2	32.7	33.7	35.0
2015:									
Passenger Cars	30.5	34.4	35.8	36.2	37.1	39.4	38.6	40.1	40.7
Light Trucks	24.4	26.2	27.2	27.5	28.3	30.3	29.4	30.5	30.7
Combined	28.0	31.0	32.2	32.6	33.4	35.6	34.7	36.0	36.5
2016:									
Passenger Cars	30.5	35.4	37.2	37.8	39.0	40.9	40.9	42.9	42.3
Light Trucks	24.4	27.0	28.3	28.8	29.7	31.1	31.1	32.6	31.8
Combined	28.1	32.0	33.6	34.1	35.2	36.9	36.9	38.7	38.0

The following figure presents this same information but in a different way, comparing estimated 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 FRIA.

[703] Also, the "MNB" and the "TCTB" alternatives depend on the inputs to the agencies' analysis. The sensitivity analysis presented in the FRIA documents the response of these alternatives to changes in key economic inputs. For example, the combined average required fuel economy under the "MNB" alternative is 36.9 mpg under the reference case economic inputs presented here, and ranges from 33.7 mpg to 37.2 mpg under the alternative economic inputs presented in the FRIA. *See* Table X–14 in the FRIA.

Figure IV.F-1 Average Estimated Required Fuel Economy (MYs 2012, 2014, and 2016)



As this figure illustrates, the final 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 final standards reflects an average annual increase of 4.3%/y. The final 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."

For each alternative, including today's final standards, NHTSA has 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. The accompanying FRIA presents a detailed analysis of these results. Table IV.F–2 presents fuel savings, CO_2 reductions, and total industry cost outlays for model year 2012—2016 for the eight alternatives.

TABLE IV.F–2—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	34	373	23
4% per Year	50	539	39
Final (4.3% per Year)	61	655	52
5% per Year	68	709	63
6% per Year	82	840	90
Maximum Net Benefit	90	925	103
7% per Year	93	945	111
Total Cost = Total Benefit	96	986	114

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 requirement that NHTSA not consider statutory credits in establishing CAFE standards, NHTSA did not consider FFV credits, credits carried forward and backward, and transferred credits in this calculation[704, 705] In addition, the analysis incorporates fines for some manufacturers that have traditionally paid fines rather than comply with the standards. 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 NHTSA's FRIA.

In reviewing the results of the various alternatives, NHTSA confirmed that progressive increases in stringency require progressively greater deployment of fuel-saving technology and corresponding increases in technology outlays and related costs, fuel savings, and CO_2 emission reductions. To begin, NHTSA estimated total incremental outlays for additional technology in each model year. The following figure shows cumulative results for MYs 2012–2016 for industry as a whole and Chrysler, Ford, General Motors, Honda, Nissan, and Toyota. This figure focuses on these manufacturers as they currently (in MY 2010) represent three large U.S.-headquartered and three large foreign-headquartered full-line manufacturers.

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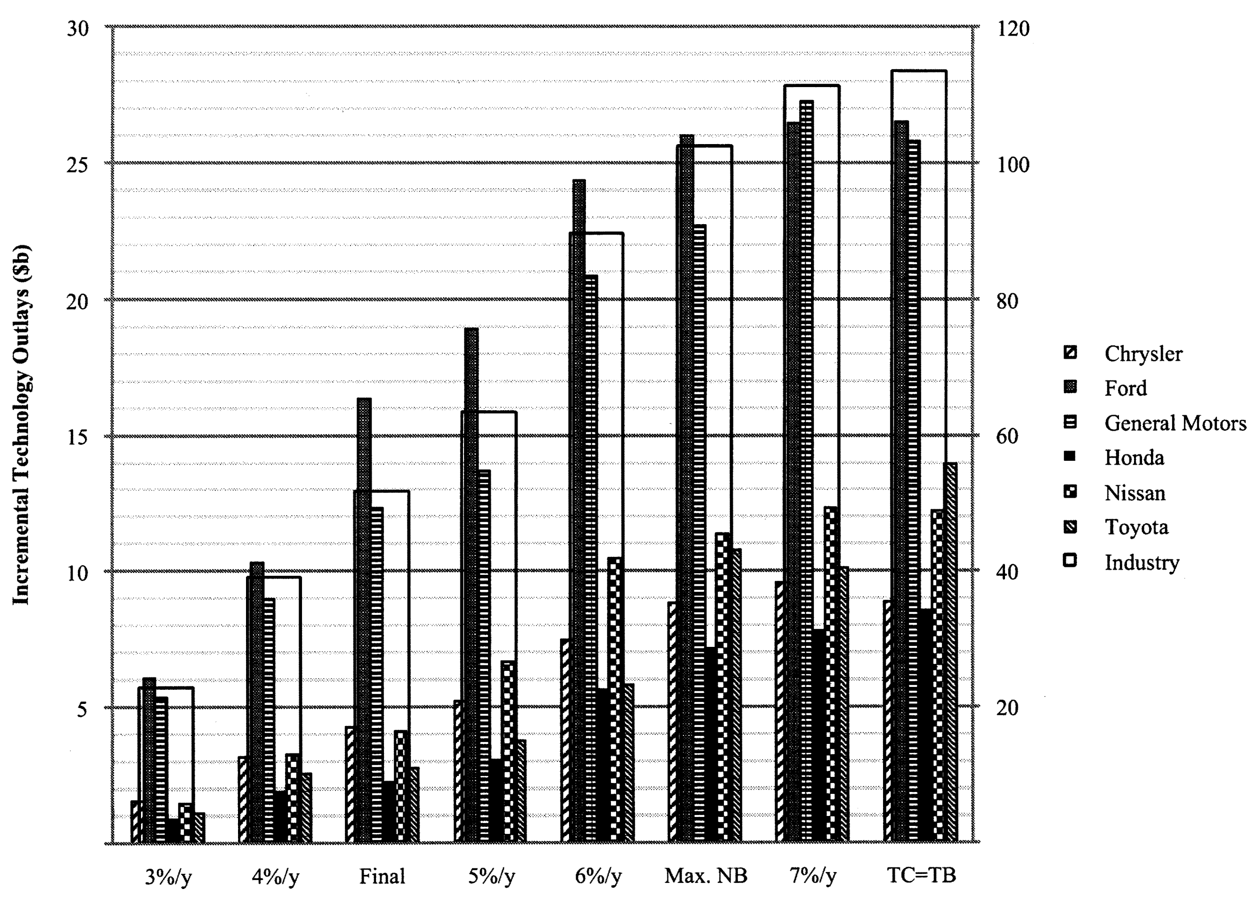
Figure IV.F-2 Incremental Technology Outlays (MYs 2012-2016)



[704] NHTSA has conducted a separate analysis, discussed above in Section I, which accounts for EPCA's provisions regarding FFVs.

[705] For a number of reasons, the results of this modeling differ from EPA's for specific manufacturers, fleets, and model years. These reasons include representing every model year explicitly, accounting for estimates of when vehicle model redesigns will occur, and not considering those compliance flexibilities where EPCA forbids such consideration in setting CAFE standards. It should be noted, however, that these flexibilities in fact provide manufacturers significant latitude to manage their compliance obligations.

As part of the incremental technology outlays, NHTSA also analyzes which technologies manufacturers could apply to meet the standards. In NHTSA's analysis, manufacturers achieve compliance with the fuel economy levels through application of technology rather than through changes in the mix of vehicles produced for sale in the U.S. The accompanying FRIA 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 by 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 presented because they 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 are presented because they represent technologies involving significant cost and related lead time challenges for widespread use through MY 2016. These figures focus on Chrysler, Ford, General Motors, Honda, Nissan, and Toyota, as above. For each alternative, the figures show additional application of technology by MY 2016.[706]

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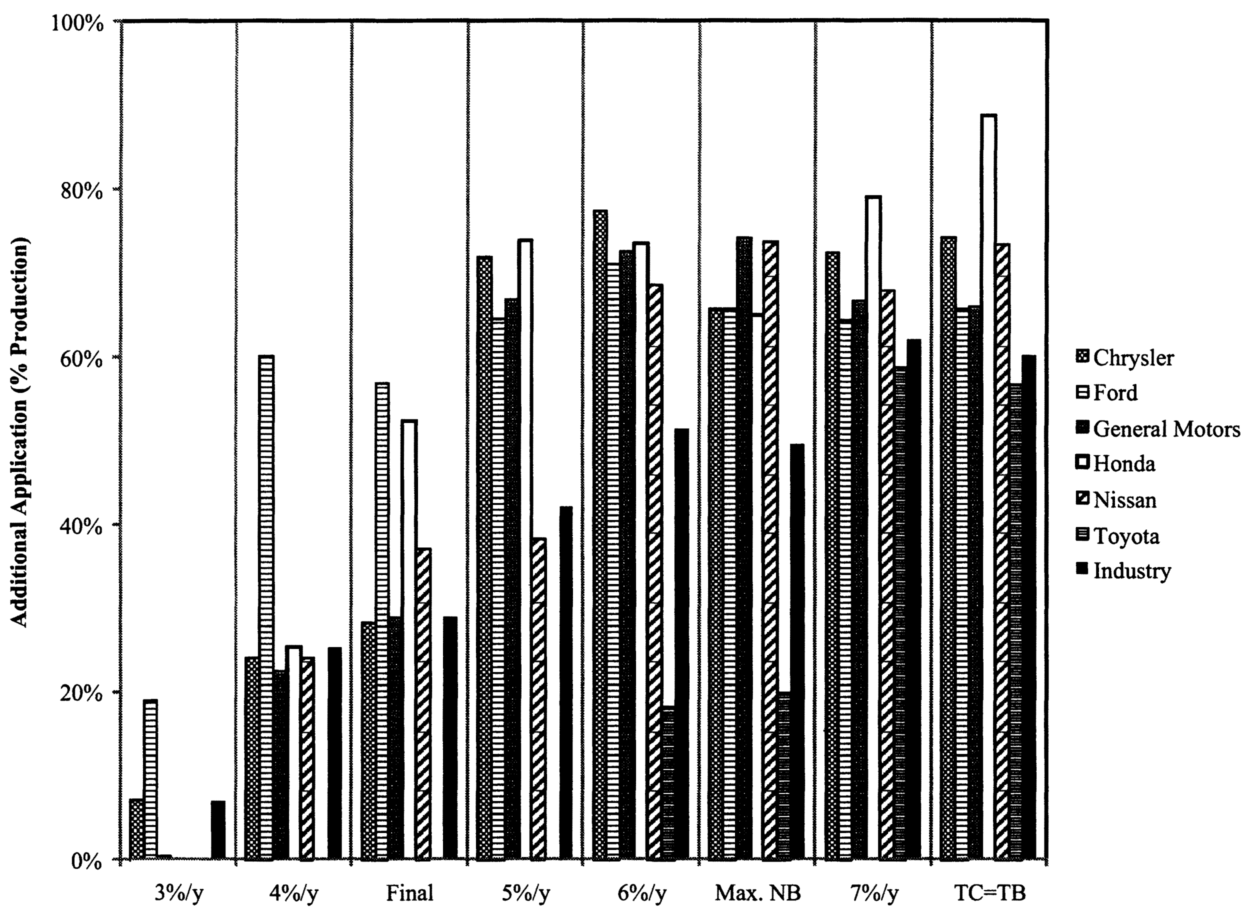
Figure IV.F-3 Additional Application of GDI (MY 2016)



[706] The FRIA 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-4 Additional Application of Engine Turbocharging & Downsizing

(MY 2016)

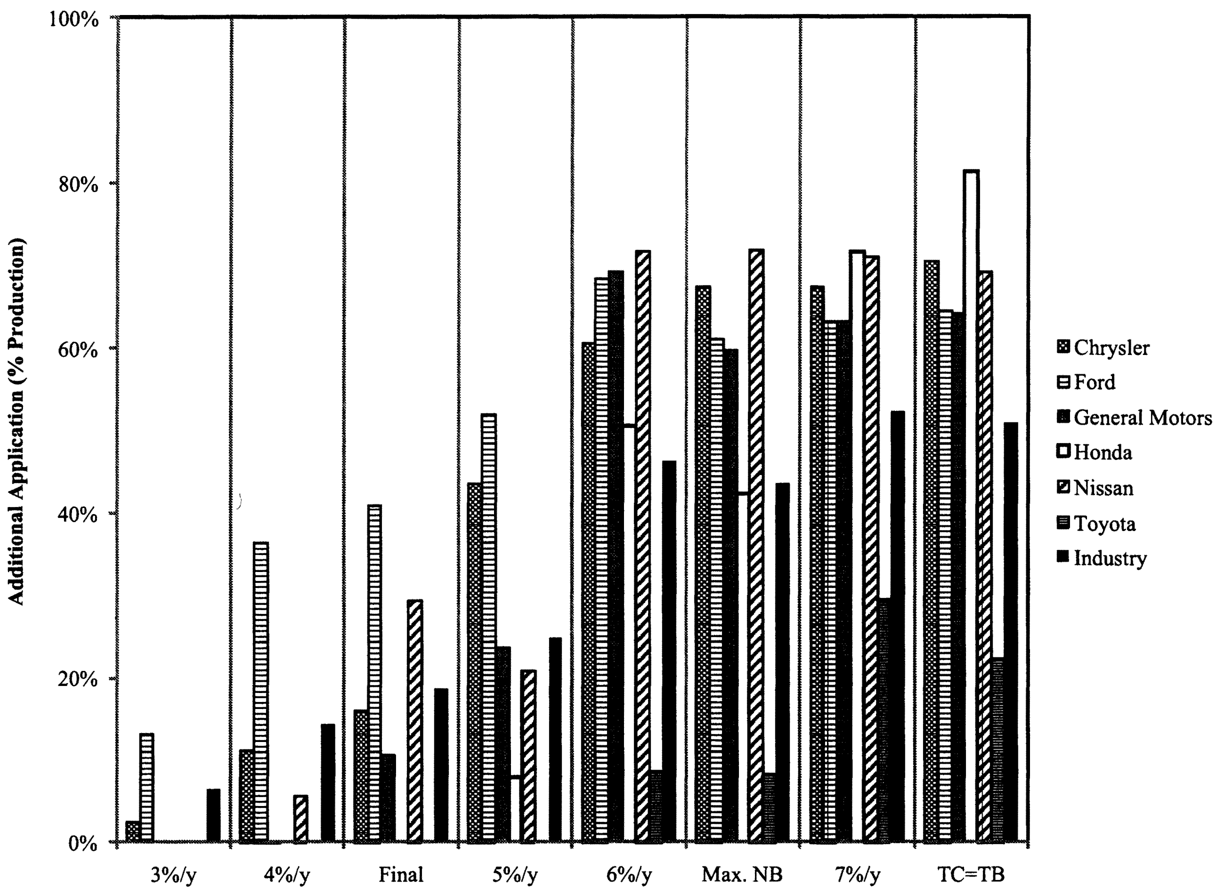


Figure IV.F-5 Additional Application of Diesel Engines (MY 2016)

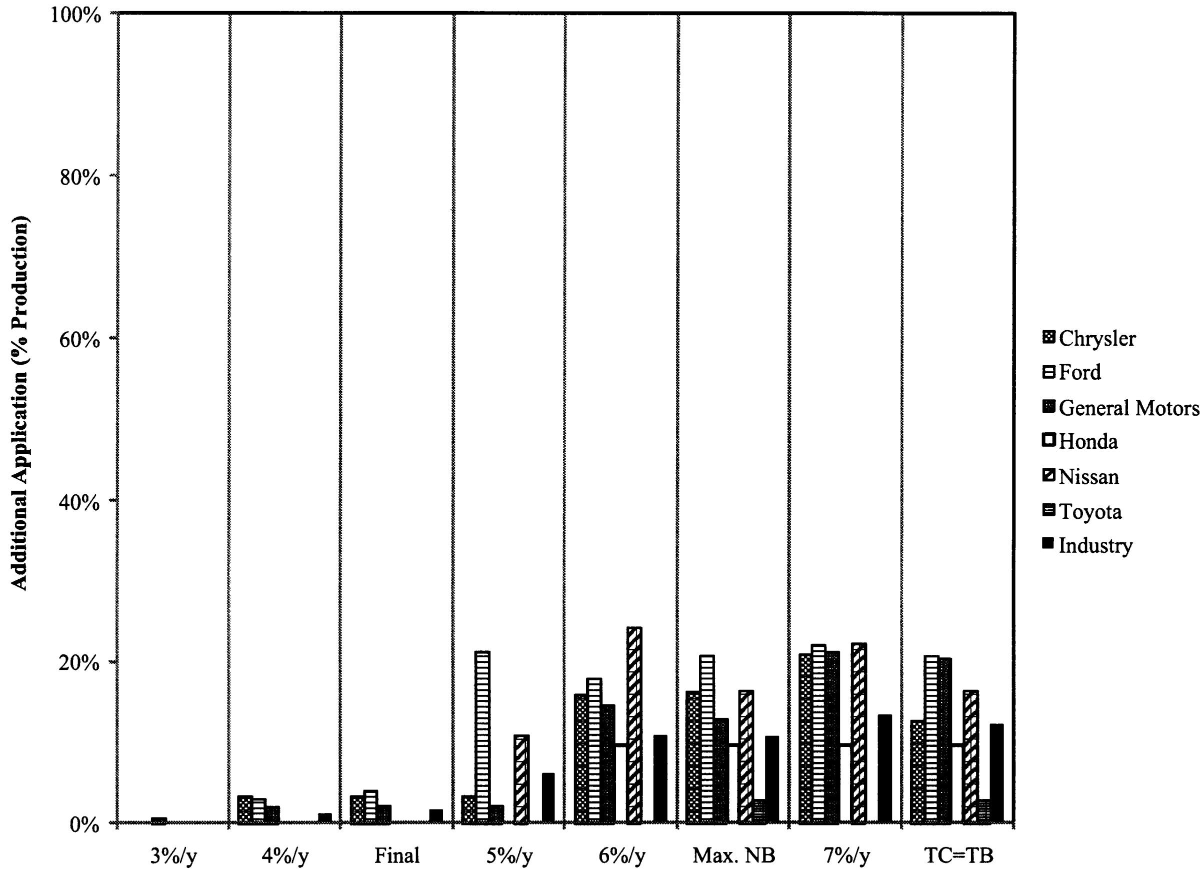
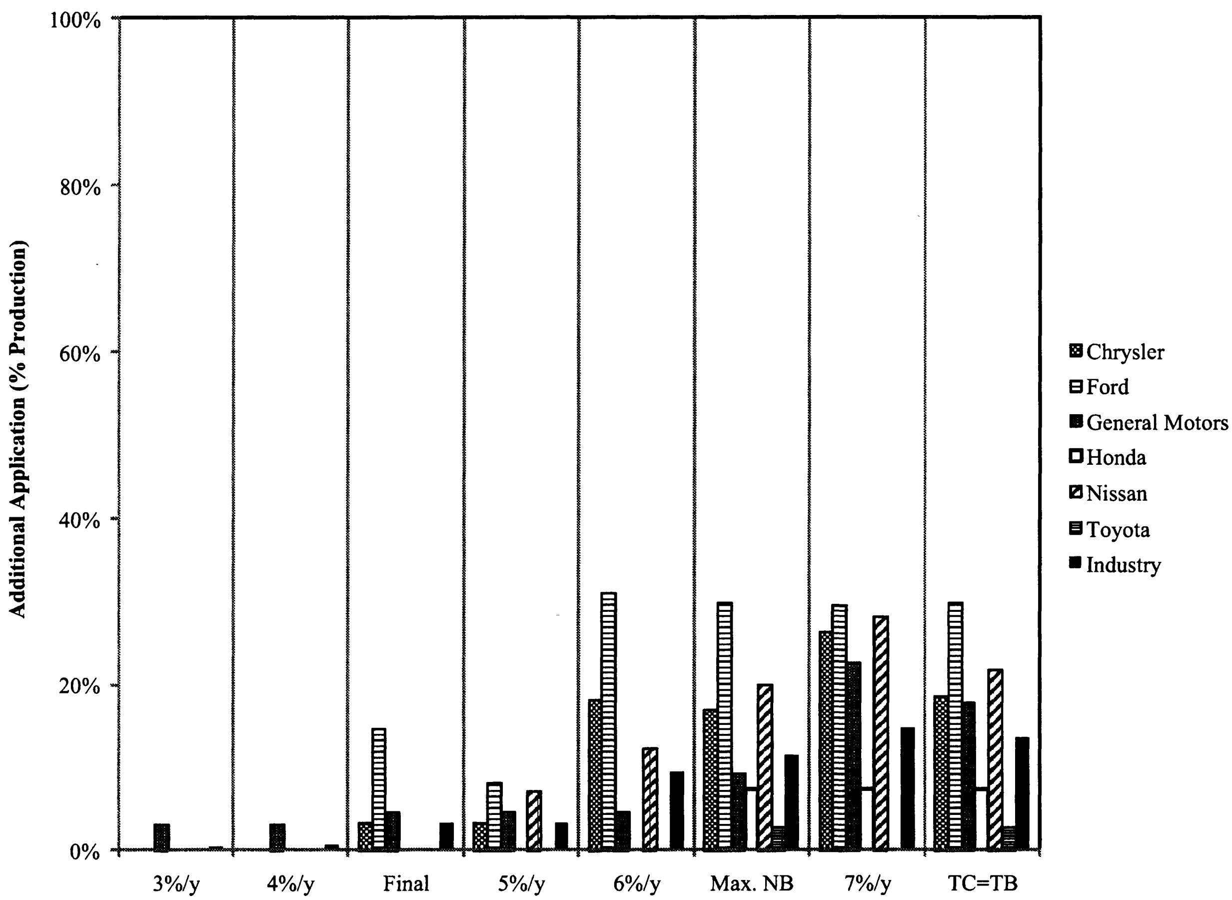
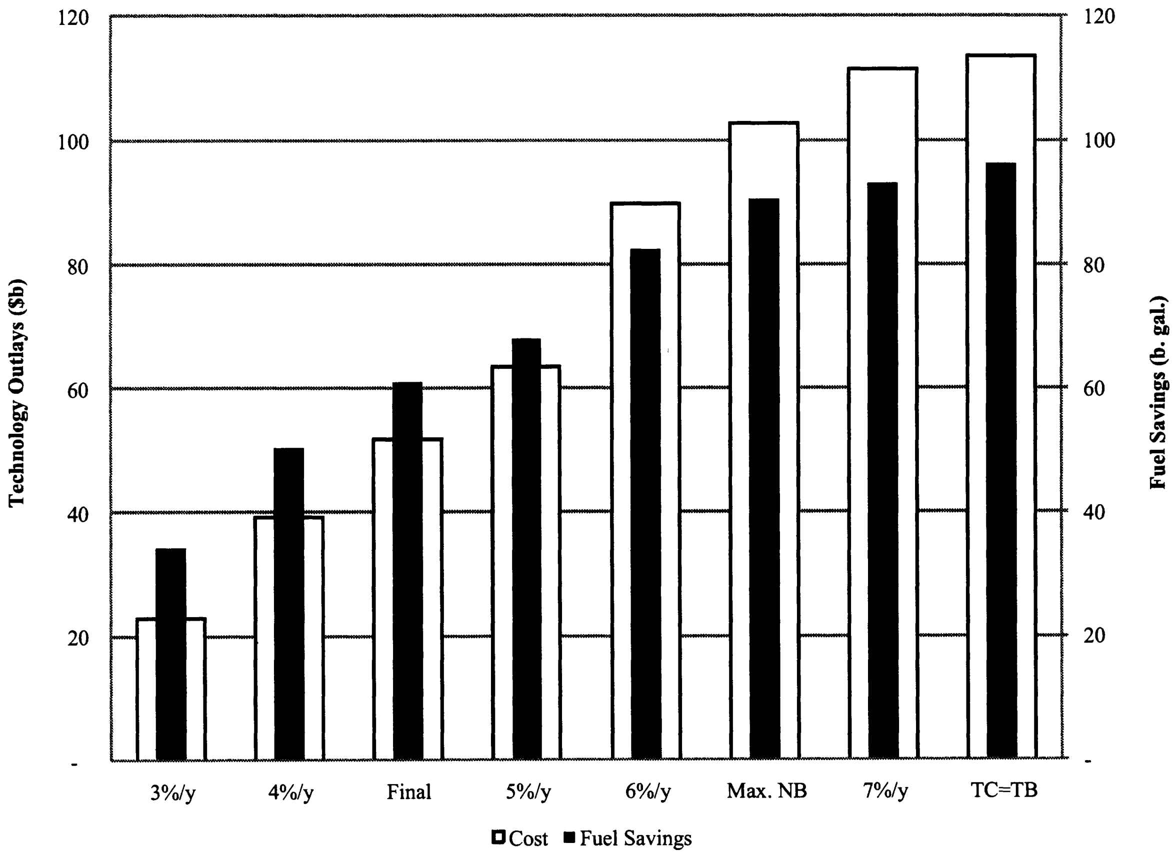


Figure IV.F-6 Additional Application of CISG and Strong HEV Systems (MY 2016)



The modeling analysis demonstrates that applying these technologies, of course, results in fuel savings. 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 and related cost presented above for the industry to the corresponding cumulative fuel savings.

Figure IV.F-7 Incremental Technology Outlays and Fuel Savings (MYs 2012-2016)



These incremental technology outlays (and corresponding fuel savings) also result in corresponding increases in incremental cost per vehicle, as shown below. 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 NHTSA's FRIA.

Figure IV.F-8 Average Incremental Per-Vehicle Costs (MY 2012)

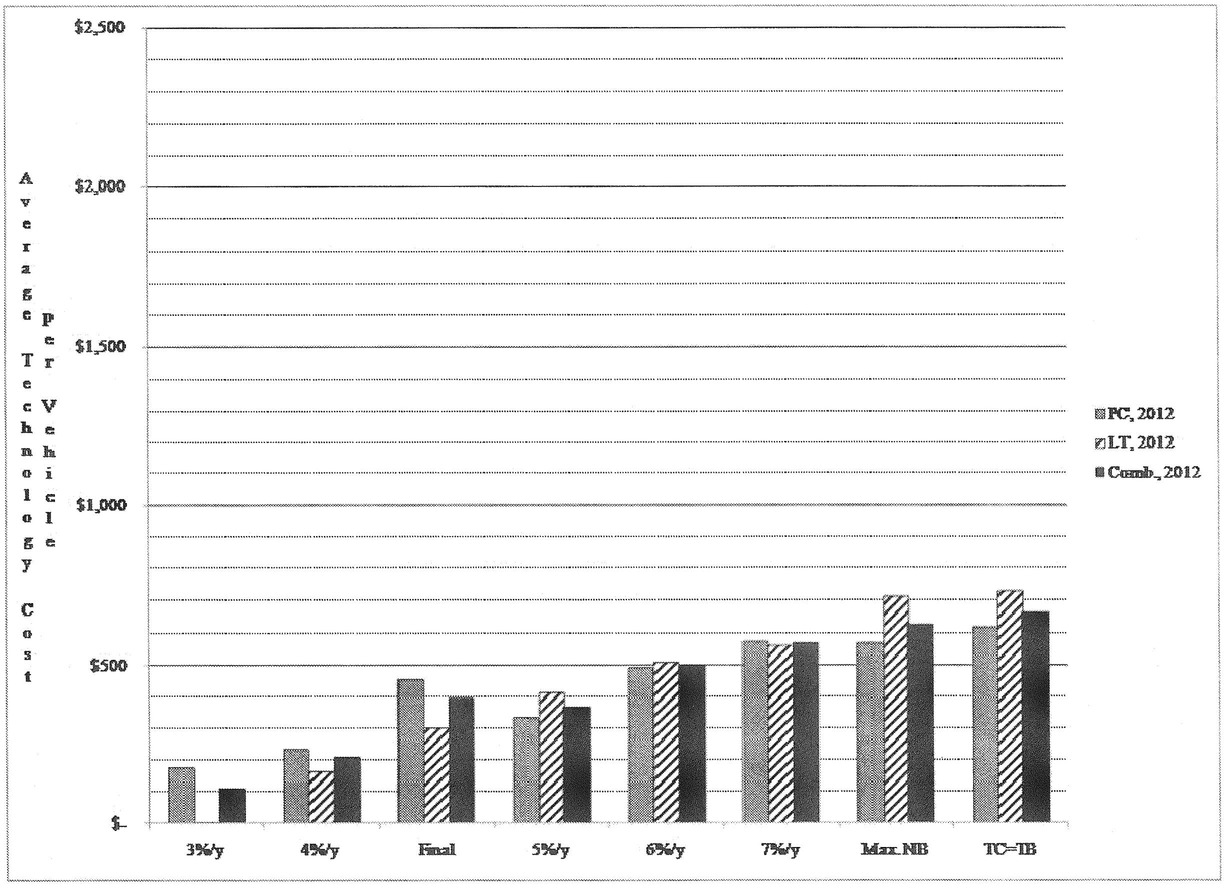


Figure IV.F-9 Average Incremental Per-Vehicle Costs (MY 2013)

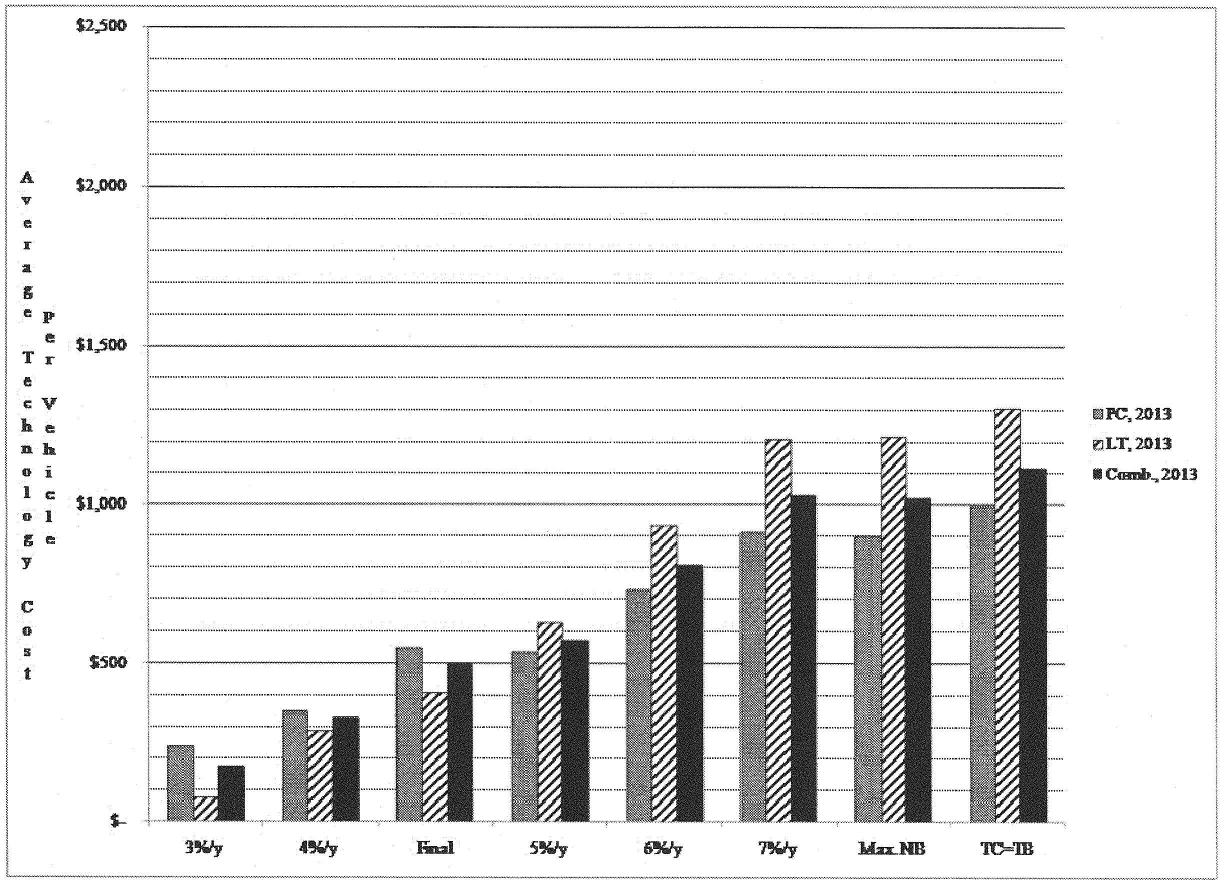


Figure IV.F-10 Average Incremental Per-Vehicle Costs (MY 2014)

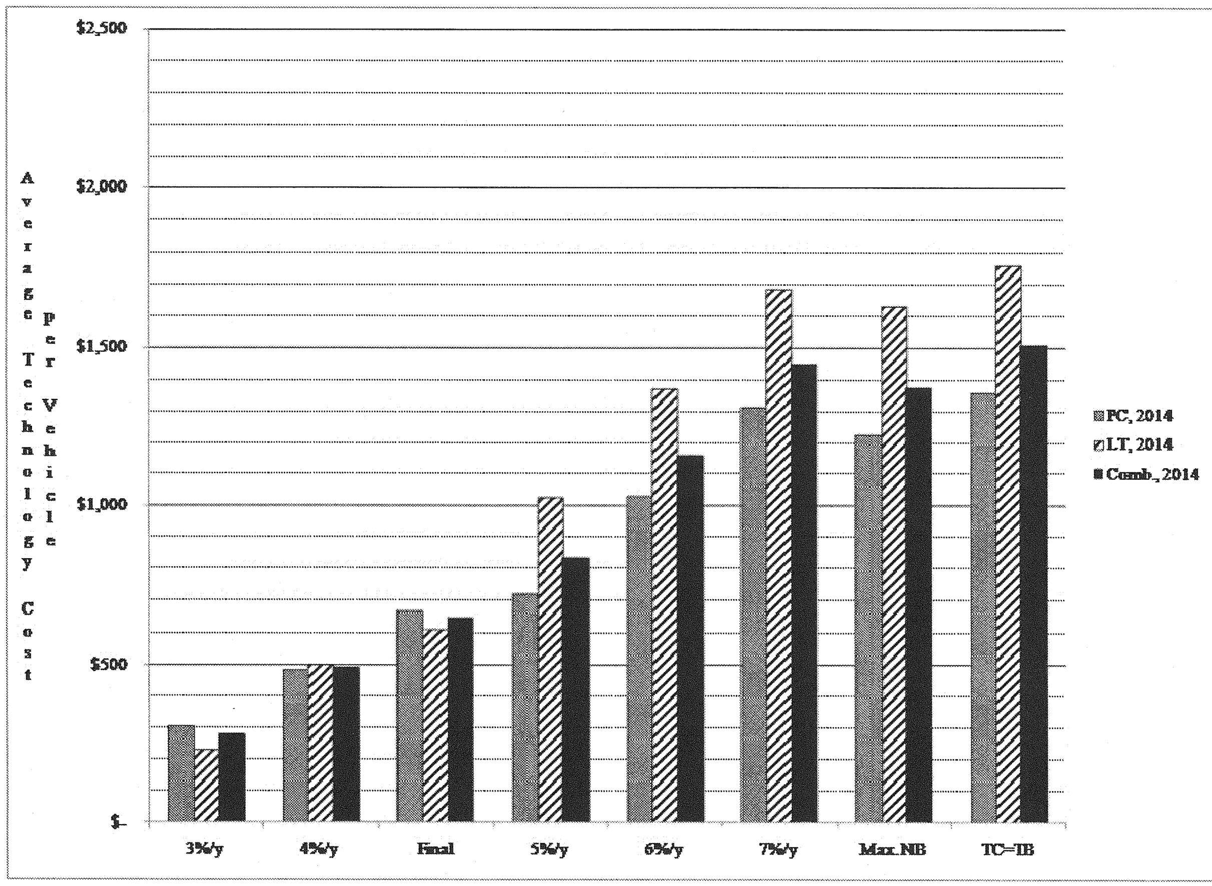


Figure IV.F-11 Average Incremental Per-Vehicle Costs (MY 2015)

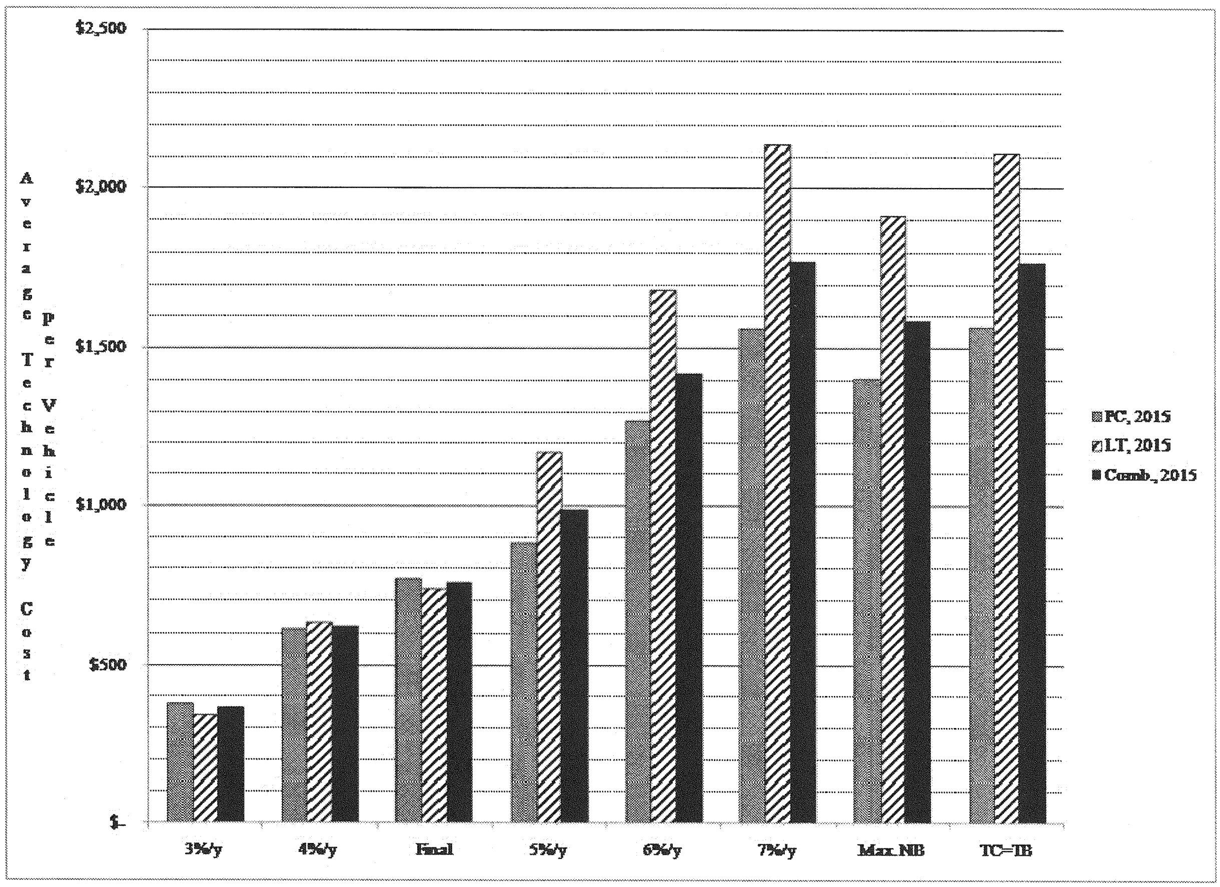
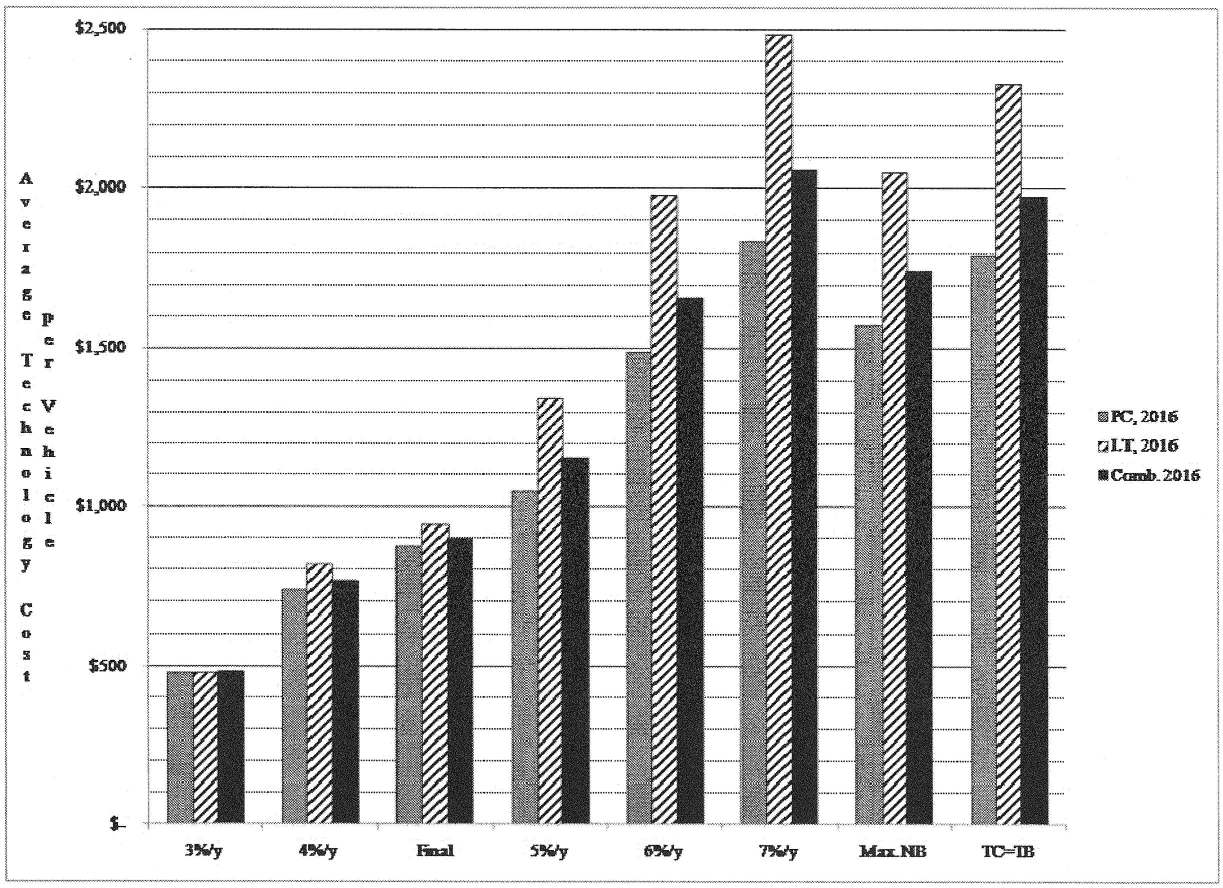


Figure IV.F-12 Average Incremental Per-Vehicle Costs (MY 2016)



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As discussed in the NPRM, 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. Additionally, given that CO_2 and fuel savings are very closely correlated, 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. And finally, neither the 3%/y nor the 4%/y alternatives 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. These alternatives would give inadequate weight to other standards of the Government, specifically EPA's and CARB's. Thus, the agency concluded that alternatives less stringent than the proposed standards would not yield the emissions reductions required to produce a harmonized national program and would not produce corresponding fuel savings, and therefore would not place adequate emphasis on the nation's need to conserve energy. NHTSA has therefore concluded that it must reject the 3%/y and 4%/y alternatives.

NHTSA then considered the "environmentally-preferable" alternative. Based on the information provided in the FEIS, the environmentally-preferable alternative would be that involving stringencies that increase at 7% annually.[707] 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 technology and cost required by the environmentally-preferable alternative and the lack of lead time to achieve such levels between now and MY 2016, as discussed further below, NHTSA concludes that the environmentally-preferable alternative would not be economically practicable or technologically feasible, and thus concludes that it would result in standards that would be beyond the level achievable for MYs 2012–2016.

For the other alternatives, NHTSA determined that it would be inappropriate to choose any of the other more stringent alternatives due to concerns over lead time and economic practicability. There are real-world technological and economic 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. The alternatives more stringent than the final standards begin to accrue costs considerably more rapidly than they accrue fuel savings and emissions reductions, and at levels that are increasingly economically burdensome, especially considering the need to make underlying investments (*e.g.,* for

[707] *See, e.g.,* FEIS, figure S–12, p. 18, which shows that 7%/y alternative yields greatest cumulative effect on global mean temperature.

engineering and tooling) well in advance of actual production. As shown in Figures IV–2 to IV–6 above, while the final standards already require aggressive application of technologies, more stringent standards would require more widespread use (including more substantial implementation of advanced technologies such as stoichiometric gasoline direct injection engines, diesel engines, and strong hybrids), and would raise serious issues of adequacy of lead time, not only to meet the standards but to coordinate such significant changes with manufacturers' redesign cycles. The agency maintains, as it has historically, that there is an important distinction between considerations of technological feasibility and economic practicability, both of which enter into the agency's determination of the maximum feasible levels of stringency. A given level of performance may be technologically feasible (*i.e.,* setting aside economic constraints) for a given vehicle model. However, it would not be economically practicable to require a level of fleet average performance that assumes every vehicle will immediately (*i.e.,* within 18 months of the rule's promulgation) perform at its highest technologically feasible level, because manufacturers do not have unlimited access to the financial resources or the time required to hire enough engineers, build enough facilities, and install enough tooling. The lead time reasonably needed to make capital investments and to devote the resources and time to design and prepare for commercial production of a more fuel efficient vehicle is an important element that NHTSA takes into consideration in establishing the standards.

In addition, the figures presented above reveal that increasing stringency beyond the final standards would entail significant additional application of technology. Among the more stringent alternatives, the one closest in stringency to the standards being finalized 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 11% and 8% higher, respectively, than the final standards. However, compared to the final standards, this alternative would increase outlays for new technologies during MY 2012–2016 by about 22%, or $12b. Average MY 2016 cost increases would, in turn, rise from $903 under the final standards to $1,152 when stringency increases at 5% annually. This represents a 28% 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). Additionally, the 5%/y alternative disproportionally burdens the light truck fleet requiring a nearly $400 (42 percent) cost increase in MY 2016 compared to the final standards. 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	3	4	24	184	585
Chrysler	734	1,303	1,462	1,653	1,727
Daimler			410	801	1,109
Ford	743	1,245	1,261	1,583	1,923
General Motors	448	823	1,187	1,425	1,594
Honda	50	109	271	375	606
Hyundai	747	877	1,057	1,052	1,124
Kia	49	128	197	261	369
Mazda	555	718	1,166	1,407	1,427
Mitsubishi	534	507	2,534	3,213	3,141
Nissan	294	491	965	1,064	1,125
Porsche	68	(52)	(51)	(50)	(49)
Subaru	292	324	1,372	1,723	1,679
Suzuki		959	1,267	1,316	1,540
Tata	111	93	183	306	710
Toyota	31	29	52	129	212
Volkswagen	145	428	477	492	783
Average	337	540	726	886	1,053

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	169	160	201	453	868
Chrysler	360	559	1,120	1,216	1,432
Daimler	60	55	51	52	51
Ford	1,207	1,663	1,882	2,258	2,225
General Motors	292	628	866	968	1,136
Honda	258	234	611	750	1,047
Hyundai	711	685	1,923	1,909	1,862
Kia	47	293	556	782	1,157
Mazda	248	408	419	519	768
Mitsubishi			1,037	1,189	1,556
Nissan	613	723	2,142	2,148	2,315
Porsche		(0)	(1)	469	469
Subaru	1,225	1,220	1,365	1,374	1,330
Suzuki		1,998	1,895	1,837	2,096

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
Tata					503
Toyota	63	187	594	734	991
Volkswagen			514	458	441
Average	415	628	1,026	1,173	1,343

TABLE IV.F–5—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER THE 5%/Y ALTERNATIVE CAFE STANDARDS FOR PASSENGER CARS AND LIGHT TRUCKS COMBINED

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	72	64	84	265	666
Chrysler	499	870	1,272	1,414	1,569
Daimler	20	20	281	554	773
Ford	914	1,407	1,498	1,838	2,034
General Motors	371	726	1,033	1,205	1,379
Honda	135	157	396	518	769
Hyundai	742	838	1,237	1,186	1,235
Kia	49	168	273	355	506
Mazda	500	667	1,053	1,272	1,330
Mitsubishi	371	352	1,973	2,386	2,506
Nissan	399	565	1,344	1,387	1,467
Porsche	52	(39)	(35)	130	124
Subaru	617	628	1,369	1,597	1,553
Suzuki		1,134	1,381	1,404	1,630
Tata	61	56	101	182	629
Toyota	43	82	239	333	466
Volkswagen	117	333	486	486	723
Average	367	573	836	987	1,152

These cost increases derive from increased application of advanced technologies as stringency increases past the levels in the final standards. For example, under the final standards, additional diesel application rates average 1.6% for the industry and range from 0% to 3% among Chrysler, Ford, GM, Honda, Nissan, and Toyota. Under standards increasing in combined stringency at 5% annually, these rates more than triple, averaging 6.2% for the industry and ranging from 0% to 21% for the same six manufacturers.

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 final 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 now and over the next few years, under the final standards. NHTSA believes that the final rule 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 Joint Technical Support Document and the agency's Regulatory Impact Analysis, the average model year 2016 per-vehicle cost increase of more than $900 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, are 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 reduction 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.

The agency concludes that the levels of technology penetration required by the final standards are reasonable. Increasing the standards beyond those levels would lead to rapidly increasing dependence on advanced technologies with higher costs—technology that, though perhaps technologically feasible for individual vehicle models, would, at the scales involved, pose too great an economic burden given the state of the industry, particularly in the early years of the rulemaking time frame.[708]

Therefore, the agency concluded that these more stringent alternatives would give insufficient weight to economic practicability and related lead time

[708] Although the final standards are projected to be slightly more costly than the 5% alternative in MY 2012, that alternative standard becomes progressively more costly than the final standards in the remaining model years. See Figures IV.F.8 through IV.F.10 above. Moreover, as discussed above, after MY 2012, the 5% alternative standard yields less incremental fuel economy benefits at increased cost (both industry-wide and per vehicle), directionally the less desirable result. These increased costs incurred to increase fuel economy through MY 2016 would impose significantly increased economic burden on the manufacturers in the next few calendar years to prepare for these future model years. In weighing the statutory factors, NHTSA accordingly rejected this alternative in favor of the final standard.

concerns, given the current state of the industry and the rate of increase in stringency that would be required. Overall, the agency concluded that among the alternatives considered by the agency, the proposed alternative contained the maximum feasible CAFE standards for MYs 2012–2016 as they were the most appropriate balance of the various statutory factors.

Some commenters argued that the agency should select a more stringent alternative than that proposed in the NPRM. The Union of Concerned Scientists (UCS) commented that NHTSA should set standards to produce the "maximum environmental benefit" available at "reasonable" cost, and at least at the stringency maximizing net benefits. Students from the University of California at Santa Barbara commented that the agency should have based standards not just on technologies known to be available, but also on technologies that may be available in the future—and should do so in order to force manufacturers to "reach" to greater levels of performance. Also, the Center for Biological Diversity (CBD) commented that, having conducted an unbiased cost-benefit analysis showing benefits three times the magnitude of costs for the proposed alternative, the agency should select a more stringent alternative. CBD also argued that the agency should have evaluated the extent to which manufacturers could deploy technology more rapidly than suggested by a five-year redesign cycle.

Conversely, other commenters argued that NHTSA should select a less stringent alternative, either in all model years or at least in the earlier model years. Chrysler, VW, and the Alliance of Automobile Manufacturers commented that the stringency of NHTSA's CAFE standards should be further reduced relative to that of EPA's GHG emissions standards, so that manufacturers would not be required by CAFE to add any tailpipe technology beyond what they thought would be necessary to meet an mpg level of 35.5 minus the maximum possible A/C credits that could be obtained under the EPA program. Also, Chrysler, Daimler, Toyota, Volkswagen, and the Alliance argued that the agency should reduce the rate of increase in stringency to produce steadier and more "linear" increases between MY 2011 and MY 2016. In addition, the Heritage Foundation commented that the proposed standards would, in effect, force accelerated progress toward EISA's "35 mpg by 2020" requirement, causing financially-stressed manufacturers to incur undue costs that would be passed along to consumers.

However, most commenters supported the agency's selection of the proposed standards. The American Chemical Society, the New York Department of Environmental Conservation, the Washington State Department of Ecology, and several individuals all expressed general support for the levels of stringency proposed by NHTSA as part of the joint proposal. General Motors and Nissan both indicated that the proposed standards are consistent with the National Program announced by the President and supported in letters of commitment signed by these companies' executives. Finally, the California Air Resources Board (CARB) strongly supported the stringency of the proposed standards, as well as the agencies' underlying technical analysis and weighing of statutory factors. CARB further commented that the stringency increases in the earlier model years are essential to providing environmental benefits at least as great as would be achieved through state-level enforcement of CARB's GHG emissions standards.[709]

The agency has considered these comments and all others, and having considered those comments, believes the final standards best balance all relevant factors that the agency considers when determining maximum feasible CAFE standards. As discussed below, having updated inputs to its analysis and correspondingly updated its definition and analysis of these regulatory alternatives, the agency continues to conclude that manufacturers can respond to the proposed standards with technologies that will be available at reasonable cost. The agency finds that alternatives less stringent that the one adopted today would leave too much technology "on the shelf" unnecessarily, thereby failing to deliver the fuel savings that the nation needs or to yield environmental benefits necessary to support a harmonized national program. In response to some manufacturers' suggestion that NHTSA's CAFE standards should be made even less stringent compared to EPA's GHG emissions standards, NHTSA notes that the difference, consistent with the underlying Notice of Intent, is based on the agencies' estimate of the *average* amount of air conditioning credit earned, not the maximum theoretically available, and that NHTSA's analysis indicates that most manufacturers can achieve the CAFE standards by MY 2016 using tailpipe technologies. This is fully consistent with the agency's historical position. As NHTSA explained in the NPRM, the Conference Report for EPCA, as enacted in 1975, makes clear, and applicable 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." *CEI–I,* 793 F.2d 1322, 1352 (DC Cir. 1986). 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.* Thus, 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.

While some manufacturers may find greater A/C improvements to be a more cost-effective way of meeting the GHG standards, that does not mean those manufacturers will be *unable* to meet the CAFE standards with tailpipe technologies. NHTSA's analysis has demonstrated a feasible path to compliance with the CAFE standards for most manufacturers using those technologies. "Economic practicability" means just that, practicability, and need not always mean what is "cheapest" or "most cost-effective" for a specific manufacturer. Moreover, many of the A/C improvements on which manufacturers intend to rely for meeting the GHG standards will reduce GHG emissions, specifically HFC emissions, but they will not lead to greater fuel savings.[710] The core purpose of the CAFE standards under EPCA is to reduce fuel consumption. NHTSA believes that less stringent standards would allow tailpipe fuel economy technologies to be left on the table that can be feasibly and economically applied, and failing to apply them would lead to a loss in fuel savings. This would not place appropriate emphasis on the core CAFE purpose of conserving fuel. For this reason, we decline to reduce the stringency of our standards as requested by some manufacturers. Similarly, we decline to pursue with EPA in this rulemaking the suggestion by one commenter that that

[709] Generally speaking, the cumulative benefits (in terms of fuel savings and GHG reductions) of front-loaded standards will be greater than standards that increase linearly.

[710] This is not to say that NHTSA means, in any way, to deter manufacturers from employing A/C technologies to meet EPA's standards, but simply to say that NHTSA's independent obligation to set maximum feasible CAFE standards to be met through application of tailpipe technologies alone must be fulfilled, while recognizing the flexibilities offered in another regulatory program.

agency's calculation authority under EPCA be used to provide A/C credits.

With respect to some manufacturers' concerns regarding the increase in stringency through MY 2013, the agency notes that stringency increases in these model years are especially important in terms of the accumulation of fuel savings and emission reductions over time. In addition, a weakening would risk failing to produce emission reductions at least as great as might be achieved through CARB's GHG standards. Therefore, the agency believes that alternatives less stringent than the one adopted today would not give sufficient emphasis to the nation's need to conserve energy. The requirement to set standards that increase ratably between MYs 2011 and 2020 must also be considered in the context of what levels of standards would be maximum feasible. The agency believes that the rate of increase of the final standards is reasonable.

On the other hand, the agency disagrees with comments by UCS, CBD, and others indicating that more stringent standards would be appropriate. As discussed above, alternatives more stringent than the one adopted today would entail a rapidly increasing dependence on the most expensive technologies and those which are technically more demanding to implement, with commensurately rapid increases in costs. In the agency's considered judgment, these alternatives are not economically practicable, nor do they provide correspondingly sufficient lead time. The agency also disagrees with CBD's assertion that NHTSA and EPA have been overly conservative in assuming an average redesign cycle of 5 years. There are some manufacturers who apply longer cycles (such as smaller manufacturers described above), there are others who have shorter cycles for some of their products, and there are some products (*e.g.,* cargo vans) that tend to be redesigned on longer cycles. NHTSA believes that there are no full line manufacturers who can maintain significant redesigns of vehicles (with relative large sales) in 1 or 2 years, and CBD has provided no evidence indicating this would be practicable. A complete redesign of the entire U.S. light-duty fleet by model year 2012 is clearly infeasible, and NHTSA and EPA believe that several model years additional lead time is necessary in order for the manufacturers to meet the most stringent standards. The graduated increase in the stringency of the standards from MYs 2012 through 2016 accounts for the economic necessity of timing the application of many major technologies to coincide with scheduled model redesigns.

In contrast, through analysis of the illustrative results shown above, as well as the more complete and detailed results presented in the accompanying FRIA, NHTSA has concluded that the final standards are technologically feasible and economically practicable. The final standards will require manufacturers to apply considerable additional technology, starting with very significant investment in technology design, development and capital investment called for in the next few years. Although NHTSA cannot predict how manufacturers *will* respond to the final 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 final 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 costly technologies, such as diesel engines and advanced technologies, such as strong HEVs.

As shown below, NHTSA estimates that the final standards could lead to average incremental costs ranging from $303 per vehicle (for light trucks in MY 2012) to $947 per vehicle (for light trucks in MY 2016), increasing steadily from $396 per vehicle for all light vehicles in MY 2012 to $903 for all light vehicle in MY 2016. NHTSA estimates that these costs would vary considerably among manufacturers, but would rarely exceed $1,800 per vehicle. The following three tables summarize estimated manufacturer-level average incremental costs for the final standards and the average of the passenger and light truck fleets:

TABLE IV.F–6—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER FINAL PASSENGER CAR CAFE STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	3	4	24	184	585
Chrysler	734	1,043	1,129	1,270	1,358
Daimler	....	....	410	801	1,109
Ford	1,619	1,537	1,533	1,713	1,884
General Motors	448	896	1,127	1,302	1,323
Honda	33	98	205	273	456
Hyundai	559	591	768	744	838
Kia	110	144	177	235	277
Mazda	555	656	799	854	923
Mitsubishi	534	460	1,588	1,875	1,831
Nissan	119	323	707	723	832
Porsche	68	(52)	(51)	(50)	(49)
Subaru	292	324	988	1,385	1,361
Suzuki	....	625	779	794	1,005
Tata	111	93	183	306	710
Toyota	31	29	41	121	126
Volkswagen	145	428	477	492	783
Average	455	552	670	774	880

TABLE IV.F–7—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER FINAL LIGHT TRUCK CAFE STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	252	239	277	281	701
Chrysler	360	527	876	931	1,170
Daimler	60	51	51	52	51
Ford	465	633	673	1,074	1,174
General Motors	292	513	749	807	986
Honda	233	217	370	457	806
Hyundai	693	630	1,148	1,136	1,113
Kia	400	467	582	780	1,137
Mazda	144	241	250	354	480
Mitsubishi			553	686	1,371
Nissan	398	489	970	1,026	1,362
Porsche		(1)	(1)	469	469
Subaru	1,036	995	1,016	1,060	1,049
Suzuki		1,797	1,744	1,689	1,732
Tata					503
Toyota	130	150	384	499	713
Volkswagen			514	458	441
Average	303	411	615	741	947

TABLE IV.F–8—AVERAGE INCREMENTAL COSTS ($/VEHICLE) UNDER FINAL CAFE STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	106	94	110	213	618
Chrysler	499	743	989	1,084	1,257
Daimler	20	18	281	554	773
Ford	1,195	1,187	1,205	1,472	1,622
General Motors	371	705	946	1,064	1,165
Honda	116	144	266	343	585
Hyundai	577	599	847	805	879
Kia	176	221	263	334	426
Mazda	482	587	716	778	858
Mitsubishi	371	319	1,200	1,389	1,647
Nissan	211	376	792	813	984
Porsche	52	(39)	(35)	130	124
Subaru	551	552	998	1,267	1,248
Suzuki		823	954	946	1,123
Tata	61	56	101	182	629
Toyota	67	70	159	248	317
Volkswagen	117	333	486	486	723
Average	396	498	650	762	903

In summary, NHTSA has considered eight regulatory alternatives, including the final 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 final 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, and would forego these benefits even though there is adequate lead time to implement reasonable and feasible technology for the vehicles. Conversely, the agency has concluded that more stringent standards would involve levels of additional technology and cost that would be economically impracticable and, correspondingly, would provide inadequate lead time, considering the economic 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 final standards,[711] NHTSA concludes that the final 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 Final CAFE Standards

1. How will these 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

[711] *See* Section IV.G.7 below.

economy requirement of 34.1 mpg in that model year:

TABLE IV.G.1–1—ESTIMATED AVERAGE REQUIRED FUEL ECONOMY (mpg) UNDER FINAL STANDARDS

Model year	2012	2013	2014	2015	2016
Passenger Cars	33.3	34.2	34.9	36.2	37.8
Light Trucks	25.4	26.0	26.6	27.5	28.8
Combined	29.7	30.5	31.3	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 [712] in some model years and overcomply [713] in others, reaching a combined average fuel economy of 33.7 mpg in MY 2016: [714]

TABLE IV.G.1–2—ESTIMATED AVERAGE ACHIEVED FUEL ECONOMY (mpg) UNDER FINAL STANDARDS

Model year	2012	2013	2014	2015	2016
Passenger Cars	32.8	34.4	35.3	36.3	37.2
Light Trucks	25.1	26.0	27.0	27.6	28.5
Combined	29.3	30.6	31.7	32.6	33.7

NHTSA estimates that these fuel economy increases will lead to fuel savings totaling 61 billion gallons during the useful lives of vehicles manufactured in MYs 2012–2016:

TABLE IV.G.1–3—FUEL SAVED (BILLION GALLONS) UNDER FINAL STANDARDS

Model year	2012	2013	2014	2015	2016	Total
Passenger Cars	2.4	5.2	7.2	9.4	11.4	35.7
Light Trucks	1.8	3.7	5.3	6.5	8.1	25.4
Combined	4.2	8.9	12.5	16.0	19.5	61.0

The agency also estimates that these new CAFE standards will lead to corresponding reductions of CO_2 emissions totaling 655 million metric tons (mmt) during the useful lives of vehicles sold in MYs 2012–2016:

TABLE IV.G.1–4—CARBON DIOXIDE EMISSIONS (mmt) AVOIDED UNDER FINAL STANDARDS

Model year	2012	2013	2014	2015	2016	Total
Passenger Cars	25	54	77	101	123	380
Light Trucks	19	40	57	71	88	275
Combined	44	94	134	172	210	655

2. How will these 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 being finalized today for MY 2016 would be established for subsequent model years, the effects of the final 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 new 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 standards as stringent as those established for MY 2016.

As Table IV.G.2–1 shows, NHTSA estimates that the fuel economy

[712] 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.

[713] 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).

[714] 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.

increases resulting from the final standards will lead to reductions in total fuel consumption by cars and light trucks of 10 billion gallons during 2020, increasing to 32 billion gallons by 2050. Over the period from 2012, when the final standards would begin to take effect, through 2050, cumulative fuel savings would total 729 billion gallons, as Table IV.G.2–1 also indicates.

TABLE IV.G.2–1—REDUCTION IN FLEET-WIDE FUEL USE (BILLION GALLONS) UNDER FINAL STANDARDS

Calendar year	2020	2030	2040	2050	Total, 2012–2050
Passenger Cars	6	13	17	21	469
Light Trucks	4	7	9	11	260
Combined	10	20	26	32	729

The energy security analysis conducted for this rule estimates that the world price of oil will fall modestly in response to lower U.S. demand for refined fuel. One potential result of this decline in the world price of oil would be an increase in the consumption of petroleum products outside the U.S., which would in turn lead to a modest increase in emissions of greenhouse gases, criteria air pollutants, and airborne toxics from their refining and use. While additional information would be needed to analyze this "leakage effect" in detail, NHTSA provides a sample estimate of its potential magnitude in its Final EIS.[715] This analysis indicates that the leakage effect is likely to offset only a modest fraction of the reductions in emissions projected to result from the rule.

As a consequence of these reductions in fleet-wide fuel consumption, the agency also estimates that the new 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 annual CO_2 emissions associated with passenger car and light truck use in the U.S. use will decline by 116 million metric tons (mmt) in 2020 as a consequence of the new standards, as Table IV.G.2–2 reports. The table also shows that the this annual reduction is estimated to grow to nearly 400 million metric tons by the year 2050, and will total nearly 9 billion metric tons over the period from 2012, when the final 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 FINAL STANDARDS

Calendar year	2020	2030	2040	2050	Total, 2012–2050
Passenger Cars	69	153	205	255	5,607
Light Trucks	49	89	112	136	3,208
Combined	117	242	316	391	8,815

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, based on analysis documented in the final Environmental Impact Statement (EIS) that informed the agency's decisions regarding this rule, 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	3.125	−0.011
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%

[715] NHTSA Final Environmental Impact Statement: Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2012–2016, February 2010, page 3–14.

3. How will these final 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 new 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 new 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.[716]

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 final standards during calendar year 2030. By that date, the majority of light-duty vehicles in use will have met the MY 2016 CAFE standards, so these reductions provide a useful index of the long-term impact of the final 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	2,718	465	−2,442	2,523
	Fuel production and distribution	−20,970	−2,831	−12,698	−75,342
	All sources	−18,252	−2,366	−15,140	−72,820
Light Trucks	Vehicle use	3,544	176	−1,420	1,586
	Fuel production and distribution	−12,252	−1,655	−7,424	−43,763
	All sources	−8,707	−1,479	−8,845	−42,177
Total	Vehicle use	6,263	642	−3,862	4,108
	Fuel production and distribution	−33,222	−4,487	−20,122	−119,106
	All sources	−26,959	−3,845	−23,984	−114,997

TABLE IV.G.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	72	18	59
	Fuel production and distribution	−161	−2	−58
	All sources	−89	16	1
Light Trucks	Vehicle use	38	10	65
	Fuel production and distribution	−94	−1	−34
	All sources	−55	9	32
Total	Vehicle use	111	28	124
	Fuel production and distribution	−254	−3	−91
	All sources	−144	25	33

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

[716] As stated elsewhere, while the agency's analysis assumes that all changes in upstream emissions result from a decrease in petroleum production and transport, the analysis of non-GHG emissions in future calendar years also assumes that retail gasoline composition is unaffected by this rule; as a result, the impacts of this rule on downstream non-GHG emissions (more specifically, on air toxics) may be underestimated. *See* also Section III.G above for more information.

population exposure to unhealthful atmospheric concentrations of $PM_{2.5}$. The estimates reported in Table IV.G.3–2, based on analysis documented in the final Environmental Impact Statement (EIS) that informed the agency's decisions regarding this rule, 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. However, emissions changes and dollar-per-ton estimates alone are not necessarily a good indication of local or regional air quality and health impacts, as there may be localized impacts associated with this rulemaking, because the atmospheric chemistry related to ambient concentrations of $PM_{2.5}$, ozone, and air toxics is very complex. Full-scale photochemical modeling provides the necessary 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. Although EPA conducted such modeling for purposes of the final rule, it was not available in time to be included in NHTSA's FEIS. See Section III.G above for EPA's description of the full-scale air quality modeling it conducted for the 2030 calendar year in an effort to capture this variability.

TABLE IV.G.3–2—PROJECTED REDUCTIONS IN HEALTH IMPACTS OF EXPOSURE TO CRITERIA AIR POLLUTANTS FROM FINAL STANDARDS

[Calendar year 2030]

Health impact	Measure	Projected reduction (2030)
Mortality (ages 30 and older)	premature deaths per year	243 to 623.
Chronic Bronchitis	cases per year	160.
Emergency Room Visits for Asthma	number per year	222.
Work Loss	workdays per year	28,705.

4. What are the estimated costs and benefits of these final standards?

NHTSA estimates that the final 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.

TABLE IV.G.4–1—ADDITION OF TECHNOLOGIES TO PASSENGER CAR FLEET UNDER FINAL STANDARDS

Technology	MY 2012 (percent)	MY 2013 (percent)	MY 2014 (percent)	MY 2015 (percent)	MY 2016 (percent)
Low Friction Lubricants	14	18	19	21	21
Engine Friction Reduction	15	37	41	43	52
VVT—Coupled Cam Phasing (CCP) on SOHC	2	3	3	5	7
Discrete Variable Valve Lift (DVVL) on SOHC	0	1	1	4	4
Cylinder Deactivation on SOHC	0	0	0	0	0
VVT—Intake Cam Phasing (ICP)	0	0	0	0	0
VVT—Dual Cam Phasing (DCP)	11	15	16	17	24
Discrete Variable Valve Lift (DVVL) on DOHC	9	19	22	23	29
Continuously Variable Valve Lift (CVVL)	0	0	0	0	0
Cylinder Deactivation on DOHC	0	0	0	1	2
Cylinder Deactivation on OHV	0	1	1	1	1
VVT—Coupled Cam Phasing (CCP) on OHV	0	1	2	2	2
Discrete Variable Valve Lift (DVVL) on OHV	0	1	1	2	3
Conversion to DOHC with DCP	0	0	0	0	0
Stoichiometric Gasoline Direct Injection (GDI)	9	18	21	24	28
Combustion Restart	0	0	1	4	9
Turbocharging and Downsizing	8	14	16	19	21
Exhaust Gas Recirculation (EGR) Boost	0	8	10	13	17
Conversion to Diesel following TRBDS	2	2	2	2	2
Conversion to Diesel following CBRST	0	0	0	0	0
6-Speed Manual/Improved Internals	1	1	1	1	1
Improved Auto. Trans. Controls/Externals	0	3	4	1	−3
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	12	26	34	47	54
Electric Power Steering	9	22	25	26	38
Improved Accessories	18	25	27	31	41
12V Micro-Hybrid	0	0	0	0	0
Belt mounted Integrated Starter Generator	4	11	19	24	25

TABLE IV.G.4–1—ADDITION OF TECHNOLOGIES TO PASSENGER CAR FLEET UNDER FINAL STANDARDS—Continued

Technology	MY 2012 (percent)	MY 2013 (percent)	MY 2014 (percent)	MY 2015 (percent)	MY 2016 (percent)
Crank mounted Integrated Starter Generator	3	3	3	3	3
Power Split Hybrid	2	2	2	2	2
2-Mode Hybrid	0	0	0	0	0
Plug-in Hybrid	0	0	0	0	0
Mass Reduction (1.5)	18	26	32	39	46
Mass Reduction (3.5 to 8.5)	0	0	17	31	40
Low Rolling Resistance Tires	4	16	23	32	35
Low Drag Brakes	2	3	4	4	6
Secondary Axle Disconnect—Unibody	0	0	0	0	0
Secondary Axle Disconnect—Ladder Frame	1	2	2	2	2
Aero Drag Reduction	6	20	29	34	38

TABLE IV.G.4–2—ADDITION OF TECHNOLOGIES TO LIGHT TRUCK FLEET UNDER FINAL STANDARDS

Technology	MY 2012 (percent)	MY 2013 (percent)	MY 2014 (percent)	MY 2015 (percent)	MY 2016 (percent)
Low Friction Lubricants	18	20	22	23	23
Engine Friction Reduction	14	34	35	40	51
VVT—Coupled Cam Phasing (CCP) on SOHC	2	3	3	2	2
Discrete Variable Valve Lift (DVVL) on SOHC	1	2	2	2	3
Cylinder Deactivation on SOHC	6	6	6	6	5
VVT—Intake Cam Phasing (ICP)	0	0	0	1	1
VVT—Dual Cam Phasing (DCP)	6	8	13	13	17
Discrete Variable Valve Lift (DVVL) on DOHC	9	12	17	17	18
Continuously Variable Valve Lift (CVVL)	0	0	0	0	0
Cylinder Deactivation on DOHC	1	1	1	1	0
Cylinder Deactivation on OHV	0	1	1	2	7
VVT—Coupled Cam Phasing (CCP) on OHV	0	0	0	0	13
Discrete Variable Valve Lift (DVVL) on OHV	0	13	14	19	19
Conversion to DOHC with DCP	0	0	0	0	0
Stoichiometric Gasoline Direct Injection (GDI)	12	17	23	24	31
Combustion Restart	0	0	3	5	18
Turbocharging and Downsizing	3	6	10	10	14
Exhaust Gas Recirculation (EGR) Boost	0	2	6	6	9
Conversion to Diesel following TRBDS	1	1	1	1	1
Conversion to Diesel following CBRST	0	0	0	0	0
6-Speed Manual/Improved Internals	0	0	0	0	0
Improved Auto. Trans. Controls/Externals	0	−11	−17	−28	−32
Continuously Variable Transmission	0	0	0	0	0
6/7/8-Speed Auto. Trans with Improved Internals	−2	−2	−2	−2	−1
Dual Clutch or Automated Manual Transmission	10	32	46	58	65
Electric Power Steering	7	11	11	20	27
Improved Accessories	7	9	10	15	23
12V Micro-Hybrid	0	0	0	0	0
Belt mounted Integrated Starter Generator	5	10	19	20	21
Crank mounted Integrated Starter Generator	0	0	0	0	0
Power Split Hybrid	1	1	1	1	1
2-Mode Hybrid	0	0	0	0	0
Plug-in Hybrid	0	0	0	0	0
Mass Reduction (1.5)	4	5	21	35	48
Mass Reduction (3.5 to 8.5)	0	0	19	33	54
Low Rolling Resistance Tires	11	12	13	16	17
Low Drag Brakes	14	32	30	31	40
Secondary Axle Disconnect—Unibody	0	0	0	0	0
Secondary Axle Disconnect—Ladder Frame	17	19	20	21	28
Aero Drag Reduction	13	15	20	22	25

TABLE IV.G.4–3—ADDITION OF TECHNOLOGIES TO OVERALL FLEET UNDER FINAL STANDARDS

Technology	MY 2012 (percent)	MY 2013 (percent)	MY 2014 (percent)	MY 2015 (percent)	MY 2016 (percent)
Low Friction Lubricants	16	18	20	22	22
Engine Friction Reduction	15	36	39	42	51
VVT—Coupled Cam Phasing (CCP) on SOHC	2	3	3	4	5
Discrete Variable Valve Lift (DVVL) on SOHC	0	1	2	3	3
Cylinder Deactivation on SOHC	2	3	2	2	2
VVT—Intake Cam Phasing (ICP)	0	0	0	0	0

TABLE IV.G.4–3—ADDITION OF TECHNOLOGIES TO OVERALL FLEET UNDER FINAL STANDARDS—Continued

Technology	MY 2012 (percent)	MY 2013 (percent)	MY 2014 (percent)	MY 2015 (percent)	MY 2016 (percent)
VVT—Dual Cam Phasing (DCP)	9	13	15	16	22
Discrete Variable Valve Lift (DVVL) on DOHC	9	16	20	21	25
Continuously Variable Valve Lift (CVVL)	0	0	0	0	0
Cylinder Deactivation on DOHC	0	1	0	1	1
Cylinder Deactivation on OHV	0	1	1	1	3
VVT—Coupled Cam Phasing (CCP) on OHV	0	1	1	1	6
Discrete Variable Valve Lift (DVVL) on OHV	0	6	6	8	8
Conversion to DOHC with DCP	0	0	0	0	0
Stoichiometric Gasoline Direct Injection (GDI)	10	17	22	24	29
Combustion Restart	0	0	1	4	12
Turbocharging and Downsizing	6	11	14	16	19
Exhaust Gas Recirculation (EGR) Boost	0	6	8	11	14
Conversion to Diesel following TRBDS	1	2	2	2	2
Conversion to Diesel following CBRST	0	0	0	0	0
6-Speed Manual/Improved Internals	0	0	0	0	1
Improved Auto. Trans. Controls/Externals	0	−2	−4	−10	−13
Continuously Variable Transmission	0	0	0	0	0
6/7/8-Speed Auto. Trans with Improved Internals	−1	0	0	0	1
Dual Clutch or Automated Manual Transmission	11	28	38	51	58
Electric Power Steering	8	18	20	24	34
Improved Accessories	13	19	21	25	35
12V Micro-Hybrid	0	0	0	0	0
Belt mounted Integrated Starter Generator	5	11	19	23	23
Crank mounted Integrated Starter Generator	2	2	2	2	2
Power Split Hybrid	2	2	2	1	1
2-Mode Hybrid	0	0	0	0	0
Plug-in Hybrid	0	0	0	0	0
Mass Reduction (1.5)	13	18	28	37	47
Mass Reduction (3.5 to 8.5)	0	0	18	32	45
Low Rolling Resistance Tires	7	14	19	26	29
Low Drag Brakes	6	14	14	14	18
Secondary Axle Disconnect—Unibody	0	0	0	0	0
Secondary Axle Disconnect—Ladder Frame	7	8	8	8	11
Aero Drag Reduction	9	18	26	30	34

In order to pay for this additional technology (and, for some manufacturers, civil penalties), NHTSA estimates that the cost of an average passenger car and light truck will, relative to levels resulting from compliance with baseline (MY 2011) standards, increase by $505–$907 and $322–$961, respectively, during MYs 2011–2016. The following tables summarize the agency's estimates of average cost 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 COST INCREASES ($) UNDER FINAL STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	157	196	255	443	855
Chrysler	794	1,043	1,129	1,270	1,358
Daimler	160	198	564	944	1,252
Ford	1,641	1,537	1,533	1,713	1,884
General Motors	552	896	1,127	1,302	1,323
Honda	33	98	205	273	456
Hyundai	559	591	768	744	838
Kia	110	144	177	235	277
Mazda	632	656	799	854	923
Mitsubishi	644	620	1,588	1,875	1,831
Nissan	119	323	707	723	832
Porsche	316	251	307	390	496
Subaru	413	472	988	1,385	1,361
Suzuki	242	625	779	794	1,005
Tata	243	258	370	532	924
Toyota	31	29	41	121	126
Volkswagen	293	505	587	668	964
Total/Average	505	573	690	799	907

TABLE IV.G.4–5—AVERAGE LIGHT TRUCK INCREMENTAL COST INCREASES ($) UNDER FINAL STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	252	272	338	402	827
Chrysler	409	527	876	931	1,170
Daimler	98	123	155	189	260
Ford	465	633	673	1,074	1,174
General Motors	336	513	749	807	986
Honda	233	217	370	457	806
Hyundai	693	630	1,148	1,136	1,113
Kia	406	467	582	780	1,137
Mazda	144	241	250	354	480
Mitsubishi	39	77	553	686	1,371
Nissan	398	489	970	1,026	1,362
Porsche	44	76	109	568	640
Subaru	1,036	995	1,016	1,060	1,049
Suzuki	66	1,797	1,744	1,689	1,732
Tata	66	110	137	198	690
Toyota	130	150	384	499	713
Volkswagen	44	77	552	557	606
Total/Average	322	416	621	752	961

TABLE IV.G.4–6—AVERAGE INCREMENTAL COST INCREASES ($) BY MANUFACTURER UNDER FINAL STANDARDS

Manufacturer	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
BMW	196	225	283	430	847
Chrysler	553	743	989	1,084	1,257
Daimler	139	171	417	695	937
Ford	1,209	1,187	1,205	1,472	1,622
General Motors	446	705	946	1,064	1,165
Honda	116	144	266	343	585
Hyundai	577	599	847	805	879
Kia	177	221	263	334	426
Mazda	545	587	716	778	858
Mitsubishi	459	453	1,200	1,389	1,647
Nissan	211	376	792	813	984
Porsche	250	207	243	452	544
Subaru	630	650	998	1,267	1,248
Suzuki	231	823	954	946	1,123
Tata	164	199	265	396	832
Toyota	67	70	159	248	317
Volkswagen	245	410	579	648	901
Total/Average	434	513	665	782	926

Based on the agencies' estimates of manufacturers' future sales volumes, these cost increases will lead to a total of $51.7 billion in incremental outlays during MYs 2012–2016 for additional technology attributable to the final standards:

TABLE IV.G.4–7—INCREMENTAL TECHNOLOGY OUTLAYS ($b) UNDER FINAL STANDARDS

	2012	2013	2014	2015	2016	Total
Passenger Cars	4.1	5.4	6.9	8.2	9.5	34.2
Light Trucks	1.8	2.5	3.7	4.3	5.4	17.6
Combined	5.9	7.9	10.5	12.5	14.9	51.7

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 is intended 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 final CAFE standards. Although these costs are difficult to estimate accurately, they nonetheless represent a notable category of omitted costs if they have not been adequately accounted for in the cost estimates. Similarly, the agency's estimates of net benefits for meeting higher CAFE standards does not estimate the economic value of potential changes in motor vehicle fatalities and injuries that could result from reductions in the size or weight of vehicles. While NHTSA reports a range of estimates of these potential safety effects below and in the FRIA (ranging from a net negative monetary impact to a net positive benefits for society), no estimate of their economic value is included in the agency's estimates of the net benefits resulting from the final standards.

Finally, while NHTSA is confident that the cost estimates are the best available and appropriate for purposes of this final rule, 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. 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 final standards.

However, offsetting these costs, the achieved increases in fuel economy will also produce significant benefits to society. NHTSA attributes most of these benefits to reductions in fuel consumption, valuing fuel savings at future pretax prices in EIA's reference case forecast from AEO 2010. The total benefits also include other benefits and dis-benefits, 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 FRIA accompanying today's final rule presents a detailed analysis of the rule's specific benefits.

As Table IV.G.4–8 shows, NHTSA estimates that at the discount rate of 3 percent prescribed in OMB guidance for regulatory analysis, the present value of total benefits from the final CAFE standards over the lifetimes of MY 2012–2016 passenger cars and light trucks will be $182.5 billion.

TABLE IV.G.4–8—PRESENT VALUE OF BENEFITS ($BILLION) UNDER FINAL STANDARDS USING 3 PERCENT DISCOUNT RATE [717]

	2012	2013	2014	2015	2016	Total
Passenger Cars	6.8	15.2	21.6	28.7	35.2	107.5
Light Trucks	5.1	10.7	15.5	19.4	24.3	75.0
Combined	11.9	25.8	37.1	48.0	59.5	182.5

Table IV.G.4–9 reports that the present value of total benefits from requiring cars and light trucks to achieve the fuel economy levels specified in the final CAFE standards for MYs 2012–16 will be $146.2 billion when discounted at the 7 percent rate also required by OMB guidance. Thus the present value of fuel savings and other benefits over the lifetimes of the vehicles covered by the final standards is $36.3 billion—or about 20 percent—lower when discounted at a 7 percent annual rate than when discounted using the 3 percent annual rate.[718]

TABLE IV.G.4–9—PRESENT VALUE OF BENEFITS ($BILLION) UNDER FINAL STANDARDS USING 7 PERCENT DISCOUNT RATE

	2012	2013	2014	2015	2016	Total
Passenger Cars	5.5	12.3	17.5	23.2	28.6	87.0
Light Trucks	4.0	8.4	12.2	15.3	19.2	59.2
Combined	9.5	20.7	29.7	38.5	47.8	146.2

For both the passenger car and light truck fleets, NHTSA estimates that the benefits of today's final standards will exceed the corresponding costs in every model year, so that the *net* social benefits from requiring higher fuel economy—the difference between the total benefits that result from higher fuel economy and the technology outlays required to achieve it—will be substantial. Because the technology outlays required to achieve the fuel economy levels required by the final standards are incurred during the model years when vehicles are produced and sold, however, they are not subject to discounting, so that their present value does not depend on the discount rate used.[719] Thus the net benefits of the final standards differ depending on whether the 3 percent or 7 percent discount rate is used, but only because the choice of discount rates affects the present value of total benefits, and not that of technology costs.

As Table IV.G.4–10 shows, over the lifetimes of the affected (MY 2012–2016)

[717] Unless otherwise indicated, all tables in Section IV report benefits calculated using the Reference Case input assumptions, with future benefits resulting from reductions in carbon dioxide emissions discounted at the 3 percent rate prescribed in the interagency guidance on the social cost of carbon.

[718] For tables that report total or net benefits using a 7 percent discount rate, future benefits from reducing carbon dioxide emissions are discounted at 3 percent, in order to maintain consistency with the discount rate used to develop the reference case estimate of the social cost of carbon. All other future benefits reported in these tables are discounted using the 7 percent rate.

[719] Although technology costs are incurred at the beginning of each model year's lifetime and thus are not subject to discounting, the discount rate does influence the effective cost of some technologies. Because NHTSA assumes some manufacturers will be willing to pay civil penalties when compliance costs become sufficiently high, It is still possible for the discount rate to affect the agency's estimate of total technology outlays. However, this does not occur under the alternative NHTSA has adopted for its final MY 2012–16 CAFE standards.

vehicles, the agency estimates that when the benefits of the final standards are discounted at a 3 percent rate, they will exceed the costs of the final standards by $130.7 billion:

TABLE IV.G.4–10—PRESENT VALUE OF NET BENEFITS ($BILLION) UNDER FINAL STANDARDS USING 3 PERCENT DISCOUNT RATE

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.7	9.7	14.8	20.5	25.7	73.3
Light Trucks	3.4	8.2	11.8	15.0	18.9	57.4
Combined	6.0	18.0	26.6	35.5	44.6	130.7

As indicated previously, when fuel savings and other future benefits resulting from the final standards are discounted at the 7 percent rate prescribed in OMB guidance, they are $36.3 billion lower than when the 3 percent discount rate is applied. Because technology costs are not subject to discounting, using the higher 7 percent discount rate reduces net benefits by exactly this same amount. Nevertheless, Table IV.G.4–11 shows that the net benefits from requiring passenger cars and light trucks to achieve higher fuel economy are still substantial even when future benefits are discounted at the higher rate, totaling $94.5 billion over MYs 2012–16. Net benefits are thus about 28 percent lower when future benefits are discounted at a 7 percent annual rate than at a 3 percent rate.

TABLE IV.G.4–11—PRESENT VALUE OF NET BENEFITS ($BILLION) UNDER FINAL STANDARDS USING 7 PERCENT DISCOUNT RATE

	2012	2013	2014	2015	2016	Total
Passenger Cars	1.3	6.8	10.6	15.0	19.0	52.9
Light Trucks	2.3	5.9	8.6	11.0	13.9	41.6
Combined	3.6	12.8	19.2	26.0	32.9	94.5

NHTSA's estimates of economic benefits from establishing higher CAFE standards are 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 MYs 2012–16 passenger cars and light trucks. Specifically, if the agency has underestimated the fuel economy levels that manufacturers would have achieved under the baseline scenario—or is too optimistic about the fuel economy levels that manufacturers will actually achieve under the final standards—its estimates of fuel savings and the resulting economic benefits attributable to this rule will be too large.

Another major source of potential overestimation in the agency's estimates of benefits from requiring higher fuel economy stems from its reliance on the Reference Case fuel price forecasts reported in AEO 2010. Although NHTSA believes that these forecasts are the most reliable that are available, they are nevertheless significantly higher than the fuel price projections reported in most previous editions of EIA's Annual Energy Outlook, and reflect projections of world oil prices that are well above forecasts issued by other firms and government agencies. If the future fuel prices projected in AEO 2010 prove to be too high, the agency's estimates of the value of future fuel savings—the major component of benefits from this rule—will also be too high.

In addition, it is possible that NHTSA's estimates of economic benefits from the effects of saving fuel on U.S. petroleum consumption and imports are too high. The estimated "energy security premium" the agency uses to value reductions in U.S. petroleum imports includes both increased payments for petroleum imports that occur when world oil prices increase rapidly, and losses in U.S. GDP losses and adjustment costs that result from oil price shocks. One commenter suggested increased import costs associated with rapid increases in petroleum prices represent transfers from U.S. oil consumers to petroleum suppliers rather than real economic costs, so any reduction in their potential magnitude should be excluded when calculating benefits from lower U.S. petroleum imports. If this view is correct, then the agency's estimates of benefits from the effect of reduced fuel consumption on U.S. petroleum imports would indeed be too high.[720]

However, it is also possible that NHTSA's estimates of economic benefits from establishing higher CAFE standards *under*estimate the true economic benefits of the fuel savings those standards would produce. If the AEO 2010 forecast of fuel prices proves to be too low, for example, NHTSA will have underestimated the value of fuel savings that will result from adopting higher CAFE standards for MY 2012–16. 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

[720] Doing so, however, would represent a significant departure from how disruption costs associated with oil price shocks have been quantified in research on the value of energy security, and NHTSA believes this issue should be analyzed in more detail before these costs are excluded. Moreover, the agency believes that increases in import costs during oil supply disruptions differ from transfers due to the existence of U.S. monopsony power in the world oil market, since they reflect real resource shortages and costly short-run shifts in demand by energy users, rather than losses to consumers of petroleum products that that are matched by offsetting gains to suppliers. Thus the agency believes that reducing their expected value provides real economic benefits, and they do not represent pure transfers.

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.

NHTSA's benefit estimates could also be too low because they exclude or understate the economic value of certain potentially significant categories of benefits from reducing fuel consumption. As one example, EPA's estimates 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. EPA's estimates exclude these benefits because no reliable dollar-per-ton 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.

Similarly, 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.[721] For example, none of the three models used to value climate-related economic damages includes ocean acidification or loss of species and wildlife. The models also may not adequately capture certain other impacts, such as potentially abrupt changes in climate associated with thresholds that govern climate system responses, inter-sectoral and inter-regional interactions, including global security impacts of high-end extreme warming, or limited near-term substitutability between damage to natural systems and increased consumption. 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 following tables present itemized costs and benefits for the combined passenger car and light truck fleets for each model year affected by the final standards as well as for all model years combined, using both discount rates prescribed by OMB regulatory guidance. Table IV.G.4–12 reports technology outlays, each separate component of benefits (including costs associated with additional driving due to the rebound effect, labeled "dis-benefits"), the total value of benefits, and net benefits, using the 3 percent discount rate. (Numbers in parentheses represent negative values.)

TABLE IV.G.4–12—ITEMIZED COST AND BENEFIT ESTIMATES FOR THE COMBINED VEHICLE FLEET USING 3 PERCENT DISCOUNT RATE ($M)

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
Costs						
Technology Costs	5,903	7,890	10,512	12,539	14,904	51,748
Benefits						
Savings in Lifetime Fuel Expenditures	9,265	20,178	29,083	37,700	46,823	143,048
Consumer Surplus from Additional Driving	696	1,504	2,150	2,754	3,387	10,491
Value of Savings in Refueling Time	706	1,383	1,939	2,464	2,950	9,443
Reduction in Petroleum Market Externalities	545	1,154	1,630	2,080	2,543	7,952
Reduction in Climate-Related Damages from Lower CO_2 Emissions[722]	921	2,025	2,940	3,840	4,804	14,528
Reduction in Health Damage Costs from Lower Emissions of Criteria Air Pollutants:						
CO	0	0	0	0	0	0
VOC	42	76	102	125	149	494
NO_X	70	104	126	146	166	612
PM	205	434	612	776	946	2,974
SO_X	158	332	469	598	731	2,288
Dis-Benefits from Increased Driving:						
Congestion Costs	(447)	(902)	(1,282)	(1,633)	(2,000)	(6,264)
Noise Costs	(9)	(18)	(25)	(32)	(39)	(122)
Crash Costs	(217)	(430)	(614)	(778)	(950)	(2,989)
Total Benefits	11,936	25,840	37,132	48,040	59,509	182,457

[721] *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,* Interagency Working Group on Social Cost of Carbon, United States Government, February 2010. Available in Docket No. NHTSA–2009–0059.

[722] Using the central value of $21 per metric ton for the SCC, and discounting future benefits from reduced CO_2 emissions at a 3 percent annual rate. Additionally, we note that the $21 per metric ton value for the SCC applies to calendar year 2010, and increases over time. See the interagency guidance on SCC for more information.

TABLE IV.G.4–12—ITEMIZED COST AND BENEFIT ESTIMATES FOR THE COMBINED VEHICLE FLEET USING 3 PERCENT DISCOUNT RATE ($M)—Continued

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
Net Benefits	6,033	17,950	26,619	35,501	44,606	130,709

Similarly, Table IV.G.4–13 below reports technology outlays, the individual components of benefits (including "dis-benefits" resulting from additional driving) and their total, and net benefits, using the 7 percent discount rate. (Again, numbers in parentheses represent negative values.)

TABLE IV.G.4–13—ITEMIZED COST AND BENEFIT ESTIMATES FOR THE COMBINED VEHICLE FLEET USING 7 PERCENT DISCOUNT RATE ($M)

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016	Total
Costs						
Technology Costs	5,903	7,890	10,512	12,539	14,904	51,748
Benefits						
Savings in Lifetime Fuel Expenditures	7,197	15,781	22,757	29,542	36,727	112,004
Consumer Surplus from Additional Driving	542	1,179	1,686	2,163	2,663	8,233
Value of Savings in Refueling Time	567	1,114	1,562	1,986	2,379	7,608
Reduction in Petroleum Market Externalities	432	917	1,296	1,654	2,023	6,322
Reduction in Climate-Related Damages from Lower CO_2 Emissions [723]	921	2,025	2,940	3,840	4,804	14,530
Reduction in Health Damage Costs from Lower Emissions of Criteria Air Pollutants:						
CO	0	0	0	0	0	0
VOC	32	60	80	99	119	390
NO_X	53	80	98	114	131	476
PM	154	336	480	611	748	2,329
SO_X	125	265	373	475	581	1,819
Dis-Benefits from Increased Driving:						
Congestion Costs	(355)	(719)	(1,021)	(1,302)	(1,595)	(4,992)
Noise Costs	(7)	(14)	(20)	(26)	(31)	(98)
Crash Costs	(173)	(342)	(488)	(619)	(756)	(2,378)
Total Benefits	9,488	20,682	29,743	38,537	47,793	146,243
Net Benefits	3,586	12,792	19,231	25,998	32,890	94,497

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 final standards to a meaningful extent.

As discussed in the FRIA, 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 multi-year planning effects are represented, there is no basis to estimate reliably how manufacturers might use these mechanisms. Accounting for the FFV provisions indicates that achieved fuel economies would be 0.5–1.3 mpg lower than when these provisions are not considered (for comparison see Table IV.G.1–2 above):

[723] Using the central value of $21 per metric ton for the SCC, and discounting future benefits from reduced CO_2 emissions at a 3 percent annual rate. Additionally, we note that the $21 per metric ton value for the SCC applies to calendar year 2010, and increases over time. *See* the interagency guidance on SCC for more information.

TABLE IV.G.4–14—AVERAGE ACHIEVED FUEL ECONOMY (mpg) UNDER FINAL STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016
Passenger Cars	32.3	33.5	34.2	35.0	36.2
Light Trucks	24.5	25.1	25.9	26.7	27.5
Combined	28.7	29.7	30.6	31.5	32.7

As a result, NHTSA estimates that, when FFV credits are taken into account, fuel savings will total 58.6 billion gallons—about 3.9 percent less than the 61.0 billion gallons estimated when these credits are not considered:

TABLE IV.G.4–15—FUEL SAVED (BILLION GALLONS) UNDER FINAL STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.7	4.7	6.4	8.4	11.0	33.1
Light Trucks	2.3	3.6	5.0	6.6	8.1	25.5
Combined	4.9	8.2	11.3	15.0	19.1	58.6

The agency similarly estimates CO_2 emissions reductions will total 636 million metric tons (mmt), about 2.9 percent less than the 655 mmt estimated when these credits are not considered:[724]

TABLE IV.G.4–16—AVOIDED CARBON DIOXIDE EMISSIONS (mmt) UNDER FINAL STANDARDS (WITH FFV CREDITS)

	2012	2013	2014	2015	2016	Total
Passenger Cars	28	50	69	91	119	357
Light Trucks	25	39	54	72	88	279
Combined	53	89	123	163	208	636

This analysis further indicates that significant reductions in outlays for additional technology will result when FFV provisions are taken into account. Table IV.G.4–17 below shows that as a result, total technology costs are estimated to decline to $37.5 billion, or about 27 percent less than the $51.7 billion estimated when excluding these provisions:

TABLE IV.G.4–17—INCREMENTAL TECHNOLOGY OUTLAYS ($B) UNDER FINAL STANDARDS WITH FFV CREDITS

	2012	2013	2014	2015	2016	Total
Passenger Cars	2.6	3.6	4.8	6.1	7.5	24.6
Light Trucks	1.1	1.5	2.5	3.4	4.4	12.9
Combined	3.7	5.1	7.3	9.5	11.9	37.5

Because NHTSA's analysis indicated that FFV provisions will not significantly reduce fuel savings, the agency's estimate of the present value of total benefits will be $175.6 billion when discounted at a 3 percent annual rate, as Table IV.G.4–18 following reports. This estimate of total benefits is $6.9 billion, or about 3.8 percent, lower than the $182.5 billion reported previously for the analysis that excluded these provisions:

TABLE IV.G.4–18—PRESENT VALUE OF BENEFITS ($BILLION) UNDER FINAL STANDARDS WITH FFV CREDITS USING 3 PERCENT DISCOUNT RATE

	2012	2013	2014	2015	2016	Total
Passenger Cars	7.6	13.7	19.1	25.6	34.0	100.0
Light Trucks	6.4	10.4	14.6	19.8	24.4	75.6
Combined	14.0	24.1	33.7	45.4	58.4	175.6

[724] Differences in the application of diesel engines lead to differences in the incremental percentage changes in fuel consumption and carbon dioxide emissions.

Similarly, because the FFV are not expected to reduce fuel savings significantly, NHTSA estimates that the present value of total benefits will decline only slightly from its previous estimate when future fuel savings and other benefits are discounted at the higher 7 percent rate. Table IV.G.4–19 reports that the present value of benefits from requiring higher fuel economy for MY 2012–16 cars and light trucks will total $140.7 billion when discounted using a 7 percent rate, about $5.5 billion (or again, 3.8 percent) below the previous $146.2 billion estimate of total benefits when FFV credits were not permitted:

TABLE IV.G.4–19—PRESENT VALUE OF BENEFITS ($BILLION) UNDER FINAL STANDARDS WITH FFV CREDITS USING 7 PERCENT DISCOUNT RATE

	2012	2013	2014	2015	2016	Total
Passenger Cars	6.1	11.1	15.5	20.7	27.6	80.9
Light Trucks	5.0	8.2	11.5	15.6	19.3	59.7
Combined	11.2	19.3	27.0	36.4	46.9	140.7

Although the discounted present value of total benefits will be slightly lower when FFV provisions are taken into account, the agency estimates that these provisions will slightly *increase* net benefits. This occurs because the flexibility these provisions provide to manufacturers will allow them to reduce technology costs for meeting the new standards by considerably more than the reduction in the value of fuel savings and other benefits. As Table IV.G.4–20 shows, the agency estimates that the availability of FFV credits will increase net benefits from the final CAFE standards to $138.2 billion from the previously-reported estimate of $130.7 billion without those credits, or by about 5.7 percent.

TABLE IV.G.4–20—PRESENT VALUE OF NET BENEFITS ($BILLION) UNDER FINAL STANDARDS WITH FFV CREDITS USING 3% DISCOUNT RATE

	2012	2013	2014	2015	2016	Total
Passenger Cars	5.1	10.1	14.3	19.5	26.5	75.4
Light Trucks	5.3	8.8	12.1	16.4	20.0	62.7
Combined	10.4	19.0	26.5	35.9	46.5	138.2

Similarly, Table IV.G.4–21 immediately below shows that NHTSA estimates manufacturers' use of FFV credits will raise net benefits from requiring higher fuel economy for MY 2012–16 cars and light trucks to $103.2 billion if a 7 percent discount rate is applied to future benefits. This estimate is $8.7 billion—or about 9.2%—higher than the previously-reported $94.5 billion estimate of net benefits without the availability of FFV credits using that same discount rate.

TABLE IV.G.4–21—PRESENT VALUE OF NET BENEFITS ($BILLION) UNDER FINAL STANDARDS WITH FFV CREDITS USING 7% DISCOUNT RATE

	2012	2013	2014	2015	2016	Total
Passenger Cars	3.6	7.5	10.7	14.6	20.0	56.4
Light Trucks	3.9	6.6	9.1	12.3	14.9	46.8
Combined	7.5	14.1	19.7	26.9	35.0	103.2

The agency has also performed several sensitivity analyses to examine the effects of varying important assumptions that affect its estimates of benefits and costs from higher CAFE standards for MY 2012–16 cars and light trucks. We examine the sensitivity of fuel savings, total economic benefits, and technology costs with respect to the following five economic parameters:

(1) The price of gasoline: The Reference Case uses the AEO 2010 reference case estimate for the price of gasoline. In this sensitivity analysis we examine the effect of instead using the AEO 2009 high and low price forecasts.

(2) 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 instead using a 5 percent or 15 percent rebound effect.

(3) The values of CO_2 benefits: The Reference Case uses $21 per ton (in 2010 in 2007$, rising over time to $45 in 2030) to quantify the benefits of reducing CO_2 emissions and $0.17 per gallon to quantify the energy security benefits from reducing fuel consumption. In the sensitivity analysis, we examine the effect of using values of $5, and $65 per ton instead of the reference value of $21 per ton to value CO_2 benefits. These values can be translated into cents per gallon by multiplying by 0.0089,[725] giving the following values:

($5 per ton CO_2) × 0.0089 = $0.045 per gallon

[725] 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/1,000kg * kg/1,000g * 2,433g/gallon = (3.67 * 2,433)/1,000 * 1,000 = $0.0089/gallon.

($21 per ton CO_2) × 0.0089 = $0.187 per gallon
($35 per ton CO_2) × 0.0089 = $0.312 per gallon
($67 per ton CO_2) × 0.0089 = $0.596 per gallon

(4) 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 instead using a value of 5 cents per gallon.

Varying each of these four parameters in isolation results in 9 additional economic scenarios, in addition to the Reference case. These are listed in Table IV.G.4–22 below, together with two additional scenarios that use combinations of these parameters that together produce the lowest and highest benefits.

TABLE IV.G.4–22—SENSITIVITY ANALYSES EVALUATED IN NHTSA'S FRIA

Name	Fuel price	Discount rate (percent)	Rebound effect (percent)	SCC	Military security
Reference	AEO 20210 Reference Case	3	10	$21	0¢/gal.
High Fuel Price	AEO 2009 High Price Case	3	10	21	0¢/gal.
Low Fuel Price	AEO 2009 Low Price Case	3	10	21	0¢/gal.
5% Rebound Effect	AEO 20210 Reference Case	3	5	21	0¢/gal.
15% Rebound Effect	AEO 20210 Reference Case	3	15	21	0¢/gal.
$67/ton CO_2 Value	AEO 20210 Reference Case	3	10	67	0¢/gal.
$35/ton CO_2 Value	AEO 20210 Reference Case	3	10	35	0¢/gal.
$5/ton CO_2 Value	AEO 20210 Reference Case	3	10	5	0¢/gal.
$5/ton CO_2	AEO 20210 Reference Case	3	10	5	0¢/gal.
5¢/gal Military Security Value	AEO 20210 Reference Case	3	10	21	5¢/gal.
Lowest Discounted Benefits	AEO 2009 Low Price Case	7	15	5	0¢/gal.
Highest Discounted Benefits	AEO 2009 High Price Case	3	5	67	5¢/gal.

The basic results of the sensitivity analyses were as follows:

(1) The various economic assumptions have no effect on the final passenger car and light truck standards established by this rule, because these are determined without reference to economic benefits.

(2) Varying the economic assumptions *individually* has comparatively modest impacts on fuel savings resulting from the adopted standards. The range of variation in fuel savings in response to changes in individual assumptions extends from a reduction of nearly 5 percent to an increase of that same percentage.

(3) The economic parameter with the greatest impacts on fuel savings is the magnitude of the rebound effect. Varying the rebound effect from 5 percent to 15 percent is responsible for a 4.6 percent increase and 4.6 percent reduction in fuel savings compared to the Reference results.

(4) The only other parameter that has a significant effect on fuel savings is forecast fuel prices, although its effect is complex because changes in fuel prices affect vehicle use and fuel consumption in both the baseline and under the final standards.

(5) Variation in forecast fuel prices and in the value of reducing CO_2 emissions have significant effects on the total economic benefits resulting from the final standards. Changing the fuel price forecast to AEO's High Price forecast raises estimated economic benefits by almost 40 percent, while using AEO's Low Price forecast reduces total economic benefits by only about 5 percent. Raising the value of eliminating each ton of CO_2 emissions to $67 increases total benefits by 15 percent.

(6) Varying all economic parameters simultaneously has a significant effect on total economic benefits. The combination of parameter values producing the highest benefits increases their total by slightly more than 50 percent, while that producing the lowest benefits reduces their value by almost 55 percent. However, varying these parameters in combination has less significant effects on other measures; for example, the high- and low-benefit combinations of parameter values raise or lower fuel savings and technology costs by only about 5 percent.

For more detailed information regarding NHTSA's sensitivity analyses for this final rule, please see Chapter X of NHTSA's FRIA.

5. How would these final standards impact vehicle sales?

The effect of this rule on sales of new vehicles depends partly on how potential buyers evaluate and respond to its effects on vehicle prices and fuel economy. The rule will make new cars and light trucks more expensive, as manufacturers attempt to recover their costs for complying with the rule by raising vehicle prices, which by itself would discourage sales. At the same time, the rule will require manufacturers to improve the fuel economy of at least some of their models, which will lower their operating costs.

However, this rule will *not* change the way that potential buyers evaluate improved fuel economy. If some consumers find it difficult to estimate the value of future fuel savings and correctly compare it with the increased cost of purchasing higher fuel economy (possibilities discussed below in Section IV.G.6)—or if they simply have low values of saving fuel—this rule will not change that situation, and they are unlikely to purchase the more fuel-efficient models that manufacturers offer. To the extent that other consumers more completely or correctly account for the value of fuel savings and the costs of acquiring higher fuel economy in their purchasing decisions, they will also continue to do so, and they are likely to view models with improved fuel economy as more attractive purchases than currently available models. The effect of the rule on sales of new vehicles will depend on which form of behavior is more widespread.

In general we would expect that the net effect of this rule would be to reduce sales of new vehicles or leave them unchanged. If consumers are satisfied with the combinations of fuel economy levels and prices that current models offer, we would expect some to decide that the higher prices of those models no longer justify purchasing them, even though they offer higher fuel economy. Other potential buyers may decide to purchase the same vehicle they would have before the rule took effect, or to adjust their purchases in favor of models offering other attributes. Thus sales of new models would decline, regardless of whether "consumer-side" failures in the market for fuel economy currently lead buyers to under-invest in fuel economy. However, if there is some market failure on the producer or supply side that currently inhibits manufacturers from offering increases in fuel economy that would increase their profits—for example, if producers have underestimated the demand for fuel economy, or do not compete vigorously to provide as much as buyers would prefer—then the new standards would make vehicles more attractive to many buyers, and their sales should increase (potential explanations for such producer market failures are discussed in Section IV.G.6 below).

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. The methodology NHTSA used for estimating the impact on vehicle sales in effect assumes that the latter situation will prevail; although it is relatively straightforward, it relies on a number of simplifying assumptions.

There is a broad consensus in the economic literature that the price elasticity for demand for automobiles is approximately −1.0.[726] 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.[727] 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 potentially increase beyond that estimated here, which could result in 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.[728] The 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 depend on vehicle value. The Insurance Information Institute provides the average value of collision plus comprehensive insurance in 2006 as $448.[729] This is compared to an average price for light vehicles of $24,033 for 2006.[730] 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.[731] 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

[726] Kleit, A.N. (1990). "The Effect of Annual Changes in Automobile Fuel Economy Standards," *Journal of Regulatory Economics,* vol. 2, pp 151–172 (Docket EPA–HQ–OAR–2009–0472–0015); Bordley, R. (1994). "An Overlapping Choice Set Model of Automotive Price Elasticities," *Transportation Research B,* vol 28B, no 6, pp 401–408 (Docket NHTSA–2009–0059–0153); 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 (Docket NHTSA–2009–0059–0039).

[727] Gron, Ann and Swenson, Deborah, 2000, "Cost Pass-Through in the U.S. Automobile Market," *The Review of Economics and Statistics,* 82: 316–324. (Docket EPA–HQ–OAR–2009–0472–0007).

[728] 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 February 26, 2010).

[729] 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 March 15, 2010).

[730] $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.

[731] 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.

the vehicle at the time of purchase.[732] Discounting the additional 3.2 percent (16 percent/5 years) per year over the 5 years using a 3 percent mid-year discount rate [733] 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.[734] 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, results 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, light trucks, and both combined for the final standards. 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, AND COMBINED

	MY 2012	MY 2013	MY 2014	MY 2015	MY 2016
Passenger Cars	−65,202	46,801	103,422	168,334	227,039
Light Trucks	48,561	106,658	139,893	171,920	213,868
Combined	−16,641	153,459	243,315	340,255	440,907

The estimates provided in the tables above 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 fuel savings associated with this rule are expected to exceed the technology costs, the effective prices of vehicles (the adjusted increase in technology cost less the fuel savings over five years) to consumers will fall, and consumers will buy more new vehicles. As a result, the lower net cost of the vehicles is projected to lead to an increase in sales for both cars and trucks.

As discussed above, this result depends on the assumption that more fuel efficient vehicles yielding net consumer benefits over their first five years would not otherwise be offered, due to market failures on the part of vehicle manufacturers. However, vehicle models that achieve the fuel economy targets prescribed by today's rulemaking are already available, and consumers do not currently purchase a combination of them that meets the fuel economy levels this rule requires. This suggests that the rule may not result in an increase in vehicle sales, because it does not alter how consumers currently make decisions about which models to purchase. In addition, this analysis has not accounted for a number of factors that might affect consumer vehicle purchases, such as changing market conditions, changes in vehicle characteristics that might accompany improvements in fuel economy, or consumers considering a different "payback period" for their fuel economy purchases. If consumers use a shorter payback period, sales will increase by less than estimated here, and might even decline, while if consumers use longer payback periods, the increase in sales is likely to be larger than reported. In addition, because this is an aggregate analysis some individual consumers (including those who drive less than estimated here) will receive lower net benefits from the increase n fuel economy this rule requires, while others (who drive more than estimated here) will realize even greater savings. These complications—which have not been taken into account in our analysis—add considerable uncertainty to our estimates of changes in vehicle sales resulting from this rule.

6. Potential Unquantified Consumer Welfare Impacts of the Final Standards

The underlying goal of the CAFE and GHG standards is to increase social welfare, in the broadest sense, and as shown in earlier sections, NHTSA projects that the MY 2012–2016 CAFE standards will yield large net social benefits. In its net benefits analysis, NHTSA made every attempt to include all of the costs and benefits that could be identified and quantified.

It is important to highlight several features of the rulemaking analysis that NHTSA believes gives high confidence to its conclusion that there are large net social benefits from these standards. First, the agencies adopted footprint-based standards in large part so that the full range of vehicle choices in the marketplace could be maintained. Second, the agencies performed a rigorous technological feasibility, cost, and leadtime analysis that showed that the standards could be met while maintaining current levels of other vehicle attributes such as safety, utility, and performance. Third, widespread automaker support for the standards, in conjunction with the future product plans that have been provided by automakers to the agencies and recent industry announcements on new product offerings, provides further indication that the standards can be met while retaining the full spectrum of vehicle choices.

Notwithstanding these points, and its high degree of confidence that the benefits amply justify the costs, NHTSA recognizes the possibility of consumer welfare impacts that are not accounted for in its analysis of benefits and costs

[732] Based on *http://www.bankrate.com* auto loan calculator for a 5 year loan at 6 percent.

[733] 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.

[734] 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 February 26, 2010).

from higher CAFE standards. The agencies received public comments expressing diverging views on this issue. The majority of commenters suggested that potential losses in welfare from requiring higher fuel economy were unlikely to be a significant concern, because of the many imperfections in the market for fuel economy. In contrast, other comments suggested that potential unidentified and unquantified consumer welfare losses could be large. Acknowledging the comments, the FRIA provides a sensitivity analysis showing how various levels of unidentified consumer welfare losses would affect the projected net social benefits from the CAFE standards established by this final rule.

There are two viewpoints for evaluating the costs and benefits of the increase in CAFE standards: The private perspective of vehicle buyers themselves on the higher fuel economy levels that the rule would require, and the economy-wide or "social" perspective on the costs and benefits of requiring higher fuel economy. It is important, in short, to distinguish between costs and benefits that are "private" and costs and benefits that are "social." The agency's analysis of benefits and costs from requiring higher fuel efficiency, presented above, includes several categories of benefits ("social benefits") that are not limited to automobile purchasers and that extend throughout the U.S. economy, such as reductions in the energy security costs associated with U.S. petroleum imports and in the economic damages expected to result from climate change. In contrast, other categories of benefits—principally the economic value of future fuel savings projected to result from higher fuel economy—will be experienced exclusively by the initial purchasers and subsequent owners of vehicle models whose fuel economy manufacturers elect to improve as part of their strategies for complying with higher CAFE standards ("private benefits").

Although the economy-wide or "social" benefits from requiring higher fuel economy represent an important share of the total economic benefits from raising CAFE standards, NHTSA estimates that benefits *to vehicle buyers themselves* will significantly exceed the costs of complying with the stricter fuel economy standards this rule establishes, as shown above. Since the agency also assumes that the costs of new technologies manufacturers will employ to improve fuel economy will ultimately be shifted to vehicle buyers in the form of higher purchase prices, NHTSA concludes that the benefits to vehicle buyers from requiring higher fuel efficiency will far outweigh the costs they will be required to pay to obtain it. However, this raises the question of why current purchasing patterns do not already result in higher average fuel economy, and why stricter fuel efficiency standards should be necessary to achieve that goal.

As an illustration, Table IV.G.6–1 reports the agency's estimates of the average lifetime values of fuel savings for MY 2012–2016 passenger cars and light trucks calculated using future retail fuel prices, which are those likely to be used by vehicle buyers to project the value of fuel savings they expect from higher fuel economy. The table compares NHTSA's estimates of the average lifetime value of fuel savings for cars and light trucks to the price increases it projects to result as manufacturers attempt to recover their costs for complying with increased CAFE standards for those model years by increasing vehicle sales prices. As the table shows, the agency's estimates of the present value of lifetime fuel savings (discounted using the OMB-recommended 3% rate) substantially outweigh projected vehicle price increases for both cars and light trucks in every model year, even under the assumption that all of manufacturers' technology outlays are passed on to buyers in the form of higher selling prices for new cars and light trucks. By model year 2016, NHTSA projects that average lifetime fuel savings will exceed the average price increase by more than $2,000 for cars, and by more than $2,700 for light trucks.

TABLE IV.G.6–1—VALUE OF LIFETIME FUEL SAVINGS VS. VEHICLE PRICE INCREASES

Fleet	Measure	Model year				
		2012	2013	2014	2015	2016
Passenger Cars	Value of Fuel Savings	$759	$1,349	$1,914	$2,480	$2,932
	Average Price Increase	505	573	690	799	907
	Difference	255	897	1,264	1,680	2,025
Light Trucks	Value of Fuel Savings	828	1,634	2,277	2,887	3,700
	Average Price Increase	322	416	621	752	961
	Difference	506	1,218	1,656	2,135	2,739

The comparisons above immediately raise the question of why current vehicle purchasing patterns do not already result in average fuel economy levels approaching those that this rule would require, and why stricter CAFE standards should be necessary to increase the fuel economy of new cars and light trucks. They also raise the question of why manufacturers do not elect to provide higher fuel economy even in the absence of increases in CAFE standards, since the comparisons in Table IV.G.6–1 suggest that doing so would increase the value of many new vehicle models by far more than it would raise the cost of producing them (and thus raise their purchase prices), thus presumably increasing sales of new vehicles. More specifically, why would potential buyers of new vehicles hesitate to make investments in higher fuel economy that would produce the substantial economic returns illustrated by the comparisons presented in Table IV.G.6–1? And why would manufacturers voluntarily forego opportunities to increase the attractiveness, value, and competitive positioning of their car and light truck models by improving their fuel economy?

The majority of comments received on this topic answered these questions by pointing out many reasons why the market for vehicle fuel economy does not appear to work perfectly, and accordingly, that properly designed CAFE standards would be expected to increase consumer welfare. Some of these imperfections might stem from standard market failures (such as an absence of adequate information on the part of consumers); some of them might involve findings in behavioral economics (including, for example, a lack of sufficient consumer attention to long-term savings, or a lack of salience, to consumers at the time of purchase, of relevant benefits, including fuel and time savings). Both theoretical and empirical research suggests that many consumers do not make energy-efficient investments even when those investments would pay off in the relatively short-term.[735] This research is in line with related findings that consumers may underweigh benefits and costs that are less salient or that will be realized only in the future.[736]

Existing work provides support for the agency's conclusion that the benefits buyers will receive from requiring manufacturers to increase fuel economy far outweigh the costs they will pay to acquire those benefits, by identifying aspects of normal behavior that may explain buyers' current reluctance to purchase vehicles whose higher fuel economy appears to offer an attractive economic return. For example, consumers' understandable aversion to the prospect of losses ("loss aversion") may produce an exaggerated sense of uncertainty about the value of future fuel savings, making consumers reluctant to purchase a more fuel-efficient vehicle seem unattractive, even when doing so *is* likely to be a sound economic decision. Compare the finding in Greene et al. (2009) to the effect 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.[737]

The well-known finding that as gas prices rise, consumers show more willingness to pay for fuel-efficient vehicles is not inconsistent with the possibility that many consumers undervalue gasoline costs and fuel economy at the time of purchase. In ordinary circumstances, such costs may be a relatively "shrouded" attribute in consumers' decisions, in part because the savings are cumulative and extend over a significant period of time. This claim fits well with recent findings to the effect that many consumers are willing to pay less than $1 upfront to obtain a $1 benefit reduction in discounted gasoline costs.[738]

Some research suggests that the consumers' apparent unwillingness to purchase more fuel efficient vehicles stems from their inability to value future fuel savings correctly. For example, Larrick and Soll (2008) find evidence that consumers do not understand how to translate changes in fuel economy, which is denominated in miles per gallon, into resulting changes in fuel consumption, measured in gallons per time period.[739] Sanstad and Howarth (1994) argue that consumers resort to imprecise but convenient rules of thumb to compare vehicles that offer different fuel economy ratings, and that this behavior can cause many buyers to underestimate the value of fuel savings, particularly from significant increases in fuel economy.[740] If the behavior identified in these studies is widespread, then the agency's estimates suggesting that the benefits to vehicle owners from requiring higher fuel economy significantly exceed the costs of providing it are indeed likely to be correct.

Another possible reconciliation of the agency's claim that the *average* vehicle buyer will experience large fuel savings from the higher CAFE standards this rule establishes with the fact that the *average* fuel economy of vehicles currently purchased falls well short of the new standards is that the values of future savings from higher fuel economy vary widely across consumers. As an illustration, one recent review of consumers' willingness to pay for improved fuel economy found estimates that varied from less than 1% to almost ten times the present value of the resulting fuel savings when those are discounted at 7% over the vehicle's expected lifetime.[741] The wide variation in these estimates undoubtedly reflects methodological and measurement differences among the studies surveyed. However, it may also reveal that the expected savings from purchasing a vehicle with higher fuel economy vary widely among individuals, because they travel different amounts, have different driving styles, or simply have varying expectations about future fuel prices.

These differences reflect the possibility that many buyers with high valuations of increased fuel economy *already* purchase vehicle models that offer it, while those with lower values of fuel economy emphasize other vehicle attributes in their purchasing decisions. A related possibility is that because the effects of differing fuel economy levels are relatively modest when compared to those provided by other, more prominent features of new vehicles—passenger and cargo-carrying capacity, performance, safety, etc.—it is simply not in many shoppers' interest to spend the time and effort necessary to determine the economic value of higher fuel economy, attempt to isolate the component of a new vehicle's selling price that is related to its fuel economy, and compare these two. (This possibility is consistent with the view that fuel economy is a relatively "shrouded" attribute.) In either case, the agency's estimates of the *average* value of fuel savings that will result from requiring cars and light trucks to achieve higher fuel economy may be correct, but those savings may not be large enough to lead a sufficient number of buyers to push for vehicles with higher fuel economy to increase average fuel economy from its current levels.

Defects in the market for cars and light trucks could also lead manufacturers to undersupply fuel economy, even in cases where many buyers were willing to pay the increased prices necessary to provide it.

To be sure, the relevant market, taken as a whole, has a great deal of competition. But even in those circumstances, there may not such competition with respect to all vehicle attributes. Incomplete or "asymmetric" access to information on vehicle attributes such as fuel economy—whereby manufacturers of new vehicles or sellers of used cars and light trucks

[735] Jaffe, A. B., and Stavins, R. N. (1994). The Energy Paradox and the Diffusion of Conservation Technology. Resource and Energy Economics, 16(2); see Hunt Alcott and Nathan Wozny, Gasoline Prices, Fuel Economy, and the Energy Paradox (2010, available at *http://web.mit.edu/allcott/www/Allcott%20and%20Wozny%202010%20-%20Gasoline%20Prices,%20Fuel%20Economy,%20and%20the%20Energy%20Paradox.pdf.*

[736] Hossain, Janjim, and John Morgan (2009). "* * * Plus Shipping and Handling: Revenue (Non)Equivalence in Field Experiments on eBay," Advances in Economic Analysis and Policy vol. 6; Barber, Brad, Terrence Odean, and Lu Zheng (2005). "Out of Sight, Out of Mind: The Effects of Expenses on Mutual Fund Flows," Journal of Business vol. 78, no. 6, pp. 2095–2020.

[737] 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. Surprisingly, the authors find that uncertainty regarding the future price of gasoline appears to be less important than uncertainty surrounding the expected lifetimes of new vehicles. (Docket NHTSA–2009–0059–0154).

[738] *See* Alcott and Wozny.

[739] Larrick, R. P., and J.B. Soll (2008). "The MPG illusion." *Science* 320: 1593–1594.

[740] Sanstad, A., and R. Howarth (1994). "'Normal' Markets, Market Imperfections, and Energy Efficiency." Energy Policy 22(10): 811–818.

[741] Greene, David L., "How Consumers Value Fuel Economy: A Literature Review," Draft report to U.S. Environmental Protection Agency, Oak Ridge National Laboratory, December 29, 2009; *see* Table 10, p. 37.

See also David Greene and Jin-Tan Liu (1988). "Automotive Fuel Economy Improvements and Consumers' Surplus." Transportation Research Part A 22A(3): 203–218 (Docket EPA–HQ–OAR–2009–0472–0045). The study actually calculated the willingness to pay for reduced vehicle operating costs, of which vehicle fuel economy is a major component.

have more complete knowledge of the value of purchasing higher fuel economy, than do potential buyers—may also prevents sellers of new or used vehicles from capturing its full value. In this situation, the level of fuel efficiency provided in the markets for new or used vehicles might remain persistently lower than that demanded by potential buyers (at least if they are well-informed).

It is also possible that deliberate decisions by manufacturers of cars and light trucks, rather than constraints on the combinations of fuel economy, carrying capacity, and performance that manufacturers can offer using current technologies, limit the range of fuel economy available to buyers within individual vehicle market segments, such as full-size automobiles, small SUVs, or minivans. As an illustration, once a potential buyer has decided to purchase a minivan, the range of fuel economy among current models extends only from 18 to 24 mpg.[742] Manufacturers might make such decisions if they underestimate the premiums that shoppers in certain market segments are willing to pay for more fuel-efficient versions of the vehicle models they currently offer to prospective buyers within those segments. If this occurs, manufacturers may fail to supply levels of fuel efficiency as high as those buyers are willing to pay for, and the average fuel efficiency of their entire new vehicle fleets could remain below the levels that potential buyers demand and are willing to pay for. (Of course this possibility is most realistic if it is also assumed that buyers are imperfectly informed or if fuel economy savings are not sufficiently salient.) However, other commenters suggested that, if one assumes a perfectly functioning market, there must be unidentified consumer welfare losses that could offset the private fuel savings that consumers are currently foregoing.

One explanation for this apparent paradox is that NHTSA's estimates of benefits and costs from requiring manufacturers to improve the fuel efficiency of their vehicle models do not match potential vehicle buyers' assessment of the likely benefits and costs from requiring higher fuel efficiency. This could occur because the agency's underlying assumptions about some of the factors that affect the value of fuel savings differ from those made by potential buyers, because NHTSA has used different estimates for some components of the benefits from saving fuel than do buyers, or because the agency has failed to account for some potential costs of achieving higher fuel economy.

For example, buyers may not value increased fuel economy as highly as the agencies' calculations suggest, because they have shorter time horizons than the full vehicle lifetimes assumed by NHTSA and EPA, or because, when buying vehicles, they discount future fuel future savings using higher rates than those prescribed by OMB for evaluating Federal regulations. Potential buyers may also anticipate lower fuel prices in the future than those forecast by the Energy Information Administration, or may expect larger differences between vehicles rated and actual on-road MPG levels than the agencies' estimate.

To illustrate the first of these possibilities, Table IV.G.6–2 shows the effect of differing assumptions about vehicle buyers' time horizons for assessing the value of future fuel savings. Specifically, the table compares the average value of fuel savings from purchasing a MY 2016 car or light truck when fuel savings are evaluated over different time horizons to the estimated increase in its price. This table shows that as reported previously in Table IV.G.6–2, when fuel savings are evaluated over the entire expected lifetime of a MY 2016 car (approximately 14 years) or light truck (about 16 years), their discounted present value (using the OMB-recommended 3% discount rate) lifetime fuel savings exceeds the estimated average price increase by more than $2,000 for cars and by more than $2,700 for light trucks.

If buyers are instead assumed to consider fuel savings over a 10-year time horizon, however, the present value of fuel savings exceeds the projected price increase for a MY 2016 car by about $1,300, and by somewhat more than $1,500 for a MY 2016 light truck. Finally, Table VI.G.6–2 shows that under the assumption that buyers consider fuel savings only over the length of time for which they typically finance new car purchases (slightly more than 5 years during 2009), the value of fuel savings exceeds the estimated increase in the price of a MY 2016 car by only about $350, and the corresponding difference is reduced to slightly more than $500 for a MY 2016 light truck.

TABLE IV.G.6–2—VALUE OF FUEL SAVINGS VS. VEHICLE PRICE INCREASES WITH ALTERNATIVE ASSUMPTIONS ABOUT VEHICLE BUYER TIME HORIZONS

Vehicle	Measure	Value over alternative time horizons		
		Expected lifetime [743]	10 years	Average loan term [744]
MY 2016 Passenger Car	Fuel Savings	$2,932	$2,180	$1,254
	Price Increase	907	907	907
	Difference	2,025	1,273	347
MY 2016 Light Truck	Fuel Savings	3,700	2,508	1,484
	Price Increase	961	961	961
	Difference	2,739	1,547	523

Potential vehicle buyers may also discount future fuel future savings using higher rates than those typically used to evaluate Federal regulations. OMB guidance prescribes that future benefits and costs of regulations that mainly

[742] This is the range of combined city and highway fuel economy levels from lowest (Toyota Siena 4WD) to highest (Mazda 5) available for model year 2010; *http://www.fueleconomy.gov/feg/bestworstEPAtrucks.htm* (last accessed February 15, 2010).

[743] Expected lifetimes are approximately 14 years for cars and 16 years for light trucks.

[744] Average term on new vehicle loans made by auto finance companies during 2009 was 62 months; *See* Board of Governors of the Federal Reserve System, Federal Reserve Statistical Release G.19, Consumer Credit. *Available at http://www.federalreserve.gov/releases/g19/Current* (last accessed March 1, 2010).

affect private consumption decisions, as will be the case if manufacturers' costs for complying with higher fuel economy standards are passed on to vehicle buyers, should be discounted using a consumption rate of time preference.[745] OMB estimates that savers currently discount future consumption at an average real or inflation-adjusted rate of about 3 percent when they face little risk about its likely level, which makes it a reasonable estimate of the consumption rate of time preference. However, vehicle buyers may view the value of future fuel savings that results from purchasing a vehicle with higher fuel economy as risky or uncertain, or they may instead discount future consumption at rates reflecting their costs for financing the higher capital outlays required to purchase more fuel-efficient models. In either case, they may discount future fuel savings at rates well above the 3% assumed in NHTSA's evaluation in their purchase decisions.

Table IV.G.6–3 shows the effects of higher discount rates on vehicle buyers' evaluation of the fuel savings projected to result from the CAFE standards established by this rule, again using MY 2016 passenger cars and light trucks as an example. As Table IV.G.6–1 showed previously, average future fuel savings discounted at the OMB 3% consumer rate exceed the agency's estimated price increases by more than $2,000 for MY 2016 passenger cars and by more than $2,700 for MY 2016 light trucks. If vehicle buyers instead discount future fuel savings at the average new-car loan rate during 2009 (6.7%), however, these differences decline to slightly more than $1,400 for cars and $1,900 for light trucks, as Table IV.G.6–3 illustrates.

This is a potentially plausible alternative assumption, because buyers are likely to finance the increases in purchase prices resulting from compliance with higher CAFE standards as part of the process of financing the vehicle purchase itself. Finally, as the table also shows, discounting future fuel savings using a consumer credit card rate (which averaged 13.4% during 2009) reduces these differences to less than $800 for a MY 2016 passenger car and less than $1,100 for the typical MY 2016 light truck. Note, however, that even at these higher discount rates, the table shows that the private net benefits from purchasing a vehicle with the average level of fuel economy this rule requires remains large.

TABLE IV.G.6–3—VALUE OF FUEL SAVINGS VS. VEHICLE PRICE INCREASES WITH ALTERNATIVE ASSUMPTIONS ABOUT CONSUMER DISCOUNT RATES

Vehicle	Measure	Value over alternative time horizons			
		OMB consumer rate (3%)	New car loan rate (6.7%) [746]	OMB investment rate (7%)	Consumer credit card rate (13.4%) [747]
MY 2016 Passenger Car	Fuel Savings	$2,932	$2,336	$2,300	$1,669
	Price Increase	907	907	907	907
	Difference	2,025	1,429	1,393	762
MY 2016 Light Truck	Fuel Savings	3,700	2,884	2,836	2,030
	Price Increase	961	961	961	961
	Difference	2,739	1,923	1,875	1,069

Combinations of a shorter time horizon and a higher discount rate could further reduce or even eliminate the difference between the value of fuel savings and the agency's estimates of increases in vehicle prices. One plausible combination would be for buyers to discount fuel savings over the term of a new car loan, using the interest rate on that loan as a discount rate. Doing so would reduce the amount by which future fuel savings exceed the estimated increase in the prices of MY 2016 vehicles to about $340 for passenger cars and $570 for light trucks. Some evidence also suggests directly that vehicle buyers may employ combinations of higher discount rates and shorter time horizons for their purchase decisions; for example, 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.[748] As these comparisons and evidence illustrate, reasonable alternative assumptions about how consumers might evaluate the major benefit from requiring higher fuel economy can significantly affect the benefits they expect to receive when they decide to purchase a new vehicle.

Imaginable combinations of shorter time horizons, higher discount rates, and lower expectations about future fuel prices or annual vehicle use and fuel savings could make potential buyers hesitant or even unwilling to purchase vehicles offering the increased fuel economy levels this rule will require manufacturers to produce. At the same time, they might cause vehicle buyers' collective assessment of the aggregate benefits and costs of this rule to differ from NHTSA's estimates. If consumers' views about critical variables such as future fuel prices or the appropriate discount rate differ sufficiently from the assumptions used by the agency, some or perhaps many potential vehicle buyers might conclude that the value of fuel savings and other benefits they will experience from higher fuel economy are not sufficient to justify the increase in purchase prices they expect to pay. This would explain why their current choices among available models do not result in average fuel economy levels

[745] Office of Management and Budget, Circular A–4, "Regulatory Analysis," September 17, 2003, 33. *Available at http://www.whitehouse.gov/omb/assets/regulatory_matters_pdf/a-4.pdf* (last accessed March 1, 2010).

[746] Average rate on 48-month new vehicle loans made by commercial banks during 2009 was 6.72%; *See* Board of Governors of the Federal Reserve System, Federal Reserve Statistical Release G.19, Consumer Credit. *Available at http://www.federalreserve.gov/releases/g19/Current* (last accessed March 1, 2010).

[747] Average rate on consumer credit card accounts at commercial banks during 2009 was 13.4%; *See* Board of Governors of the Federal Reserve System, Federal Reserve Statistical Release G.19, Consumer Credit. *Available at http://www.federalreserve.gov/releases/g19/Current* (last accessed March 1, 2010).

[748] Kubik, M. (2006). Consumer Views on Transportation and Energy. Second Edition. Technical Report: National Renewable Energy Laboratory. *Available at* Docket No. NHTSA–2009–0059–0038.

approaching those this rule would require.

Another possibility is that achieving the fuel economy improvements required by stricter fuel economy standards might mean that manufacturers will forego planned future improvements in performance, carrying capacity, safety, or other features of their vehicle models that represent important sources of utility to vehicle owners. Although the specific economic values that vehicle buyers attach to individual vehicle attributes such as fuel economy, performance, passenger- and cargo-carrying capacity, and other sources of vehicles' utility are difficult to infer from their purchasing decisions and vehicle prices, changes in vehicle attributes can significantly affect the overall utility that vehicles offer to potential buyers. Foregoing future improvements in these or other highly-valued attributes could be viewed by potential buyers as an additional cost of improving fuel economy.

As indicated in its previous discussion of technology costs, NHTSA has approached this potential problem by developing cost estimates for fuel economy-improving technologies that include allowances for any additional manufacturing costs that would be necessary to maintain the reference fleet (or baseline) levels of performance, comfort, capacity, or safety of light-duty vehicle models to which those technologies are applied. In doing so, the agency followed the precedent established by the 2002 NAS Report on improving fuel economy, which estimated "constant performance and utility" costs for technologies that manufacturers could employ to increase the fuel efficiency of cars or light trucks. Although NHTSA 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, safety, carrying capacity, and utility of vehicle models while improving their fuel economy. The adoption of the footprint-based standards also addresses this concern.

Finally, vehicle buyers may simply prefer the choices of vehicle models they now have available to the combinations of price, fuel economy, and other attributes that manufacturers are likely to offer when required to achieve higher overall fuel economy. If this is the case, their choices among models—and even some buyers' decisions about whether to purchase a new vehicle—will respond accordingly, and their responses to these new choices will reduce their overall welfare. Some may buy models with combinations of price, fuel efficiency, and other attributes that they consider less desirable than those they would otherwise have purchased, while others may simply postpone buying a new vehicle. The use of the footprint-based standards, the level of stringency, and the lead time this rule allows manufacturers are all intended to ensure that this does not occur. Although the potential losses in buyers' welfare associated with these responses cannot be large enough to offset the estimated value of fuel savings reported in the agencies' analyses, they might reduce the benefits from requiring manufacturers to achieve higher fuel efficiency, particularly in combination with the other possibilities outlined previously.

As the foregoing discussion suggests, the agency does not have a complete answer to the question of why the apparently large differences between its estimates of benefits from requiring higher fuel economy and the costs of supplying it do not result in higher average fuel economy for new cars and light trucks in the absence of this rule. One explanation is that NHTSA's estimates are reasonable, and that for the reasons outlined above, the market for fuel economy is not operating efficiently. NHTSA believes that the existing literature gives support for the view that because of various market failures (including behavioral factors, such as emphasis on the short-term and a lack of salience), there are likely to be substantial private gains, on net, from the rule, but it will continue to investigate new empirical literature as it becomes available.

NHTSA acknowledges the possibility that it has incorrectly characterized the impact of the CAFE standards this rule establishes on consumers. To recognize this possibility, this section presents an alternative accounting of the benefits and costs of CAFE standards for MYs 2012–2016 passenger cars and light trucks and discusses its implications. Table IV.G.6–4 displays the economic impacts of the rule as viewed from the perspective of potential buyers, and also reconciles the estimated net benefits of the rule as they are likely to be viewed by vehicle buyers with its net benefits to the economy as a whole.

As the table shows, the total benefits to vehicle buyers (line 4) consist of the value of fuel savings at retail fuel prices (line 1), the economic value of vehicle occupants' savings in refueling time (line 2), and the economic benefits from added rebound-effect driving (line 3). As the zero entries in line 5 of the table suggest, the agency's estimate of the retail value of fuel savings reported in line 1 is assumed to be correct, and no losses in consumer welfare from changes in vehicle attributes (other than those from increases in vehicle prices) are assumed to occur. Thus there is no reduction in the total private benefits to vehicle owners, so that net private benefits to vehicle buyers (line 6) are equal to total private benefits (reported previously in line 4).

As Table IV.G.6–4 also shows, the decline in fuel tax revenues (line 7) that results from reduced fuel purchases is in effect a social cost that offsets part of the benefits of fuel savings to vehicle buyers (line 1).[749] Thus the sum of lines 1 and 7 is the savings in fuel production costs that was reported previously as the value of fuel savings at pre-tax prices in the agency's usual accounting of benefits and costs. Lines 8 and 9 of Table IV.G.6–4 report the value of reductions in air pollution and climate-related externalities resulting from lower emissions during fuel production and consumption, while line 10 reports the savings in energy security externalities to the U.S. economy from reduced consumption and imports of crude petroleum and refined fuel. Line 12 reports the costs of increased congestion delays, accidents, and noise that result from additional driving due to the fuel economy rebound effect; net social benefits (line 13) is thus the sum of the change in fuel tax revenues, the reduction in environmental and energy security externalities, and increased costs from added driving.

Line 14 of Table IV.G.6–4 shows manufacturers' technology outlays for meeting higher CAFE standards for passenger cars and light trucks, which represent the principal cost of requiring higher fuel economy. The net total benefits (line 15 of the table) resulting from the rule consist of the sum of private (line 6) and external (line 13) benefits, minus technology costs (line 14); as expected, the figures reported in line 15 of the table are identical to those reported previously in the agency's customary format.

Table IV.G.6–4 highlights several important features of this rule's

[749] Strictly speaking, fuel taxes represent a transfer of resources from consumers of fuel to government agencies and not a use of economic resources. Reducing the volume of fuel purchases simply reduces the value of this transfer, and thus cannot produce a real economic cost or benefit. Representing the change in fuel tax revenues in effect as an economy-wide cost is necessary to offset the portion of fuel savings included in line 1 that represents savings in fuel tax payments by consumers. This prevents the savings in tax revenues from being counted as a benefit from the economy-wide perspective.

economic impacts. First, comparing the rule's net private (line 6) and external (line 13) benefits makes it clear that a substantial majority of the benefits from requiring higher fuel economy are experienced by vehicle buyers, with only a small share distributed throughout the remainder of the U.S. economy. In turn, the vast majority of private benefits stem from fuel savings. External benefits are small because the value of reductions in environmental and energy security externalities is almost exactly offset by the decline in fuel tax revenues and the increased costs associated with added vehicle use via the rebound effect of higher fuel economy. As a consequence, the net economic benefits of the rule mirror closely its benefits to private vehicle buyers and the technology costs for achieving higher fuel economy, again highlighting the importance of accounting for any other effects of the rule on the economic welfare of vehicle buyers.

TABLE IV.G.6–4—PRIVATE, SOCIAL, AND TOTAL BENEFITS AND COSTS OF MY 2012–16 CAFE STANDARDS: PASSENGER CARS PLUS LIGHT TRUCKS

Entry	Model year					
	2012	2013	2014	2015	2016	Total, 2012–2016
1. Value of Fuel Savings (at Retail Fuel Prices)	$10.5	$22.9	$32.9	$42.5	$52.7	$161.6
2. Savings in Refueling Time	0.7	1.4	1.9	2.5	3.0	9.4
3. Consumer Surplus from Added Driving	0.7	1.5	2.2	2.8	3.4	10.5
4. Total Private Benefits (= 1+ 2 + 3)	11.9	25.8	37.0	47.8	59.0	181.5
5. Reduction in Private Benefits	0.0	0.0	0.0	0.0	0.0	0.0
6. Net Private Benefits (= 1 + 2)	11.9	25.8	37.0	47.8	59.0	181.5
7. Change in Fuel Tax Revenues	−1.3	−2.7	−3.8	−4.8	−5.9	−18.5
8. Reduced Health Damages from Criteria Emissions	0.5	0.9	1.3	1.6	2.0	6.4
9. Reduced Climate Damages from CO_2 Emissions	0.9	2.0	2.9	3.8	4.8	14.5
10. Reduced Energy Security Externalities	0.5	1.2	1.6	2.1	2.5	8.0
11. Reduction in Externalities (= 8 + 9 + 10)	1.9	4.1	5.9	7.6	9.3	28.8
12. Increased Costs of Congestion, etc	−0.7	−1.3	−1.9	−2.4	−3.0	−9.4
13. Net Social Benefits (= 7 + 11 + 12)	0.0	0.1	0.1	0.3	0.5	1.0
14. Technology Costs	5.9	7.9	10.5	12.5	14.9	51.7
15. Net Social Benefits (= 6 + 12 − 14)	6.0	17.9	26.6	35.5	44.6	130.7

As discussed in detail previously, NHTSA believes that the aggregate benefits from this rule amply justify its aggregate costs, but it remains possible that the agency has overestimated the value of fuel savings to buyers and subsequent owners of the cars and light trucks to which higher CAFE standards will apply. It is also possible that the agency has failed to identify and value reductions in consumer welfare that could result from buyers' responses to changes in vehicle attributes that manufacturers make as part of their efforts to achieve higher fuel economy. To acknowledge these possibilities, NHTSA examines their potential impact on the rule's benefits and costs, showing the rule's economic impacts for MY 2012–16 passenger cars and light trucks under varying theoretical assumptions about the agency's potential overestimation of private benefits from higher fuel economy and the value of potential changes in other vehicle attributes. See Chapter VIII of the FRIA.

7. What other impacts (quantitative and unquantifiable) will these final standards have?

In addition to the quantified benefits and costs of fuel economy standards, the final standards 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 final 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. Several commenters agreed. These innovative approaches may reduce the cost of the final 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 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 final rule raises vehicle costs by over $900 by 2016, and for some manufacturers costs will increase by $1,000–$1,800. Depending on the retail price of the vehicle, this could represent a significant increase in the overall vehicle cost and subsequently increase insurance rates, operation costs, and maintenance costs. Comprehensive insurance costs are likely to be directly related to price increases, but liability premiums will go up by a smaller proportion because the bulk of liability coverage reflects the cost of personal injury. The impact on operation and maintenance costs is less clear, because the maintenance burden and useful life of each technology are not known. However, 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 for purposes of this final rule. The agency will analyze this issue further for future rulemakings to attempt to gauge its impact more completely.

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 most vehicles will to some extent be impacted by the standards. 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. Elsewhere in this analysis, NHTSA estimates that vehicle sales will increase. This would occur because 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' costs. Under these circumstances, 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 would decline, as would 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.

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 or decrease the cost of blended gasoline and diesel depending on crude oil prices and tax subsidies. The potential extra cost of renewable fuels would be borne through a cross-subsidy: The price of every gallon of blended gasoline could rise sufficiently to pay for any extra cost of renewable fuels. However, if the price of fuel increases enough, the consumer could actually realize a savings through the increased usage of renewable fuels. The final CAFE rule, by reducing total fuel consumption, could 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.

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 corresponding 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 final rule will itself be small.

Macroeconomic Impacts of This Rule

The final 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 passenger cars and light trucks 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 final rule, however a discussion of the economy-wide impacts of this rule conducted by EPA is presented in Section III.H and is included in the docket. 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 final rule 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 the risk of oil market disruption. We have not included estimates of monopsony effects or the cost of military expenditures associated with petroleum imports.

Distributional Effects

The final rule analysis provides a national-level distribution of impacts for gas price and similar variables. NHTSA also shows the effects of the EIA high and low gas price forecasts on the aggregate benefits in the sensitivity analysis. Generally, this rule has the greatest impact on those individuals who purchase vehicles. In terms of how the benefits of the rule might accrue differently for different consumers, consumers who drive more than our mean estimates for VMT will see more fuel savings, while those who drive less than our mean VMT estimates will see less fuel savings.

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.[750] 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*.[751] 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, NHTSA recognizes that manufacturers may have an incentive to classify vehicles as light trucks if 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 often the case given the current fleet, 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 and towing and hauling capacity (and correspondingly, although not necessarily, heavier 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 choose to make such changes before or during the model years covered by this rulemaking.

In the NPRM, 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 sought comment on the following potential changes to NHTSA's vehicle classification system, as well as 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

[750] 49 U.S.C. 32901(a)(18). We note that the statute refers both to vehicles that are 4WD and to vehicles over 6,000 lbs GVWR as potential candidates for off-road capability, if they also meet the "significant feature * * * designed for off-highway operation" as defined by the Secretary. NHTSA would consider "AWD" vehicles as 4WD for purposes of this determination—they send power to all wheels of the vehicle all the time, while 4WD vehicles may only do so part of the time, which appears to make them equal candidates for off-road capability given other necessary characteristics.

[751] 538 F.3d 1172 (9th Cir. 2008).

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 did not feel that it could say with certainty that moving these vehicles could negatively affect potential stringency levels for either passenger cars or light trucks. Thus, although such a change would not be made applicable during the MY 2012–2016 time frame, NHTSA sought comment on why the agency 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.

Comments received on this issue were split between support and opposition. As perhaps expected, the Alliance, AIAM, NADA, Chrysler, Ford, and Toyota all commented in favor of maintaining 3-row vehicles as light trucks indefinitely. The Alliance and Chrysler stated that the existing definitions for light trucks are consistent with Congressional intent in EPCA and EISA, given that Congress could have changed the 3-row definition in passing EISA but did not do so. The Alliance, AIAM, and Chrysler also argued that the functional characteristics of 3-row vehicles do make them “truck-like,” citing their “high load characteristics” and ability to carry cargo if their seats are stowed or removed. Ford and Toyota emphasized the need for stability in the definitions as manufacturers adjust to the recent reclassification of many 2WD SUVs from the truck to the car fleet, and the Alliance argued further that moving the 3-row vehicles to the car fleet would simply deter manufacturers from continuing to provide them, causing consumers to purchase larger full-size vans instead and resulting in less fuel savings and emissions reductions. Toyota stated further that no significant changes have occurred in the marketplace (as in, not all 2WD SUVs suddenly have 3 rows) to trigger additional reclassification beyond that required by the MY 2011 final rule. Hyundai neither supported nor objected to reclassification, but requested ample lead time for the industry if any changes are eventually made.

Other commenters favored reclassification of 3-row vehicles from the truck to the car fleet: NJ DEP expressed general support for reclassifying 3-row vehicles for MYs 2017 and beyond, while the UCSB student commenters seemed to support reclassifying these vehicles for the current rulemaking. The UCSB students stated that EPCA/EISA properly distinguishes light trucks based on their “specialized utility,” either their ability to go off-road or to transport material loads, but that 3-row vehicles do not generally have such utility as sold, and are clearly primarily sold and used for transporting passengers. The UCSB students suggested that reclassifying the 3-row vehicles from the truck to the car fleet could help to ensure the anticipated levels of fuel savings by moving the fleet closer to the 67/33 fleet split assumed in the agencies' analysis for MY 2016, and stated that this would increase fuel economy over the long term. The students urged NHTSA to look at the impact on fuel savings from reclassifying these vehicles for the model years covered by the rulemaking.

In response, NHTSA did conduct such an analysis to attempt to consider the impact of moving these vehicles. As previously stated, the agency's hypothesis is that moving 3-row vehicles from the truck to the car fleet will tend to bring the achieved fuel economy levels down in both fleets—the car fleet achieved levels could theoretically fall due to the introduction of many more vehicles that are relatively heavy for their footprint and thus comparatively less fuel economy-capable, while the truck fleet achieved levels could theoretically fall due to the characteristics of the vehicles remaining in the fleet (4WDs and pickups, mainly) that are often comparatively less fuel-economy capable than 3-row vehicles, although more vehicles would be subject to the relatively more stringent passenger car standards, assuming the curves were not refit to the data.

The agency first identified which vehicles should be moved. We identified all of the 3-row vehicles in the baseline (MY 2008) fleet,[752] and then considered whether any could be properly classified as a light truck under a different provision of 49 CFR 523.5—about 40 vehicles were classifiable under § 523.5(b) as off-highway capable.

The agency then transferred those remaining 3-row vehicles from the light truck to the passenger car input sheets for the Volpe model, re-estimated the gap in stringency between the passenger car and light truck standards, shifted the curves to obtain the same overall average required fuel economy as under the final standards, and ran the model to evaluate potential impacts (in terms of costs, fuel savings, etc.) of moving these vehicles. The results of this analysis may be found in the same location on NHTSA's Web site as the results of the analysis of the final standards. In summary, moving the vehicles reduced the stringency of the passenger car standards by approximately 0.8 mpg on average for the five years of the rule, and reduced the stringency of the light truck standards by approximately 0.2 mpg on average for the five years of the rule. It also caused the gap between the car curve and the truck curve to decrease or narrow slightly, by 0.1 mpg. However, the analysis also showed that such a shift in 3-row vehicles could result in approximately 676 million fewer gallons of fuel consumed (equivalent to about 1 percent of the reduction in fuel consumption under the final standards) and 7.1 mmt fewer CO_2 emissions (equivalent to about 1 percent of the reduction in CO_2 emissions under the final standards) over the lifetime of the MYs 2012–2016 vehicles. This result is attributable to slight differences (due to rounding precision) in the overall average required fuel economy levels in MYs 2012–2014, and to the retention of the relatively high lifetime mileage accumulation (compared to “traditional” passenger cars) of the vehicles moved from the light truck fleet to the passenger car fleet.

The changes in overall costs and vehicle price did not necessarily go in the same direction for both fleets, however. Overall costs of applying technology for the passenger car fleet went up approximately $1 billion per year for each of MYs 2012–2016, while overall costs for the light truck fleet went down by an average of approximately $800 million for each year, such that the net effect was approximately $200 million additional spending on technology each year (equivalent to about 2 percent of the average increase in annual technology outlays under the final standards). Assuming manufacturers would pass that cost forward to consumers by increasing vehicle costs, vehicle prices would increase by an average of approximately $13 during MYs 2012–2016.

However, one important point to note in this comparative analysis is that, due to time constraints, the agency did not attempt to refit the respective fleet target curves or to change the intended required stringency in MY 2016 of 34.1 mpg for the combined fleets. If we had refitted curves following the same procedures described above in Section II, considering the vehicles in question, we expect that we might have obtained a somewhat steeper passenger car curve, and a somewhat flatter light truck curve.

[752] Of the 430 light trucks models in the fleet, 175 of these had 3 rows.

If so, this might have increased the gap in between portions of the passenger car and light truck curves.

NHTSA agrees with the industry commenters that some degree of stability in the passenger car and light truck definitions will assist the industry in making the transition to the stringency of the new National Program, and therefore will not reclassify 3-row vehicles to the passenger car fleet for purposes of MYs 2012–2016. Going forward, the real question is how to balance the benefits of regulatory stability against the potential benefits of greater fuel savings if reclassification is determined to lead in that direction. NHTSA believes that this question merits much further analysis before the agency can make a decision for model years beyond MY 2016, and will provide further opportunity for public comment regarding that analysis prior to finalizing any changes in the future.

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 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 sought comment in the NPRM on how the agency might go about reviewing this question as more information about manufacturer behavior is accumulated, but no commenters really responded to this issue directly, although several cited the possibility that manufacturers might cease to build 2WD SUVs as a way of avoiding the higher passenger car curve targets in arguing that the agencies should implement backstop standards for all fleets. Since NHTSA has already stated above that it will revisit the backstop question as necessary in the future, we may as well add that we will consider the need to classify "like" vehicles together as necessary in the future.

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 suggested in the NPRM that it could explore additional approaches, although it cautioned that 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 sought comment on whether and why it should pursue any of these courses of action.

Some commenters (ICCT, CBD, NESCAUM) did raise the issue of removing the regulatory distinction between cars and trucks and setting standards for the entire fleet of vehicles, but those commenters did not appear to recognize the fact that EPCA/EISA expressly requires that NHTSA set separate standards for passenger cars and light trucks. As the statute is currently written, NHTSA does not believe that a single standard would be appropriate unless the observed relationship between footprint and fuel economy of the two fleets converged significantly over time. Nevertheless, NHTSA will continue to monitor the issue going forward.

Besides these issues in vehicle classification, NHTSA additionally received comments from two manufacturers on issues not raised by NHTSA in the NPRM. VW requested clarification with respect to how the agency evaluates a vehicle for off-road capability under 49 CFR 523.5(b)(2), asking the agency to measure vehicles with "active ride height management" at the "height setting representative of off-road operation if the vehicle has the capability to change ride height." NHTSA issued an interpretation to Porsche in 2004 addressing this issue, when Porsche asked whether a driver-controlled variable ride height suspension system could be used in the "off-road" ride height position to meet the suspension parameters required for an off- road classification determination.[753] Porsche argued that a vehicle should not need to satisfy the four-out-of-five criteria at all ride heights in order to be deemed capable of off-highway operation. NHTSA agreed that 523.5(b)(2) does not require a vehicle to meet four of the five criteria at *all* ride heights, but stated that a vehicle must meet four out of the five criteria in at *least one* ride height. The agency determined that it would be appropriate to measure the vehicle's running clearance with the vehicle's adjustable suspension placed in the position(s) intended for off-road operation under real-world conditions.

Thus, NHTSA clarifies that the agency would consider it appropriate to measure vehicles for off-road capability at the height setting intended for off-road operation under real-world conditions. However, we note that before this question need be asked and answered, the vehicle must first either

[753] *Available at http://isearch.nhtsa.gov/files/porschevrhs.html* (last accessed Mar. 1, 2010).

be equipped with 4WD or be rated at more than 6,000 pounds gross vehicle weight to be eligible for classification as a light truck under 49 CFR 523.5(b).

The final comment on the issue of vehicle classification was received from Honda, who recommended that deformable aero parts, such as strakes, should be excluded from the ride height measurements that determine whether a vehicle qualifies as a truck for off-road capability. The air strakes described by Honda are semi-deformable parts similar to a mud flap that can be used to improve a vehicle's aerodynamics, and thus to improve its fuel economy. Honda argued that NHTSA would deter the application of this technology if it did not agree to measure ride height with the air strakes at their most deformed state, because otherwise a vehicle so equipped would have to be classified as a passenger car and thus be faced with the more stringent standard.

In response, Honda did not provide enough information to the agency for the agency to make a decision with regard to how air strakes should be considered in measuring a vehicle for off-road capability. NHTSA personnel would prefer to directly examine a vehicle equipped with these devices before considering the issue further. The agency will defer consideration of this issue to another time, and no changes will be made in this final rule in response to this comment.

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.[754] The reports for the current model year are submitted to NHTSA every December and July. As of the time of this final rule, NHTSA has received pre-model year reports from manufacturers for MY 2010, and anticipates receiving mid-model year reports for MY 2010 in July 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 proposed to amend part 537 to allow for electronic submission of the pre- and mid-model year CAFE reports. The only comments addressing this proposal were from Ferrari, who supported it in the interest of efficiency, and Ford, who did not object as long as CBI was sufficiently protected. Having received no comments objecting, NHTSA is finalizing this change to part 537.

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[755] 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.

As discussed above in Section III, a number of commenters raised the issue of whether the city and highway test procedures and the calculation are still appropriate or whether they may be outdated. Several commenters argued that the calculation should be more "real-world": For example, ACEEE stated that EPA should use a "correction factor" like the one used for the fuel economy label in the interim until test procedures can be changed, while BorgWarner, Cummins, Honeywell, MECA, and MEMA argued that EPA should change the weighting of the city and highway cycles (to more highway and less city) to reflect current American driving patterns and to avoid biasing the calculation against technologies that provide greater efficiency in highway driving than in city driving. Sierra Club *et al.* commented that the fact that EPA was proposing to allow off-cycle credits indicated that the test procedures and the calculation needed updating. Several commenters (API, James Hyde, MECA, NACAA, and NY DEC) stated that the test procedures should use more "real-world" fuel, like E–10 instead of "indolene clear." The UCSB students also had a number of comments aimed at making the test procedures more thorough and real-world. Several industry-related commenters (AIAM, Ferrari, and Ford) argued to the contrary that existing test procedures and calculations are fine for now, and that any changes would require significant lead time to allow manufacturers to adjust their plans to the new procedures.

Statutorily, the decision to change the test procedures or calculation is within EPA's discretion, so NHTSA will not attempt to answer these comments in detail, see *supra* Section III for EPA's responses. We note simply that the agency recognizes the need for lead time for the industry if test procedures were to change in the future to become more real-world, and will keep it in mind.

One notable shortcoming of the 1975 test procedure is that it does not include

[754] 49 CFR part 537 is authorized by 49 U.S.C. 32907.

[755] 49 U.S.C. 32904(c).

a provision for air conditioner usage during the test cycle. As discussed in Section III above, 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 equipping 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. In the NPRM, NHTSA sought comment regarding implementing such amendments beginning in MY 2017 and also on the more immediate 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. NHTSA emphasized that modernizing the passenger car test procedures as well would not be possible under EPCA as currently written.

Comments were split as to whether the test procedure should be changed. Several manufacturers and manufacturer groups (BMW, GM, Toyota, VW, the Alliance) opposed changes to the test procedures to account for A/C usage on the grounds that any changes could create negative unintended consequences. Public Citizen also opposed changes to the test procedure, arguing that the fuel economy information presented to the consumer on the fuel economy label is already confusing, and that further changes to the light truck test procedures when there was no authority to change the passenger car test procedures would simply result in more confusion. In contrast, NJ DEP fully supported changes to the light truck test procedures beginning with MY 2017, and an individual commenter (Weber) also supported the inclusion of A/C in the test procedures to represent real-world "A/C on" time.

However, some of the same commenters—BMW, Toyota, and VW, for example—that opposed changes to the test procedure supported NHTSA allowing credits for A/C. Toyota stated that it supported anything that increased compliance flexibility, while VW emphasized that A/C credits for CAFE would help to address the fact that NHTSA's standards could end up being more stringent than EPA's for manufacturers relying heavily on A/C improvements to meet the GHG standards. NJ DEP also supported interim A/C credits for light trucks, but in contrast to VW, argued that the light truck standards would have to be made more stringent to account for those credits if they were allowed.

Other commenters (Chrysler, Daimler, Ferrari) supported interim A/C credits for light truck CAFE, but stated that such credits could simply be added to EPA's calculation of CAFE under 49 U.S.C. 32904(c) without any change in the test procedure ever being necessary. Daimler stated that the prohibition on changing the test procedure, according to legislative history, was to avoid sudden and dramatic changes and provide consistency for manufacturers in the beginning of the CAFE program, but that nothing indicated that EPA was barred from updating the way a manufacturer's fuel economy is calculated after the test procedures are followed. Daimler emphasized that EPA has broad authority in how it calculates fuel economy, and that adding credits at the end of the calculation would make CAFE more consistent with the GHG program and recognize real-world benefits not measured by the test cycle. Daimler argued that if EPA did not include A/C credits as part of the calculation, it would remove incentives to improve A/C, because those gains could not be used for CAFE compliance and NHTSA has no authority to include A/C in determining stringency, because A/C is a "parasitic load" that does not impact mpg.

Some commenters opposed interim A/C credits. CARB stated that no A/C credits should be given under EPCA unless the test procedures can be changed to fully account for A/C and NHTSA is given clear authority for A/C, while GM stated that NHTSA's authority to create additional types of credits must be limited by the fact that Congress clearly provided in EPCA for some types of CAFE credits but not for A/C-related credits for CAFE.

NHTSA has decided not to implement interim A/C credits for purposes of this final rule and MYs 2012–2016 light trucks. Changes to the test procedure for light trucks will be considered by the agencies in subsequent rulemakings.

While NHTSA agrees with commenters that the EPA authority to consider how fuel economy is calculated is broad, especially as to light trucks, we disagree that credits could simply be added to the CAFE calculation without making parallel changes in CAFE standard stringency to reflect their availability. CAFE stringency is determined, in part, with reference to the technologies available to manufacturers to improve mpg. If a technology draws power from the engine, like A/C, then making that technology more efficient to reduce its load on the engine will conserve fuel, consistent with EPCA's purposes. However, as noted above, some technologies that improve mpg are not accounted for in current CAFE test procedures. NHTSA agrees that the test procedures should be updated to account for the real-world loads on the engine and their impact on fuel economy, but recognizes that manufacturers will need lead-time and advance notice in order to ready themselves for such changes and their impact on CAFE compliance.

Thus, if manufacturers are able to achieve improvements in mpg that are not reflected on the test cycle, then the level of CAFE that they are capable of achieving is higher than that which their performance on the test cycle would otherwise indicate, which suggests, in turn, that a higher stringency is feasible. NHTSA has determined that the current CAFE levels being finalized today are feasible using traditional "tailpipe technologies" alone. If manufacturers are capable of improving fuel economy beyond that level using A/C technologies, and wish to receive credit for doing so, then NHTSA believes that more stringent CAFE standards would need to be established. Not raising CAFE could allow manufacturers to leave tailpipe technology on the table and make cheaper A/C improvements, which would not result in the maximum feasible fuel savings contemplated by EPCA.

Because raising CAFE stringency in conjunction with allowing A/C credits was not a possibility clearly contemplated in the NPRM, NHTSA does not believe that it would be within scope of notice for purposes of this rulemaking. Accordingly, the final rule cannot provide for interim A/C credits. However, if NHTSA were to allow A/C credits in the future, NHTSA believes it would be required to increase standard stringency accordingly, to avoid losses in fuel savings, as stated above. NHTSA will consider this approach further, ensuring that any changes to the treatment of A/C and accompanying changes in CAFE stringency are made with sufficient notice and lead-time.

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), and 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 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.[756]

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[757] 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.

Several commenters encouraged the agency to increase the transparency of how the agency monitors and enforces CAFE compliance. EDF, Public Citizen, Sierra Club *et al.,* UCS, and Porsche all commented that NHTSA should publish an annual compliance report for manufacturers, and Porsche suggested that it be available online. Sierra Club *et al.* and Porsche stated that this would help clarify manufacturers' credit status (for the benefit of the public and manufacturers looking to purchase credits, respectively) and sales, and Sierra Club *et al.* further stated that the agency should make public all information regarding credits and attained versus projected fleet average mpg levels. EDF similarly urged the agency to provide publicly a compliance report every year that would include any recommended adjustments to the program, enforcement actions, or prospective policy action to ensure the policy objectives are achieved.

In response, NHTSA agrees that there could be substantial benefits to increasing the transparency of information concerning the credit holdings of each credit holder. Along with the MY 2011 final rule, NHTSA issued a new regulation 49 CFR part 536 to implement the new CAFE credit trading and transfer programs authorized by EISA. Paragraph 536.5(e) requires that we periodically publish credit holding information. NHTSA plans to make this information available to the public on the NHTSA Web site. The exact format that will be used to display this information has not been finalized but it is our plan to begin making this information available no later than calendar year 2011 to coincide with MY 2011 when manufacturers may begin utilizing credit trades and transfers.

[756] Honeywell commented that any fines imposed and collected under the CAFE and GHG standards should be appropriated to the development of vehicle technologies that continue to improve fuel economy in the future, and that the direct application of the penalties collected would support the underlying legislative policy and drive innovation. While NHTSA certainly would not oppose such an outcome, it would lie within the hands of Congress and not the agency to direct the use of the fines in that manner.

[757] 49 U.S.C. 30120, Remedies for defects and noncompliance.

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, 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.[758] 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.[759]

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).[760] 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.[761] 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 updated part 538 as part of this final rule to reflect the EISA changes extending the incentive to MY 2019, 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. The manufacturer would then be allowed to weight the gasoline and alternative fuel test results based on the proportion of actual usage of both fuels, as discussed above in Section III. 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 requested comment in the NPRM on whether it should seek legislative changes to revise its authority to address this issue.

NHTSA received only one comment on this issue: VW commented that NHTSA should not seek a change in its authority, because Congress' intent for NHTSA is already clear. VW did, however, encourage NHTSA to include the statutory FFV credit phase-out in Part 538, which the agency is doing.

b. Credit Trading and Transfer

As part of 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.[762] 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.[763] EISA also prohibits credits

[758] 49 U.S.C. 32905(a).

[759] 49 U.S.C. 32905(b).

[760] 49 U.S.C. 32905(c).

[761] 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.

[762] 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.

[763] Ford and Toyota both commented on NHTSA's use of the adjustment factor: Ford stated that it preferred a streamlined "megagrams"

Continued

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.[764] 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 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 sought comment in the NPRM on this interpretation of EISA.

Only one commenter, VW, commented on NHTSA's interpretation of EISA as allowing the banking of transferred credits, and agreed with it. VW suggested that NHTSA revise part 536 to clarify accordingly, and that NHTSA include the statutory transfer cap in part 536 as well. While NHTSA does not believe that including the statutory transfer cap in the regulation is necessary, NHTSA will revise Part 536 in this final rule by amending the definition of "transfer" as follows (in bold and italics):

Transfer means the application by a manufacturer of credits earned by that manufacturer in one compliance category or credits acquired be trade (and originally earned by another manufacturer in that category) to achieve compliance with fuel economy standards with respect to a different compliance category. For example, a manufacturer may purchase light truck credits from another manufacturer, and transfer them to achieve compliance in the manufacturer's domestically manufactured passenger car fleet. ***Subject to the credit transfer limitations of 49 U.S.C. 32903 (g)(3), credits can also be transferred across compliance categories and banked or saved in that category to be carried forward or backward to address a credit shortfall.***

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 $785,772,714.50 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 2008 fleets, six manufacturers paid CAFE fines for not meeting an applicable standard—Ferrari, Maserati, Mercedes-Benz, Porsche, Chrysler and Fiat—for a total of $12,922,255,50.

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 conformity 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

approach like EPA was proposing, while Toyota stated that NHTSA and EPA should use consistent VMT estimates for purposes of all analysis and for use in the adjustment factor. In response to Ford, NHTSA is maintaining use of the adjustment factor just finalized last March, which uses mpg rather than gallons or grams and is thus consistent with the rest of the CAFE program. In response to Toyota, NHTSA agrees that consistency of VMT estimates should be maintained and will revise the adjustment factor as necessary.

[764] 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.

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 requested in the NPRM 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.

Only Ferrari and Daimler commented on this issue. Both manufacturers argued that raising the penalty would have no impact on fuel savings and would simply hurt the manufacturers forced to pay it. Daimler stated further that the agency's asking for a quantitative analysis ignores the fact that manufacturers pay fines because they cannot increase energy savings any further. Thus, again, the agency finds itself without a clear quantitative explanation of what the benefits and drawbacks to raising the penalty might be, but it continues to appear that the range of possible increase is insufficient to result in additional substantial energy conservation. NHTSA will therefore defer consideration of this issue for purposes of this rulemaking.

4. Other CAFE Enforcement Issues—Variations in Footprint

NHTSA has a standardized test procedure for determining vehicle footprint,[765] 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.[766]

"Track width," in turn, is defined as "the lateral distance between the centerlines of the base tires at ground, including the camber angle." [767] "Wheelbase" is defined as "the longitudinal distance between front and rear wheel centerlines." [768]

NHTSA began requiring manufacturers to submit this information on footprint, wheelbase, and track width 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 2010. 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 as discussed below.

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,[769] 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 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. No comments were received on this issue.

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 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

[765] 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).

[766] 49 CFR 523.2.

[767] *Id.*

[768] *Id.*

[769] 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).

accurate result. No comments were received on this issue.

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. No comments were received on this issue.

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 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 sought comment in the NPRM on any potential benefits or drawbacks to requiring a more standardized reporting methodology. NHTSA requested that, if commenters recommend increasing standardization, they provide specific examples of what information should be required and how NHTSA should require it to be provided but no comments were received on this specific issue.

However, on a related topic, Honda and Toyota both commented on the equations and corresponding terms used to calculate the fleet required standards. Both manufacturers indicated that the terms defined for use in the equations could be interpreted differently by vehicle manufacturers. For example, the term "footprint of a vehicle model" could be interpreted to mean that a manufacturer only has to use one representative footprint within a model type or that it is necessary to use all the unique footprints and corresponding fuel economy target standards within a model type when determining a fleet target standard. This issue is discussed in more detail in Section IV.E. above.

5. Other CAFE Enforcement Issues—Miscellaneous

Hyundai commented that 49 CFR 537.9 appeared to contain erroneous references to 40 CFR 600.506 and 600.506(a)(2), which seemed not to exist, and asked the agency to check those references. In response, NHTSA examined the issue and found that 40 CFR 600.506 was, in fact, eliminated by a final rule published on April 6, 1984 (49 FR 13832). That section of 40 CFR originally required manufacturers to submit preliminary CAFE data to EPA prior to submitting the final end of the year data. EPA's primary intent for eliminating the requirement, as stated in the final rule, was to reduce administration burden. To address these inaccurate references, NHTSA is revising part 537 to delete references to 40 CFR 600.506. This will not impact the existing requirements for the pre-model year, mid-model year and supplemental reports manufacturers must submit to NHTSA under part 537.

J. Other Near-Term Rulemakings Mandated by EISA

1. Commercial Medium- and Heavy-Duty On-Highway Vehicles and Work Trucks

EISA added new provisions to 49 U.S.C. 32902 requiring DOT, in consultation with DOE and EPA, to conduct a study regarding a program to require improvements in the fuel efficiency of commercial medium- and heavy-duty on-highway vehicles and work trucks and then to conduct a rulemaking to adopt and implement such a program. In the study, the agency must examine the fuel efficiency of commercial medium- and heavy-duty on-highway vehicles [770] and work trucks [771] 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. Then the agency must determine in a rulemaking

[770] Defined as an on-highway vehicle with a gross vehicle weight rating of 10,000 pounds or more.

[771] 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.

proceeding how to implement a commercial medium- and heavy-duty on-highway vehicle and work truck fuel efficiency improvement program designed to achieve the maximum feasible improvement, and adopt and implement appropriate test methods, measurement metrics, fuel economy standards, and compliance and enforcement protocols that are appropriate, cost-effective, and technologically feasible for commercial medium- and heavy-duty on-highway vehicles and work trucks. The agency is working closely with EPA on developing a proposal for these standards.

2. Consumer Information on Fuel Efficiency and Emissions

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. The agency is working closely with EPA on developing a proposal for these regulations.

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.

K. Record of Decision

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 GHG emissions. 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.

In accordance with President Obama's May 19, 2009 announcement, this final rule promulgates the fuel economy standards for MYs 2012–2016. This final rule constitutes the Record of Decision (ROD) for NHTSA's MYs 2012–2016 CAFE standards, pursuant to the National Environmental Policy Act (NEPA) and the Council on Environmental Quality's (CEQ) implementing regulations.[772] *See* 40 CFR 1505.2.

As required by CEQ regulations, this final rule and ROD sets forth the following: (1) The agency's decision; (2) alternatives considered by NHTSA in reaching its decision, including the environmentally preferable alternative; (3) the factors balanced by NHTSA in making its decision, including considerations of national policy; (4) how these factors and considerations entered into its decision; and (5) the agency's preferences among alternatives based on relevant factors, including economic and technical considerations and agency statutory missions. This final rule also briefly addresses mitigation.

The Agency's Decision

In the DEIS and the FEIS, the agency identified the approximately 4.3-percent average annual increase alternative as NHTSA's Preferred Alternative. After carefully reviewing and analyzing all of the information in the public record including technical support documents, the FEIS, and public and agency comments submitted on the DEIS, the FEIS, and the NPRM, NHTSA has decided to proceed with the Preferred Alternative. The Preferred Alternative requires approximately a 4.3-percent average annual increase in mpg for MYs 2012–2016. This decision results in an estimated required MY 2016 fleetwide 37.8 mpg for passenger cars and 28.7 mpg for light trucks. As stated in the FEIS, the Preferred Alternative results in a combined estimated required fleetwide 34.1 mpg in MY 2016.

Following publication of the FEIS, the Federal government Interagency Working Group on Social Cost of Carbon made public a revised estimate of the Social Cost of Carbon to support Federal regulatory activities where reducing CO_2 emissions is an important potential outcome. NHTSA relied upon the interagency group's interim guidance published in August 2009 for the FEIS analysis. For this final rule NHTSA has updated the analysis and now uses the central SCC value of $21 per metric ton (2010 emissions) identified in the interagency group's revised guidance.[773] See Section IV.C.3.l.iii.

The group's purpose in developing new estimates of the SCC was to allow

[772] NEPA is codified at 42 U.S.C. 4321–47. CEQ NEPA implementing regulations are codified at 40 Code of Federal Regulations (CFR) Parts 1500–08.

[773] The $21/ton estimate is for 2010 emissions and increases over time because of damages resulting from increased GHG concentrations. $21 is the average SCC at the 3 percent discount rate. The other three estimates include: Avg SCC at 5% ($5–$16); Avg SCC at 2.5% ($35–$65); and 95th percentile at 3% ($65–$136).

Federal agencies to incorporate the social benefits of reducing carbon dioxide (CO_2) emissions into cost-benefit analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions, as most Federal regulatory actions can be expected to have. The interagency group convened on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key inputs and assumptions in order to generate SCC estimates. The revised SCC estimates represent the interagency group's consideration of the literature and judgments about how to monetize some of the benefits of GHG mitigation.[774]

Incorporating the revised estimate, NHTSA's analysis indicates that the Agency's Decision will likely result in slightly greater fuel savings and CO_2 emissions reductions than those noted in the EIS. The revised SCC valuation applied for purposes of the final rule resulted in a slightly smaller gap in stringency between the passenger car and light truck standards; the ratio of passenger car stringency (*i.e.,* average required fuel economy) to light truck stringency in MY 2016 shrank from 1.318 to 1.313, or about 0.4 percent. Because manufacturers projected to pay civil penalties (rather than fully complying with CAFE standards) account for a smaller share of the light truck market than of the passenger car market, and because lifetime mileage accumulation is somewhat higher for light trucks than for passenger cars, this slight shift in relative stringency caused average fuel economy levels achieved under the preferred alternative to increase by about 0.02 mpg during MYs 2012–2016, resulted in corresponding lifetime (*i.e.,* over the full useful life of MYs 2012–2016 vehicles) fuel savings increases of about 0.9 percent, and corresponding increases in lifetime CO_2 emission reductions of about 1.1 percent. For environmental impacts associated with NHTSA's Decision, see Section IV.G of this final rule.

The incorporation of the revised interagency estimate of SCC results in minimal changes to the required fleetwide mpg for some model years covered by this final rule. All changes are less than or equal to .1 mpg (but may reflect an increase when rounding up during calculations) and continue to result, on average, in a 4.3 percent annual increase in mpg.[775] *See* Section IV.F for discussion of required annual fleetwide mpg.

For a discussion of the agency's selection of the Preferred Alternative as NHTSA's Decision, see Section IV.F of this final rule.

Alternatives Considered by NHTSA in Reaching Its Decision, Including the Environmentally Preferable Alternative

When preparing an EIS, NEPA requires an agency to compare the potential environmental impacts of its proposed action and a reasonable range of alternatives. NHTSA identified alternative stringencies that represent the spectrum of potential actions the agency could take. The environmental impacts of these alternatives, in turn, represent the spectrum of potential environmental impacts that could result from NHTSA's chosen action in setting CAFE standards. Specifically, the DEIS and FEIS analyzed the impacts of the following eight "action" alternatives: 3-Percent Alternative (Alternative 2), 4-Percent Alternative (Alternative 3), Preferred Alternative (Alternative 4), 5-Percent Alternative (Alternative 5), an alternative that maximizes net benefits (MNB) (Alternative 6), 6-Percent Alternative (Alternative 7), 7-Percent Alternative (Alternative 8), and an alternative under which total cost equals total benefit (TCTB) (Alternative 9). The DEIS and FEIS also analyzed the impacts that would be expected if NHTSA imposed no new requirements (the No Action Alternative). In accordance with CEQ regulations, the agency selected a Preferred Alternative in the DEIS and the FEIS (the approximately 4.3-percent average annual increase alternative).

In response to public comments, the FEIS expanded the analysis to determine how the proposed alternatives were affected by variations in the economic assumptions input into the computer model NHTSA uses to calculate the costs and benefits of various potential CAFE standards (the Volpe model). Variations in economic assumptions can be used to examine the sensitivity of costs and benefits of each of the alternatives, including future fuel prices, the value of reducing CO_2 emissions (referred to as the social cost of carbon or SCC), the magnitude of the rebound effect, and the value of oil import externalities. Different combinations of economic assumptions can also affect the calculation of environmental impacts of the various action alternatives. This occurs partly because some economic inputs to the Volpe model—notably fuel prices and the size of the rebound effect—influence its estimates of vehicle use and fuel consumption, the main factors that determine emissions of GHGs, criteria air pollutants, and airborne toxics. See section 2.4 of the FEIS for a discussion of the sensitivity analysis conducted for the FEIS.

The agency considered and analyzed each of the individual economic assumptions to determine which assumptions most accurately represent future economic conditions. For a discussion of the analysis supporting the selection of the economic assumptions relied on by the agency in this final rule, see Section IV.C.3.

Also in response to comments, the agency conducted a national-scale photochemical air quality modeling and health risk assessment for a subset of the DEIS alternatives to support and confirm the health effects and health-related economic estimates of the EIS. The photochemical air quality study is included as Appendix F to the EIS. The study used air quality modeling and health benefits analysis tools to quantify the air quality and health-related benefits associated with the alternative CAFE standards. Four alternatives from the DEIS were modeled: the No Action Alternative and Alternative 2 (the 3-Percent Alternative) to represent fuel economy requirements at the lower end of the range; Alternative 4 (the Preferred Alternative) and Alternative 8 (the 7-Percent Alternative) to represent fuel economy requirements at the higher end of the range.

The agency compared the potential environmental impacts of alternative mpg levels, analyzing direct, indirect, and cumulative impacts. For a discussion of the environmental impacts associated with each of the alternatives, *see* Chapters 3 and 4 of the FEIS.

Alternative 8 (the 7-Percent Alternative) is the overall Environmentally Preferable Alternative, because it would result in the largest reductions in fuel use and GHG emissions by vehicles produced during MYs 2012–2016 among the alternatives considered. Under each alternative the agency considered, the reduction in fuel consumption resulting from higher fuel economy causes emissions that occur during fuel refining and distribution to decline. For most pollutants, this decline is more than sufficient to offset the increase in tailpipe emissions that results from increased driving due to the fuel economy rebound effect, leading to

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[774] The interagency group intends to update these estimates as the science and economic understanding of climate change and its impacts on society improves over time.

[775] There are no "substantial changes to the proposed action" and there are no "significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts." Therefore, consistent with 40 CFR 1502.9(c), no supplement to the EIS is required. Moreover, the environmental impacts of this decision fall within the spectrum of impacts analyzed in the DEIS and the FEIS.

a net reduction in total emissions from fuel production, distribution, and use. Because it leads to the largest reductions in fuel refining, distribution, and consumption among the alternatives considered, Alternative 8 would also lead to the largest net reductions in emissions of CO_2 and other GHGs, most criteria air pollutants,[776] as well as the mobile source air toxics (MSATs) benzene and diesel particulate matter (diesel PM).

However, NHTSA's environmental analysis indicates that emissions of the MSATs acetaldehyde, acrolein, 1,3-butadiene, and formaldehyde would increase under some alternatives, with the largest increases in emissions of these MSATs projected to occur under Alternative 8 in most future years. This occurs because the rates at which these MSATs are emitted during fuel refining and distribution are very low relative to their emission rates during vehicle use. As a consequence, the reductions in their total emissions during fuel refining and distribution that result from lower fuel use are insufficient to offset the increases in emissions that result from additional vehicle use. The amount by which increased tailpipe emissions of these MSATs exceeds the reductions in their emissions during fuel refining and distribution increases for alternatives that require larger improvements in fuel economy, and in most future years is smallest under Alternative 2 (which would increase CAFE standards least rapidly among the action alternatives) and largest under Alternative 8 (which would require the most rapid increase in fuel economy). Thus while Alternative 8 is the environmentally preferable alternative on the basis of CO_2 and other GHGs, most criteria air pollutants, and some MSATs, other alternatives are environmentally preferable from the standpoint of the criteria air pollutants fine particulate matter and sulfur oxides, as well as the MSATs acetaldehyde, acrolein, 1,3-butadiene, and formaldehyde. Overall, however, NHTSA considers Alternative 8 to be the Environmentally Preferable Alternative.

For additional discussion regarding the alternatives considered by the agency in reaching its decision, including the Environmentally Preferable Alternative, *see* Section IV.F of this final rule. For a discussion of the environmental impacts associated with each alternative, *see* Chapters 3 and 4 of the FEIS.

[776] Reductions in emissions of two criteria air pollutants, fine particulate matter ($PM_{2.5}$) and sulfur oxides (SO_X), are forecast to be slightly larger for Alternative 9 (TCTB) than for Alternative 8. Because the estimates of health benefits depend most critically on changes in particulate matter emissions, this causes the health benefits estimates reported in this FEIS to be slightly larger for Alternative 9 than for Alternative 8. *See* Section 3.3 of the FEIS. Nonetheless, for the other reasons explained above, NHTSA considers Alternative 8 to be the overall Environmentally Preferable Alternative.

Factors Balanced by NHTSA in Making Its Decision

For discussion of the factors balanced by NHTSA in making its decision, see Sections IV.D. and IV.F of this final rule.

How the Factors and Considerations Balanced by NHTSA Entered Into Its Decision

For discussion of how the factors and considerations balanced by the agency entered into NHTSA's Decision, *see* Section IV.F of this final rule.

The Agency's Preferences Among Alternatives Based on Relevant Factors, Including Economic and Technical Considerations and Agency Statutory Missions

For discussion of the agency's preferences among alternatives based on relevant factors, including economic and technical considerations, *see* Section IV.F of this final rule.

Mitigation

The CEQ regulations specify that a ROD must "state whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not." 49 CFR 1505.2(c). The majority of the environmental effects of NHTSA's action are positive, *i.e.,* beneficial environmental impacts, and would not raise issues of mitigation. The only negative environmental impacts are the projected increase in emissions of carbon monoxide and certain air toxics, as discussed above under the Environmentally Preferable Alternative, and in Section 2.6 and Chapter 5 of the FEIS. The agency forecasts these increases because, under all the alternatives analyzed in the EIS, increase in vehicle use due to improved fuel economy is projected to result in growth in total miles traveled by passenger cars and light trucks. This growth is exacerbated by the expected growth in the number of passenger cars and light trucks in use in the United States. The growth in travel outpaces emissions reductions for some pollutants, resulting in projected increases for these pollutants.

NHTSA's authority to promulgate new fuel economy standards is limited and does not allow regulation of vehicle emissions or of factors affecting vehicle emissions, including driving habits. Consequently, under the CAFE program, NHTSA must set standards but is unable to take steps to mitigate the impacts of these standards. However, we note that the Department of Transportation is currently implementing initiatives that work toward the stated Secretarial policy goal of reducing annual vehicle miles traveled. Chapter 5 of the FEIS outlines a number of other initiatives across government that could ameliorate the environmental impacts of motor vehicle use.

L. Regulatory Notices and Analyses

Following is a discussion of regulatory notices and analyses relevant to this rulemaking.

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 is economically significant. Accordingly, OMB reviewed it under Executive Order 12866. The rule is also significant within the meaning of the Department of Transportation's Regulatory Policies and Procedures.

The benefits and costs of this rule are described above. Because the rule is economically significant under both the Department of Transportation's procedures and OMB guidelines, the agency has prepared a Final Regulatory Impact Analysis (FRIA) 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 rule. 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 final rule meets these criteria on all counts.

2. National Environmental Policy Act

Under NEPA, a Federal agency must prepare an Environmental Impact Statement (EIS) on proposed actions that could significantly impact the quality of the human environment. The requirement is designed to serve three major functions: (1) To provide the decisionmaker(s) with a detailed description of the potential environmental impacts of a proposed action prior to its adoption, (2) to rigorously explore and evaluate all reasonable alternatives, and (3) to inform the public of, and allow comment on, such efforts.

In addition, the CEQ regulations emphasize agency cooperation early in the NEPA process, and allow a lead agency (in this case, NHTSA) to request the assistance of other agencies that either have jurisdiction by law or have special expertise regarding issues considered in an EIS.[777] NHTSA invited EPA to be a cooperating agency because of its special expertise in the areas of climate change and air quality. On May 12, 2009, EPA agreed to become a cooperating agency.[778]

NHTSA, in cooperation with EPA, prepared a draft EIS (DEIS), solicited public comments in writing and in a public hearing, and prepared a final EIS (FEIS) responding to those comments. Specifically, in April 2009, NHTSA published an NOI to prepare an EIS for proposed MYs 2012–2016 CAFE standards.[779] *See* 40 CFR 1501.7.

On September 25, 2009, EPA issued its Notice of Availability of the DEIS,[780] triggering the 45-day public comment period. *See* 74 FR 48951. *See* also 40 CFR 1506.10. In accordance with CEQ regulations, the public was invited to submit written comments on the DEIS until November 9, 2009. *See* 40 CFR 1503, *et seq.*

NHTSA mailed (both electronically and through regular U.S. mail) over 500 copies of the DEIS to interested parties, including Federal, State, and local officials and agencies; elected officials, environmental and public interest groups; Native American tribes; and other interested individuals. NHTSA held a public hearing on the DEIS at the National Transportation Safety Board Conference Center in Washington, DC on October 30, 2009.

NHTSA received 11 written comments from interested stakeholders, including Federal agencies, state agencies, environmental advocacy groups, and private citizens. In addition, three interested parties spoke at the public hearing. The transcript from the public hearing and written comments submitted to NHTSA are part of the administrative record, and are available on the Federal Docket, which can be found on the Web at *http://www.regulations.gov,* Reference Docket No. NHTSA–2009–0059.

NHTSA reviewed and analyzed all comments received during the public comment period and revised the FEIS in response to comments on the EIS where appropriate.[781] For a more detailed discussion of NHTSA's scoping and comment periods, *see* Section 1.5 and Chapter 10 of the FEIS.

On February 22, 2010, NHTSA submitted the FEIS to the EPA. NHTSA also mailed (both electronically and through regular U.S. mail) over 500 copies of the FEIS to interested parties and posted the FEIS on its Web site, *http://www.nhtsa.gov/portal/fueleconomy.jsp.* On March 3, 2010, EPA published a Notice of Availability of the FEIS in the **Federal Register.** *See* 75 FR 9596.

The FEIS analyzes and discloses the potential environmental impacts of the proposed MYs 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 National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) regulations implementing NEPA, DOT Order 5610.1C, and NHTSA regulations.[782] The FEIS compared the potential environmental impacts of alternative mile per gallon (mpg) levels considered by NHTSA for the final rule. It also analyzed direct, indirect, and cumulative impacts and analyzes impacts in proportion to their significance. See the FEIS and the FEIS Summary for a discussion of the environmental impacts analyzed. Docket Nos. NHTSA–2009–0059–0140, NHTSA–2009–0059–0141.

The MYs 2012–2016 CAFE standards adopted in this final rule have been informed by analyses contained in the *Final Environmental Impact Statement, Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2012–2016,* Docket No. NHTSA–2009–0059 (FEIS). For purposes of this rulemaking, the agency referred to an extensive compilation of technical and policy documents available in NHTSA's EIS/Rulemaking docket and EPA's docket. NHTSA's EIS and rulemaking docket and EPA's rulemaking docket can be found on the Web at *http://www.regulations.gov*, Reference Docket Nos.: NHTSA–2009–0059 (EIS and Rulemaking) and EPA–HQ–OAR–2009–0472 (EPA Rulemaking).

Based on the foregoing, the agency concludes that the environmental analysis and public involvement process complies with NEPA implementing regulations issued by CEQ, DOT Order 5610.1C, and NHTSA regulations.[783]

3. Clean Air Act (CAA)

The CAA (42 U.S.C. 7401) is the primary Federal legislation that addresses air quality. Under the authority of the CAA and subsequent amendments, the EPA has established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants, which are relatively commonplace pollutants that can accumulate in the atmosphere as a result of normal levels of human activity. The EPA is required to review the NAAQS every five years and to change the levels of the standards

[777] 40 CFR 1501.6.

[778] Consistent with the National Fuel Efficiency Policy that the President announced on May 19, 2009, EPA and NHTSA published their Notice of Upcoming Joint Rulemaking to ensure a coordinated National Program on GHG emissions and fuel economy for passenger cars, light-duty trucks, and medium-duty passenger vehicles. NHTSA takes no position on whether the EPA proposed rule on GHG emissions could be considered a "connected action" under the CEQ regulation at 40 CFR Section 1508.25. For purposes of the EIS, however, NHTSA decided to treat the EPA proposed rule as if it were a "connected action" under that regulation to improve the usefulness of the EIS for NHTSA decisionmakers and the public. NHTSA is aware that Section 7(c) of the Energy Supply and Environmental Coordination Act of 1974 expressly exempts from NEPA requirements EPA action taken under the CAA. *See* 15 U.S.C. 793(c)(1).

[779] *See* Notice of Intent to Prepare an Environmental Impact Statement for New Corporate Average Fuel Economy Standards, 74 FR 14857 (Apr. 1, 2009).

[780] Also on September 25, 2009, NHTSA published a **Federal Register** Notice of Availability of its DEIS. *See* 74 FR 48894. NHTSA's Notice of Availability also announced the date and location of a public hearing, and invited the public to participate at the hearing on October 30, 2009, in Washington, DC. See *id.*

[781] The agency also changed the FEIS as a result of updated information that became available after issuance of the DEIS.

[782] 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.

[783] NEPA is codified at 42 U.S.C. 4321–4347. CEQ's NEPA implementing regulations are codified at 40 CFR parts 1500–1508, and NHTSA's NEPA implementing regulations are codified at 49 CFR part 520.

if warranted by new scientific information.

The air quality of a geographic region is usually assessed by comparing the levels of criteria air pollutants found in the atmosphere to the levels established by the NAAQS. Concentrations of criteria pollutants within the air mass of a region are measured in parts of a pollutant per million parts of air (ppm) or in micrograms of a pollutant per cubic meter ($\mu g/m^3$) of air present in repeated air samples taken at designated monitoring locations. These ambient concentrations of each criteria pollutant are compared to the permissible levels specified by the NAAQS in order to assess whether the region's air quality is potentially unhealthful.

When the measured concentrations of a criteria pollutant within a geographic region are below those permitted by the NAAQS, the region is designated by the EPA as an attainment area for that pollutant, while regions where concentrations of criteria pollutants exceed Federal standards are called nonattainment areas (NAAs). Former NAAs that have attained the NAAQS are designated as maintenance areas. Each NAA is required to develop and implement a State Implementation Plan (SIP), which documents how the region will reach attainment levels within time periods specified in the CAA. In maintenance areas, the SIP documents how the State intends to maintain compliance with the NAAQS. When EPA changes a NAAQS, States must revise their SIPs to address how they will attain the new standard.

Section 176(c) of the CAA prohibits Federal agencies from taking actions in nonattainment or maintenance areas that do not "conform" to the State Implementation Plan (SIP). The purpose of this conformity requirement is to ensure that Federal activities do not interfere with meeting the emissions targets in the SIPs, do not cause or contribute to new violations of the NAAQS, and do not impede the ability to attain or maintain the NAAQS. The EPA has issued two sets of regulations to implement CAA Section 176(c):

- The Transportation Conformity Rules (40 CFR part 51 subpart T), which apply to transportation plans, programs, and projects funded under title 23 United States Code (U.S.C.) or the Federal Transit Act. Highway and transit infrastructure projects funded by FHWA or the Federal Transit Administration (FTA) usually are subject to transportation conformity.
- The General Conformity Rules (40 CFR part 51 subpart W) apply to all other Federal actions not covered under transportation conformity. The General Conformity Rules established emissions thresholds, or *de minimis* levels, for use in evaluating the conformity of a project. If the net emission increases due to the project are less than these thresholds, then the project is presumed to conform and no further conformity evaluation is required. If the emission increases exceed any of these thresholds, then a conformity determination is required. The conformity determination may entail air quality modeling studies, consultation with EPA and State air quality agencies, and commitments to revise the SIP or to implement measures to mitigate air quality impacts.

The CAFE standards and associated program activities are not funded under title 23 U.S.C. or the Federal Transit Act. Further, CAFE standards are established by NHTSA and are not an action undertaken by FHWA or FTA. Accordingly, the CAFE standards are not subject to transportation conformity.

The General Conformity Rules contain several exemptions applicable to "Federal actions," which the conformity regulations define as: "any activity engaged in by a department, agency, or instrumentality of the Federal Government, or any activity that a department, agency or instrumentality of the Federal Government supports in any way, provides financial assistance for, licenses, permits, or approves, other than activities [subject to transportation conformity]." 40 CFR 51.852. "Rulemaking and policy development and issuance" are exempted at 40 CFR 51.853(c)(2)(iii). Since NHTSA's CAFE standards involve a rulemaking process, its action is exempt from general conformity. Also, emissions for which a Federal agency does not have a "continuing program responsibility" are not considered "indirect emissions" subject to general conformity under 40 CFR 51.852. "Emissions that a Federal agency has a continuing program responsibility for means emissions that are specifically caused by an agency carrying out its authorities, and does not include emissions that occur due to subsequent activities, unless such activities are required by the Federal agency." 40 CFR 51.852. Emissions that occur as a result of the final CAFE standards are not caused by NHTSA carrying out its statutory authorities and clearly occur due to subsequent activities, including vehicle manufacturers' production of passenger car and light truck fleets and consumer purchases and driving behavior. Thus, changes in any emissions that result from NHTSA's final CAFE standards are not those for which the agency has a "continuing program responsibility" and NHTSA is confident that a general conformity determination is not required. NHTSA has evaluated the potential impacts of air emissions under NEPA.

4. National Historic Preservation Act (NHPA)

The NHPA (16 U.S.C. 470) sets forth government policy and procedures regarding "historic properties"—that is, districts, sites, buildings, structures, and objects included in or eligible for the National Register of Historic Places (NRHP). *See* also 36 CFR part 800. Section 106 of the NHPA requires Federal agencies to "take into account" the effects of their actions on historic properties. The agency concludes that the NHPA is not applicable to NHTSA's Decision, because it does not directly involve historic properties. The agency has, however, conducted a qualitative review of the related direct, indirect, and cumulative impacts, positive or negative, of the alternatives on potentially affected resources, including historic and cultural resources. *See* Sections 3.5 and 4.5 of the FEIS.

5. Executive Order 12898 (Environmental Justice)

Under Executive Order 12898, Federal agencies are required to identify and address any disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. NHTSA complied with this order by identifying and addressing the potential effects of the alternatives on minority and low-income populations in Sections 3.5 and 4.5 of the FEIS, where the agency set forth a qualitative analysis of the cumulative effects of the alternatives on these populations.

6. Fish and Wildlife Conservation Act (FWCA)

The FWCA (16 U.S.C. 2900) provides financial and technical assistance to States for the development, revision, and implementation of conservation plans and programs for nongame fish and wildlife. In addition, the Act encourages all Federal agencies and departments to utilize their authority to conserve and to promote conservation of nongame fish and wildlife and their habitats. The agency concludes that the FWCA is not applicable to NHTSA's Decision, because it does not directly involve fish and wildlife.

7. Coastal Zone Management Act (CZMA)

The Coastal Zone Management Act (16 U.S.C. 1450) provides for the preservation, protection, development, and (where possible) restoration and enhancement of the nation's coastal zone resources. Under the statute, States are provided with funds and technical assistance in developing coastal zone management programs. Each participating State must submit its program to the Secretary of Commerce for approval. Once the program has been approved, any activity of a Federal agency, either within or outside of the coastal zone, that affects any land or water use or natural resource of the coastal zone must be carried out in a manner that is consistent, to the maximum extent practicable, with the enforceable policies of the State's program.

The agency concludes that the CZMA is not applicable to NHTSA's Decision, because it does not involve an activity within, or outside of, the nation's coastal zones. The agency has, however, conducted a qualitative review of the related direct, indirect, and cumulative impacts, positive or negative, of the alternatives on potentially affected resources, including coastal zones. *See* Sections 3.5 and 4.5 of the FEIS.

8. Endangered Species Act (ESA)

Under Section 7(a)(2) of the Endangered Species Act (ESA) Federal agencies must ensure that actions they authorize, fund, or carry out are "not likely to jeopardize" federally listed threatened or endangered species or result in the destruction or adverse modification of the designated critical habitat of these species. 16 U.S.C. 1536(a)(2). If a Federal agency determines that an agency action may affect a listed species or designated critical habitat, it must initiate consultation with the appropriate Service—the U.S. Fish and Wildlife Service (FWS) of the Department of the Interior and/or National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries Service) of the Department of Commerce, depending on the species involved—in order to ensure that the action is not likely to jeopardize the species or destroy or adversely modify designated critical habitat. *See* 50 CFR 402.14. Under this standard, the Federal agency taking action evaluates the possible effects of its action and determines whether to initiate consultation. *See* 51 FR 19926, 19949 (Jun. 3, 1986).

NHTSA has reviewed applicable ESA regulations, case law, guidance, and rulings in assessing the potential for impacts to threatened and endangered species from the proposed CAFE standards. NHTSA believes that the agency's action of setting CAFE standards, which will result in nationwide fuel savings and, consequently, emissions reductions from what would otherwise occur in the absence of the agency's CAFE standards, does not require consultation with NOAA Fisheries Service or the FWS under section 7(a)(2) of the ESA. For additional discussion of the agency's rationale, see Appendix G of the FEIS. Accordingly, NHTSA has concluded its review of this action under Section 7 of the ESA.

NHTSA has worked with EPA to assess ESA requirements and develop the agencies' responses to comments addressing this issue. NHTSA notes that EPA has reached the same conclusion as NHTSA, and has determined that ESA consultation is not required for its action taken today pursuant to the Clean Air Act. EPA's determination with regard to ESA is set forth in its response to comments regarding ESA requirements, and can be found in EPA's Response to Comments document, which EPA will place in the EPA docket for this rulemaking (OAR–2009–0472), and on the EPA Web site. As set forth therein, EPA adopts the reasoning of NHTSA's response in Appendix G of the FEIS as applied to EPA's rulemaking action.

9. Floodplain Management (Executive Order 11988 & DOT Order 5650.2)

These Orders require Federal agencies to avoid the long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to restore and preserve the natural and beneficial values served by floodplains. Executive Order 11988 also directs agencies to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains through evaluating the potential effects of any actions the agency may take in a floodplain and ensuring that its program planning and budget requests reflect consideration of flood hazards and floodplain management. DOT Order 5650.2 sets forth DOT policies and procedures for implementing Executive Order 11988. The DOT Order requires that the agency determine if a proposed action is within the limits of a base floodplain, meaning it is encroaching on the floodplain, and whether this encroachment is significant. If significant, the agency is required to conduct further analysis of the proposed action and any practicable alternatives. If a practicable alternative avoids floodplain encroachment, then the agency is required to implement it.

In this rulemaking, the agency is not occupying, modifying and/or encroaching on floodplains. The agency, therefore, concludes that the Orders are not applicable to NHTSA's Decision. The agency has, however, conducted a review of the alternatives on potentially affected resources, including floodplains. *See* Section 4.5 of the FEIS.

10. Preservation of the Nation's Wetlands (Executive Order 11990 & DOT Order 5660.1a)

These Orders require Federal agencies to avoid, to the extent possible, undertaking or providing assistance for new construction located in wetlands unless the agency head finds that there is no practicable alternative to such construction and that the proposed action includes all practicable measures to minimize harms to wetlands that may result from such use. Executive Order 11990 also directs agencies to take action to minimize the destruction, loss or degradation of wetlands in "conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities." DOT Order 5660.1a sets forth DOT policy for interpreting Executive Order 11990 and requires that transportation projects "located in or having an impact on wetlands" should be conducted to assure protection of the Nation's wetlands. If a project does have a significant impact on wetlands, an EIS must be prepared.

The agency is not undertaking or providing assistance for new construction located in wetlands. The agency, therefore, concludes that these Orders do not apply to NHTSA's Decision. The agency has, however, conducted a review of the alternatives on potentially affected resources, including wetlands. *See* Section 4.5 of the FEIS.

11. Migratory Bird Treaty Act (MBTA), Bald and Golden Eagle Protection Act (BGEPA), Executive Order 13186

The MBTA provides for the protection of migratory birds that are native to the United States by making it illegal for anyone to pursue, hunt, take, attempt to take, kill, capture, collect, possess, buy, sell, trade, ship, import, or export any migratory bird covered under the statute. The statute prohibits both intentional and unintentional acts. Therefore, the statute is violated if an agency acts in a manner that harms a migratory bird, whether it was intended or not. *See, e.g., United States* v. *FMC Corp.,* 572 F.2d 902 (2nd Cir. 1978).

The BGEPA (16 U.S.C. 668) prohibits any form of possession or taking of both bald and golden eagles. Under the BGEPA, violators are subject to criminal and civil sanctions as well as an enhanced penalty provision for subsequent offenses.

Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," helps to further the purposes of the MBTA by requiring a Federal agency to develop a Memorandum of Understanding (MOU) with the Fish and Wildlife Service when it is taking an action that has (or is likely to have) a measurable negative impact on migratory bird populations.

The agency concludes that the MBTA, BGEPA, and Executive Order 13186 do not apply to NHTSA's Decision, because there is no disturbance and/or take involved in NHTSA's Decision.

12. Department of Transportation Act (Section 4(f))

Section 4(f) of the Department of Transportation Act of 1966 (49 U.S.C. 303), as amended by Public Law § 109–59, is designed to preserve publicly owned parklands, waterfowl and wildlife refuges, and significant historic sites. Specifically, Section 4(f) of the Department of Transportation Act provides that DOT agencies cannot approve a transportation program or project that requires the use of any publicly owned land from a significant public park, recreation area, or wildlife and waterfowl refuge, or any land from a significant historic site, unless a determination is made that:

- There is no feasible and prudent alternative to the use of land, and
- The program or project includes all possible planning to minimize harm to the property resulting from use, or
- A transportation use of Section 4(f) property results in a *de minimis* impact.

The agency concludes that the Section 4(f) is not applicable to NHTSA's Decision because this rulemaking does not require the use of any publicly owned land. For a more detailed discussion, *please see* Section 3.5 of the FEIS.

13. 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 this final rule will 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)).

The final rule directly affects twenty-one large single stage motor vehicle manufacturers.[784] According to current information, the final rule would also affect two small domestic single stage motor vehicle manufacturers, Saleen and Tesla.[785] 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 above those finalized 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. Ferrari commented that NHTSA will not necessarily always grant the petitions of small vehicle manufacturers for alternative standards, and that therefore the relief is not guaranteed.[786] In response, NHTSA notes that the fact that the agency may not grant a petition for an alternative standard for one manufacturer at one time does not mean that the mechanism for handling small businesses is unavailable for all. Thus, 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.

14. 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. Several state agencies provided comments to the proposed standards.

Additionally, 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 will apply nationally under the National Program.

[784] BMW, Daimler (Mercedes), Chrysler, Ferrari, Ford, Subaru, General Motors, Honda, Hyundai, Kia, Lotus, Maserati, Mazda, Mitsubishi, Nissan, Porsche, Subaru, Suzuki, Tata, Toyota, and Volkswagen.

[785] 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.

[786] We note that Ferrari would not currently qualify for such an alternative standard, because it does not manufacture fewer than 10,000 passenger automobiles per year, as required by 49 U.S.C. 32902(d) for exemption from the main passenger car CAFE standard.

15. Executive Order 12988 (Civil Justice Reform)

Pursuant to Executive Order 12988, "Civil Justice Reform,"[787] NHTSA has considered whether this rulemaking would have any retroactive effect. This final rule does not have any retroactive effect.

16. 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 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 final 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 final rule, 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 concluded that the final 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.

17. 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.

18. Executive Order 13045

Executive Order 13045[788] 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 FEIS 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).[789] 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 FEIS 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. 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.* 2005). 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.* 2005).

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.* 2005); toxins associated with red tide directly affect the nervous system (Epstein *et al.* 2005).

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 FEIS, NHTSA has evaluated the environmental health and safety effects of agency's action on children.

19. 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

[787] 61 FR 4729 (Feb. 7, 1996).

[788] 62 FR 19885 (Apr. 23, 1997).

[789] The references referred to in the remainder of this section are detailed in Section 7.4.5 of the FEIS.

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 final CAFE standards.

20. Executive Order 13211

Executive Order 13211[790] 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 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 final rule and explain why the final regulation is preferable to other potentially effective and reasonably feasible alternatives considered by us.

The final 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 final rulemaking action is not designated as a significant energy action.

21. Department of Energy Review

In accordance with 49 U.S.C. 32902(j)(1), we submitted this final rule to the Department of Energy for review. That Department did not make any comments that we have not addressed.

22. 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 85

Confidential business information, Imports, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Research, Warranties.

40 CFR Part 86

Administrative practice and procedure, Confidential business information, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 600

Administrative practice and procedure, Electric power, Fuel economy, Incorporation by reference, Labeling, Reporting and recordkeeping requirements.

49 CFR Part 531 and 533

Fuel economy.

49 CFR Part 536 and 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

■ Accordingly, EPA amends 40 CFR Chapter I as follows:

PART 85—CONTROL OF AIR POLLUTION FROM MOBILE SOURCES

■ 1. The authority citation for part 85 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart T—[Amended]

■ 2. Section 85.1902 is amended by revising paragraphs (b) and (d) to read as follows:

§ 85.1902 Definitions.

* * * * *

(b) The phrase *emission-related defect* shall mean:

(1) A defect in design, materials, or workmanship in a device, system, or assembly described in the approved Application for Certification (required by 40 CFR 86.1843–01 and 86.1844–01, and by 40 CFR 86.001–22 and similar provisions of 40 CFR part 86) which affects any parameter or specification enumerated in appendix VIII of this part; or

(2) A defect in the design, materials, or workmanship in one or more emissions control or emission-related parts, components, systems, software or elements of design which must function properly to assure continued compliance with vehicle emission requirements, including compliance with CO_2, CH_4, N_2O, and carbon-related exhaust emission standards;

* * * * *

(d) The phrase *Voluntary Emissions Recall* shall mean a repair, adjustment, or modification program voluntarily initiated and conducted by a manufacturer to remedy any emission-related defect for which direct notification of vehicle or engine owners has been provided, including programs to remedy defects related to emissions standards for CO_2, CH_4, N_2O, and/or carbon-related exhaust emissions.

* * * * *

PART 86—CONTROL OF EMISSIONS FROM NEW AND IN–USE HIGHWAY VEHICLES AND ENGINES

■ 3. The authority citation for part 86 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

■ 4. Section 86.1 is amended by adding paragraphs (b)(2)(xxxix) through (xl) to read as follows:

§ 86.1 Reference materials.

* * * * *

(b) * * *

(2) * * *

(xxxix) SAE J2064, Revised December 2005, R134a Refrigerant Automotive Air-Conditioned Hose, IBR approved for § 86.166–12.

(xl) 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]

■ 5. 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 40 CFR 1065.275 for the determination of N_2O (required for 2015 and later model year vehicles). A heated

[790] 66 FR 28355 (May 18, 2001).

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:

* * * * *

■ 6. Section 86.113–04 is amended by revising the entry for RVP in the table in paragraph (a)(1) to read as follows:

§ 86.113–04 Fuel specifications.

* * * * *

(a) * * *

(1) * * *

Item	ASTM test method No.	Value
* * * * *	*	*
RVP [2, 3]	D 323	8.7–9.2 (60.0–63.4)
* * * * *	*	*

* * * * *

■ 7. A new § 86.127–12 is added to read as follows:

§ 86.127–12 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 (d) of this section, and the contents of §§ 86.135–00, 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. Paragraph (e) of this section discusses fuel spitback emissions. 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. Paragraphs (h) and (i) of this section are applicable to all vehicle emission test procedures.

(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, NMOG, CO, NO_X, CO_2, N_2O, CH_4, CH_3OH, C_2H_5OH, C_2H_4O, and HCHO.

(2) Particulates.

(3) Evaporative HC (for gasoline-fueled, methanol-fueled and gaseous-fueled vehicles) and CH_3OH (for methanol-fueled vehicles). The evaporative testing portion of the procedure occurs after the exhaust emission test; however, exhaust emissions need not be sampled to complete a test for evaporative emissions.

(4) Fuel spitback (this test is not required for gaseous-fueled vehicles).

(b) The FTP Otto-cycle exhaust emission test is designed to determine gaseous THC, NMHC, NMOG, 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 approximately 11 miles (approximately 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 the test described in paragraph (b) of this section. 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 paragraph (b) of this section. 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 paragraph (b) of this section. Additionally, for ethanol-fueled vehicles, ethanol and acetaldehyde are collected continuously for analysis as in paragraph (b) of this section. 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) The evaporative emission test (gasoline-fueled vehicles, methanol-fueled and gaseous-fueled vehicles) is designed to determine hydrocarbon and methanol evaporative emissions as a consequence of diurnal temperature fluctuation, urban driving and hot soaks following drives. It is associated with a series of events that a vehicle may experience and that may result in hydrocarbon and/or methanol vapor losses. The test procedure is designed to measure:

(1) Diurnal emissions resulting from daily temperature changes (as well as relatively constant resting losses), measured by the enclosure technique (see § 86.133–96);

(2) Running losses resulting from a simulated trip performed on a chassis dynamometer, measured by the enclosure or point-source technique (see § 86.134–96; this test is not required for gaseous-fueled vehicles); and

(3) Hot soak emissions, which result when the vehicle is parked and the hot engine is turned off, measured by the enclosure technique (see § 86.138–96).

(e) Fuel spitback emissions occur when a vehicle's fuel fill neck cannot accommodate dispensing rates. The vehicle test for spitback consists of a short drive followed immediately by a complete refueling event. This test is not required for gaseous-fueled vehicles.

(f) The element of the SFTP for exhaust emissions related to aggressive driving (US06) is designed to determine gaseous THC, NMHC, CO, CO_2, CH_4, and NO_X emissions from gasoline-fueled or diesel-fueled vehicles (see § 86.158–08 Supplemental test procedures; overview, and § 86.159–08 Exhaust emission test procedures for US06 emissions). The test cycle simulates urban driving speeds and accelerations that are not represented by the FTP Urban Dynamometer Driving Schedule simulated trips discussed in paragraph (b) of this section. The test consists of vehicle operation on a chassis dynamometer through a specified driving cycle (see paragraph (g), US06 Dynamometer Driving Schedule, of appendix I to this part). 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.

(g)(1) The element of the SFTP related to the increased exhaust emissions caused by air conditioning operation (SC03) is designed to determine gaseous THC, NMHC, CO, CO_2, CH_4, and NO_X emissions from gasoline-fueled or diesel fueled vehicles related to air conditioning use (see § 86.158–08 Supplemental Federal test procedures; overview and § 86.160–00 Exhaust emission test procedure for SC03 emissions). The test cycle simulates urban driving behavior with the air conditioner operating. The test consists of engine startups and vehicle operation on a chassis dynamometer through specified driving cycles (see paragraph (h), SC03 Dynamometer Driving Schedule, of appendix I to this part). 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. The testing sequence includes an approved preconditioning cycle, a 10 minute soak with the engine turned off, and the SC03 cycle with measured exhaust emissions.

(2) The SC03 air conditioning test is conducted with the air conditioner operating at specified settings and the ambient test conditions of:

(i) Air temperature of 95 °F;

(ii) 100 grains of water/pound of dry air (approximately 40 percent relative humidity);

(iii) Simulated solar heat intensity of 850 W/m² (see § 86.161–00(d)); and

(iv) Air flow directed at the vehicle that will provide representative air conditioner system condenser cooling at all vehicle speeds (see § 86.161–00(e)).

(3) Manufacturers have the option of simulating air conditioning operation during testing at other ambient test conditions provided they can demonstrate that the vehicle tail pipe exhaust emissions are representative of the emissions that would result from the SC03 cycle test procedure and the ambient conditions of paragraph (g)(2) of this section. The simulation test procedure must be approved in advance by the Administrator (see §§ 86.162–03 and 86.163–00).

(h) Except in cases of component malfunction or failure, all emission control systems installed on or incorporated in a new motor vehicle shall be functioning during all procedures in this subpart. Maintenance to correct component malfunction or failure shall be authorized in accordance with § 86.007–25 or § 86.1834–01 as applicable.

(i) Background concentrations are measured for all species for which emissions measurements are made. For exhaust testing, this requires sampling and analysis of the dilution air. For evaporative testing, this requires measuring initial concentrations. (When testing methanol-fueled vehicles, manufacturers may choose not to measure background concentrations of methanol and/or formaldehyde, and then assume that the concentrations are zero during calculations.)

■ 8. A new § 86.135–12 is added 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 2015 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 § 86.110–94. Parallel samples of the dilution air are similarly analyzed for THC, CO, CO_2, CH_4, NO_X, and, for 2015 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 2015 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 2015 and later model year vehicles, N_2O.

(b) During dynamometer operation, a fixed speed cooling fan shall be positioned so as to direct cooling air to the vehicle in an appropriate manner with the engine compartment cover open. In the case of vehicles with front engine compartments, the fan shall be squarely positioned within 12 inches (30.5 centimeters) of the vehicle. In the case of vehicles with rear engine compartments (or if special designs make the above impractical), the cooling fan shall be placed in a position to provide sufficient air to maintain vehicle cooling. The fan capacity shall normally not exceed 5300 cfm (2.50 m³/sec). However, if the manufacturer can show that during field operation the vehicle receives additional cooling, and that such additional cooling is needed to provide a representative test, the fan capacity may be increased, additional fans used, variable speed fan(s) may be used, and/or the engine compartment cover may be closed, if approved in advance by the Administrator. For example, the hood may be closed to provide adequate air flow to an intercooler through a factory installed hood scoop. Additionally, the Administrator may conduct certification, fuel economy and in-use testing using the additional cooling set-up approved for a specific vehicle.

(c) The vehicle speed as measured from the dynamometer rolls shall be used. A speed vs. time recording, as evidence of dynamometer test validity, shall be supplied on request of the Administrator.

(d) Practice runs over the prescribed driving schedule may be performed at test point, provided an emission sample is not taken, for the purpose of finding the minimum throttle action to maintain the proper speed-time relationship, or to permit sampling system adjustment. **Note:** When using two-roll dynamometers a truer speed-time trace may be obtained by minimizing the rocking of the vehicle in the rolls; the rocking of the vehicle changes the tire rolling radius on each roll. This rocking may be minimized by restraining the vehicle horizontally (or nearly so) by using a cable and winch.

(e) The drive wheel tires may be inflated up to a gauge pressure of 45 psi (310 kPa) in order to prevent tire damage. The drive wheel tire pressure shall be reported with the test results.

(f) If the dynamometer has not been operated during the 2-hour period immediately preceding the test, it shall be warmed up for 15 minutes by operating at 30 mph (48 kph) using a non-test vehicle or as recommended by the dynamometer manufacturer.

(g) If the dynamometer horsepower must be adjusted manually, it shall be set within 1 hour prior to the exhaust emissions test phase. The test vehicle shall not be used to make this adjustment. Dynamometers using automatic control of pre-selectable power settings may be set anytime prior to the beginning of the emissions test.

(h) The driving distance, as measured by counting the number of dynamometer roll or shaft revolutions, shall be determined for the transient cold start, stabilized cold start, and transient hot start phases of the test. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle's speed.

(i) Four-wheel drive and all-wheel drive vehicles may be tested either in a four-wheel drive or a two-wheel drive mode of operation. In order to test in the two-wheel drive mode, four-wheel drive and all-wheel drive vehicles may have one set of drive wheels disengaged; four-wheel and all-wheel drive vehicles which can be shifted to a two-wheel mode by the driver may be tested in a two-wheel drive mode of operation.

■ 9. 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 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 soak periods longer than two hours, 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 after this 600 second idle period. Manually controlled air conditioning systems must complete one additional idle period as 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 operation, 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 CO_2 is measured). Round this result to the nearest tenth of a 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 tenth of a 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 tenth of a 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.

(f) The Administrator may prescribe procedures other than those in this section for air conditioning systems and/or vehicles that may not be susceptible to satisfactory testing by the procedures and methods in this section. For example, the Administrator may prescribe alternative air conditioning system settings for systems with controls that are not able to meet the requirements in this section.

■ 10. 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 in grams per year 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:

$$\text{Grams/YR}_{TOT} = \text{Grams/YR}_{RP} + \text{Grams/YR}_{SP} + \text{Grams/YR}_{FH} + \text{Grams/YR}_{MC} + \text{Grams/YR}_{C}$$

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.

(b) *Rigid pipe connections.* Determine the grams per year emission rate for rigid pipe connections using the following equation:

$$\text{Grams/YR}_{RP} = 0.00522 \times [(125 \times SO) + (75 \times SCO) + (50 \times MO) + (10 \times SW) + (5 \times SWO) + (MG)]$$

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:

$$\text{Grams/YR}_{SP} = 0.522 \times [(0.3 \times HSSP) + (0.2 \times LSSP) + (0.2 \times STV) + (0.2 \times TXV)]$$

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 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 all hoses in the system to calculate a total flexible hose emission rate for the system. Hose end connections shall be included in the calculations in paragraph (b) of this section.

$$\text{Grams/YR}_{FH} = 0.00522 \times (3.14159 \times ID \times L \times ER)$$

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/mm^2. Select the appropriate value for ER 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:

$$\text{Grams/YR}_{C} = 0.00522 \times [(300 \times OHS) + (200 \times MHS) + (150 \times FAP) + (100 \times GHS) + (1500/SSL)]$$

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) *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.

Subpart S—[Amended]

■ 11. 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 are 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 greenhouse gas 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), nitrous oxide (N_2O), and methane (CH_4).

(j) *Exemption from greenhouse gas emission standards for small businesses.* Manufacturers that qualify as a small business under the Small Business Administration regulations in 13 CFR part 121 are exempt from the greenhouse gas emission standards specified in § 86.1818–12 and in associated provisions in this part and in part 600 of this chapter. Both U.S.-based and non-U.S.-based businesses are eligible for this exemption. The following categories of businesses (with their associated NAICS codes) may be eligible for exemption based on the Small Business Administration size standards in 13 CFR 121.201.

(1) Vehicle manufacturers (NAICS code 336111).

(2) Independent commercial importers (NAICS codes 811111, 811112, 811198, 423110, 424990, and 441120).

(3) Alternate fuel vehicle converters (NAICS codes 335312, 336312, 336322, 336399, 454312, 485310, and 811198).

(k) *Conditional exemption from greenhouse gas emission standards.* Manufacturers meeting the eligibility requirements described in paragraph (k)(1) and (2) of this section may request a conditional exemption from compliance with the emission standards described in § 86.1818–12 paragraphs (c) through (e) and associated provisions in this part and in part 600 of this chapter. The terms "sales" and "sold" as used in this paragraph (k) shall mean vehicles produced and delivered for sale (or sold) in the states and territories of the United States. For the purpose of determining eligibility the sales of related companies shall be aggregated according to the provisions of § 86.1838–01(b)(3).

(1) *Eligibility requirements.* Eligibility as determined in this paragraph (k) shall be based on the total sales of combined passenger automobiles and light trucks. Manufacturers must meet one of the requirements in paragraph (k)(1)(i) or (ii) of this section to initially qualify for this exemption.

(i) A manufacturer with 2008 or 2009 model year sales of more than zero and fewer than 5,000 is eligible for a conditional exemption from the greenhouse gas emission standards described in § 86.1818–12 paragraphs (c) through (e).

(ii) A manufacturer with 2008 or 2009 model year sales of more than zero and fewer than 5,000 while under the control of another manufacturer, where those 2008 or 2009 model year vehicles bore the brand of the producing manufacturer but were sold by or otherwise under the control of another manufacturer, and where the manufacturer producing the vehicles became independent no later than December 31, 2010, is eligible for a conditional exemption from the greenhouse gas emission standards described in § 86.1818–12 paragraphs (c) through (e).

(2) *Maintaining eligibility for exemption from greenhouse gas emission standards.* To remain eligible for exemption under this paragraph (k) the manufacturer's average sales for the three most recent consecutive model years must remain below 5,000. If a manufacturer's average sales for the three most recent consecutive model years exceeds 4999, the manufacturer will no longer be eligible for exemption and must meet applicable emission standards according to the provisions in this paragraph (k)(2).

(i) If a manufacturer's average sales for three consecutive model years exceeds 4999, and if the increase in sales is the result of corporate acquisitions, mergers, or purchase by another manufacturer, the manufacturer shall comply with the emission standards described in § 86.1818–12 paragraphs (c) through (e), as applicable, beginning with the first model year after the last year of the three consecutive model years.

(ii) If a manufacturer's average sales for three consecutive model years exceeds 4999 and is less than 50,000, and if the increase in sales is solely the result of the manufacturer's expansion in vehicle production, the manufacturer shall comply with the emission standards described in § 86.1818–12 paragraphs (c) through (e), as applicable, beginning with the second model year after the last year of the three consecutive model years.

(iii) If a manufacturer's average sales for three consecutive model years exceeds 49,999, the manufacturer shall comply with the emission standards described in § 86.1818–12 paragraphs (c) through (e), as applicable, beginning with the first model year after the last year of the three consecutive model years.

(3) *Requesting the conditional exemption from standards.* To be exempted from the standards described in § 86.1818–12(c) through (e), the manufacturer must submit a declaration to EPA containing a detailed written description of how the manufacturer qualifies under the provisions of this paragraph (k). The declaration must describe eligibility information that includes the following: model year 2008 and 2009 sales, sales volumes for each of the most recent three model years, detailed information regarding ownership relationships with other manufacturers, details regarding the application of the provisions of § 86.1838–01(b)(3) regarding the aggregation of sales of related companies, and documentation of good-faith efforts made by the manufacturer to purchase credits from other manufacturers. This declaration must be signed by a chief officer of the company, and must be made prior to each model year for which the exemption 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 exemption is requested, but not later than December of the calendar year prior to the model year for which exemption is requested. A conditional exemption will be granted when EPA approves the exemption declaration. The declaration must be sent to the Environmental Protection Agency at the following address: Director, Compliance and Innovative Strategies Division, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, Michigan 48105.

■ 12. 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 "Carbon-related exhaust emissions."

■ i. By adding the definition for "Combined CO_2."

■ j. By adding the definition for "Combined CREE."

■ 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 electric vehicle."

■ q. By adding the definition for "Highway fuel economy test procedure."

■ r. By adding the definition for "Hybrid electric vehicle."

■ s. By adding the definition for "Interior volume index."

■ t. By revising the definition for "Model type."

■ 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 length and 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.

* * * * *

Carbon-related exhaust emissions (CREE) has the meaning given in § 600.002–08 of this chapter.

* * * * *

Combined CO_2 means the CO_2 value determined for a vehicle (or vehicles) by averaging the city and highway CO_2 values, weighted 0.55 and 0.45 respectively.

Combined CREE means the CREE value determined for a vehicle (or vehicles) by averaging the city and highway fuel CREE 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) The vehicle is capable of drawing recharge energy 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).

(3) The vehicle does not have an onboard combustion engine/generator system as a means of providing electrical energy.

* * * * *

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 and on a methanol or ethanol fuel, or any mixture of the petroleum fuel and methanol or ethanol. 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 vehicle means an electric vehicle propelled solely by an electric motor where energy for the motor is supplied by an electrochemical cell that produces electricity via the non-combustion reaction of a consumable fuel, typically hydrogen.

* * * * *

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, where recharge energy for the energy storage system comes solely from sources on board the vehicle.

* * * * *

Interior volume index has the meaning given in § 600.315–08 of this chapter.

* * * * *

Model type has the meaning given in § 600.002–08 of this chapter.

* * * * *

Motor vehicle has the meaning given in § 85.1703 of this chapter.

* * * * *

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 § 88.104–94(g) of this chapter.

Plug-in hybrid electric vehicle (PHEV) means a hybrid electric vehicle that 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.

* * * * *

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.

* * * * *

■ 13. A new § 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 the fleet average CO_2 emission standards in § 86.1818–12.

(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.

■ 14. 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, CH_4, and N_2O are not required to be monitored by the OBD system.

* * * * *

■ 15. A new § 86.1809–12 is added to read as follows:

§ 86.1809–12 Prohibition of defeat devices.

(a) No new light-duty vehicle, light-duty truck, medium-duty passenger vehicle, or complete heavy-duty vehicle shall be equipped with a defeat device.

(b) The Administrator may test or require testing on any vehicle at a designated location, using driving cycles and conditions that may reasonably be expected to be encountered in normal operation and use, for the purposes of investigating a potential defeat device.

(c) For cold temperature CO and cold temperature NMHC emission control, the Administrator will use a guideline to determine the appropriateness of the CO and NMHC emission control at ambient temperatures between 25 °F (the upper bound of the FTP test temperature range) and 68 °F (the lower bound of the FTP test temperature range). The guideline for CO emission congruity across the intermediate temperature range is the linear interpolation between the CO standard applicable at 25 °F and the CO standard applicable at 68 °F. The guideline for NMHC emission congruity across the intermediate temperature range is the linear interpolation between the NMHC FEL pass limit (*e.g.* 0.3499 g/mi for a 0.3 g/mi FEL) applicable at 20 °F and the Tier 2 NMOG standard to which the vehicle was certified at 68 °F, where the intermediate temperature NMHC level is rounded to the nearest hundredth for comparison to the interpolated line. For vehicles that exceed this CO emissions guideline or this NMHC emissions guideline upon intermediate temperature cold testing:

(1) If the CO emission level is greater than the 20 °F emission standard, the vehicle will automatically be considered to be equipped with a defeat device without further investigation. If the intermediate temperature NMHC emission level, rounded to the nearest hundredth, is greater than the 20 °F FEL pass limit, the vehicle will be presumed to have a defeat device unless the manufacturer provides evidence to EPA's satisfaction that the cause of the test result in question is not due to a defeat device.

(2) If the CO emission level does not exceed the 20 °F emission standard, the Administrator may investigate the vehicle design for the presence of a defeat device under paragraph (d) of this section. If the intermediate temperature NMHC emission level, rounded to the nearest hundredth, does not exceed the 20 °F FEL pass limit the Administrator may investigate the vehicle design for the presence of a defeat device under paragraph (d) of this section.

(d) The following provisions apply for vehicle designs designated by the Administrator to be investigated for possible defeat devices:

(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 the Highway Fuel Economy Test Procedure (described in subpart B of 40 CFR part 600), or the Air Conditioning Idle Test (described in § 86.165–12), when the vehicle is operated under conditions that may reasonably be expected to be encountered in normal operation and use.

(2) The following information requirements apply:

(i) Upon request by the Administrator, the manufacturer must provide an explanation containing detailed information regarding test programs, engineering evaluations, design specifications, calibrations, on-board computer algorithms, and design strategies incorporated for operation both during and outside of the Federal emission test procedures.

(ii) For purposes of investigations of possible cold temperature CO or cold temperature NMHC defeat devices under this paragraph (d), the manufacturer must provide an explanation to show, to the satisfaction of the Administrator, that CO emissions and NMHC emissions are reasonably controlled in reference to the linear guideline across the intermediate temperature range.

(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, nitrous oxide, methane, and formaldehyde measured on the Federal Test Procedure (subpart B of this part) and on the Highway Fuel Economy Test Procedure (subpart B of 40 CFR part 600) does not occur in the temperature range of 20 to 86 °F. For diesel vehicles, the engineering evaluation must also include particulate emissions.

■ 16. 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.

* * * * *

■ 17. 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 standards and other regulations applicable to the emission of the air pollutant defined as the aggregate group of six greenhouse gases: Carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. This section 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 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 that qualify as a small business according to the requirements of § 86.1801–12(j) are exempt from the emission standards in this section. Manufacturers that have submitted a declaration for a model year according to the requirements of § 86.1801–12(k) for which approval has been granted by the Administrator are conditionally exempt from the emission standards in paragraphs (c) through (e) of this section for the approved model year.

(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 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 passenger automobiles and light trucks, 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 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 Temporary Leadtime Allowance Alternative Standards for qualifying manufacturers specified in paragraph (e) of this section shall not include vehicles subject to the Temporary Leadtime Allowance Alternative 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	244.0
2013	237.0
2014	228.0
2015	217.0
2016 and later	206.0

(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	315.0
2013	307.0
2014	299.0
2015	288.0
2016 and later	277.0

(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 and rounded to the nearest 0.1 grams/mile:

$$\text{Target } CO_2 = [4.72 \times f] + b$$

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	50.5
2013	43.3
2014	34.8
2015	23.4
2016 and later	12.7

(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	294.0
2013	284.0
2014	275.0
2015	261.0
2016 and later	247.0

(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	395.0
2013	385.0
2014	376.0
2015	362.0
2016 and later	348.0

(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 and rounded to the nearest 0.1 grams/mile:

$$\text{Target } CO_2 = (4.04 \times f) + b$$

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	128.6
2013	118.7
2014	109.4
2015	95.1
2016 and later	81.1

(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)(3)(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 shall be the combined city/highway carbon-related exhaust emission value calculated for the appropriate vehicle carline/subconfiguration according to the provisions of § 600.113–08(g)(4) of this chapter multiplied by 1.1 and rounded to the nearest whole gram per mile. For in-use vehicle carlines/subconfigurations for which a combined city/highway carbon-related exhaust emission value was not determined under § 600.113(g)(4) of this chapter, the in-use exhaust CO_2 emission standard shall be the combined city/highway carbon-related exhaust emission value calculated according to the provisions of § 600.208–12 of this chapter for the vehicle model type (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. For vehicles that are capable of operating on multiple fuels, including but not limited to alcohol dual fuel, natural gas dual fuel and plug-in hybrid electric vehicles, a separate in-use standard shall be determined for each fuel that the vehicle is capable of operating on. 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.

(e) *Temporary Lead Time Allowance Alternative Standards.* (1) The interim fleet average CO_2 standards in this paragraph (e) are optionally applicable to each qualifying manufacturer, where the terms "sales" or "sold" as used in this paragraph (e) means vehicles produced and delivered for sale (or sold) in the states and territories of the United States.

(i) A qualifying manufacturer is a manufacturer with sales of 2009 model year combined passenger automobiles and light trucks of greater than zero and less than 400,000 vehicles.

(A) If a manufacturer sold less than 400,000 but more than zero 2009 model year combined passenger automobiles and light trucks while under the control of another manufacturer, where those 2009 model year passenger automobiles and light trucks bore the brand of the producing manufacturer, and where the producing manufacturer became independent no later than December 31, 2010, the producing manufacturer is a qualifying manufacturer.

(B) In the case where two or more qualifying manufacturers combine as the result of merger or the purchase of 50 percent or more of one or more companies by another company, and if the combined 2009 model year sales of the merged or combined companies is less than 400,000 but more than zero (combined passenger automobiles and light trucks), the corporate entity formed by the combination of two or more qualifying manufacturers shall continue to be a qualifying manufacturer. The total number of vehicles that the corporate entity is allowed to include under the Temporary Leadtime Allowance Alternative Standards shall be determined by paragraph (e)(2) or (e)(3) of this section where sales is the total combined 2009 model year sales of all of the merged or combined companies. Vehicles sold by the companies that combined by merger/acquisition to form the corporate entity that were subject to the Temporary Leadtime Allowance Alternative Standards in paragraph (e)(4) of this section prior to the merger/acquisition shall be combined to determine the remaining number of vehicles that the corporate entity may include under the Temporary Leadtime Allowance Alternative Standards in this paragraph (e).

(C) In the case where two or more manufacturers combine as the result of merger or the purchase of 50 percent or more of one or more companies by another company, and if the combined 2009 model year sales of the merged or combined companies is equal to or greater than 400,000 (combined passenger automobiles and light trucks), the new corporate entity formed by the combination of two or more manufacturers is not a qualifying manufacturer. Such a manufacturer shall meet the emission standards in paragraph (c) of this section beginning with the model year that is numerically two years greater than the calendar year in which the merger/acquisition(s) took place.

(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) A qualifying manufacturer may not use these Temporary Leadtime Allowance Alternative Standards until they have used all available banked credits and/or credits available for transfer accrued under § 86.1865–12(k). A qualifying manufacturer with a net positive credit balance calculated under § 86.1865–12(k) in any model year after considering all available credits either generated, carried forward from a prior model year, transferred from other averaging sets, or obtained from other manufacturers, may not use these Temporary Leadtime Allowance Alternative Standards in such model year.

(2) Qualifying manufacturers may select any combination of 2012 through 2015 model year passenger automobiles and/or light trucks to include under the Temporary Leadtime Allowance Alternative Standards determined in this paragraph (e) 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.

(3) Qualifying manufacturers with sales of 2009 model year combined passenger automobiles and light trucks in the United States of greater than zero and less than 50,000 vehicles may select any combination of 2012 through 2015 model year passenger automobiles and/or light trucks to include under the Temporary Leadtime Allowance Alternative Standards determined in this paragraph (e) up to a cumulative total of 200,000 vehicles, and additionally may select up to 50,000 2016 model year vehicles to include under the Temporary Leadtime Allowance Alternative Standards determined in this paragraph (e). To be eligible for the provisions of this paragraph (e)(3) qualifying manufacturers must provide annual documentation of good-faith efforts made by the manufacturer to purchase credits from other manufacturers. Without such documentation, the manufacturer may use the Temporary Leadtime Allowance Alternative Standards according to the provisions of paragraph (e)(2) of this section, and the provisions of this paragraph (e)(3) shall not apply. 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.

(4) To calculate the applicable Temporary Leadtime Allowance Alternative Standards, 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 Temporary Leadtime Allowance Alternative Standards, subject to the limitations expressed in paragraphs (e)(1) through (3) of this section.

(i) The Temporary Leadtime Allowance Alternative Standard applicable to qualified passenger automobiles as defined in § 600.002–08 of this chapter 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 Temporary Leadtime Allowance Alternative Standard.

(ii) The Temporary Leadtime Allowance Alternative Standard applicable to qualified light trucks (*i.e.* non-passenger automobiles as defined in § 600.002–08 of this chapter) 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 Temporary Leadtime Allowance Alternative Standard.

(5) Manufacturers choosing to optionally apply these standards are subject to the restrictions on credit banking and trading specified in § 86.1865–12.

(f) *Nitrous oxide (N_2O) and methane (CH_4) exhaust emission standards for passenger automobiles and light trucks.* Each manufacturer's fleet of combined passenger automobile and light trucks must comply with N_2O and CH_4 standards using either the provisions of paragraph (f)(1) of this section or the provisions of paragraph (f)(2) of this section. The manufacturer may not use the provisions of both paragraphs (f)(1) and (f)(2) of this section in a model year. For example, a manufacturer may not use the provisions of paragraph (f)(1) of this section for their passenger automobile fleet and the provisions of paragraph (f)(2) for their light truck fleet in the same model year.

(1) *Standards applicable to each test group.*

(i) 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.

(ii) 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.

(2) *Including N_2O and CH_4 in fleet averaging program.* Manufacturers may elect to not meet the emission standards in paragraph (f)(1) of this section. Manufacturers making this election shall include N_2O and CH_4 emissions in the determination of their fleet average carbon-related exhaust emissions, as calculated in subpart F of part 600 of this chapter. Manufacturers using this option must include both N_2O and CH_4 full useful life values in the fleet average calculations for passenger automobiles and light trucks. Use of this option will account for N_2O and CH_4 emissions within the carbon-related exhaust emission value determined for each model type according to the provisions part 600 of this chapter. This option requires the determination of full useful life emission values for both the Federal Test Procedure and the Highway Fuel Economy Test.

■ 18. 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.* (i) For manufacturers complying with the emission standards for N_2O and CH_4 specified in § 86.1818–12(f)(1), deterioration factors for N_2O and CH_4 shall be determined according to the provisions of paragraphs (a) through (l) of this section.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2), separate deterioration factors shall be determined for the FTP and HFET test cycles. Therefore 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.

(iii) For the 2012 through 2014 model years only, manufacturers may use alternative deterioration factors. For N_2O, the alternative deterioration factor to be used to adjust FTP and HFET emissions is the deterioration factor determined for NO_X emissions according to the provisions of this section. For CH_4, the alternative deterioration factor to be used to adjust FTP and HFET emissions is the deterioration factor determined for NMOG or NMHC emissions according to the provisions of this section.

(3) *Other carbon-related exhaust emissions.* Deterioration factors shall be determined according to the provisions of paragraphs (a) through (l) of this section. Optionally, in lieu of determining emission-specific FTP and HFET deterioration factors for CH_3OH (methanol), HCHO (formaldehyde), C_2H_5OH (ethanol), and C_2H_4O (acetaldehyde), manufacturers may use the deterioration factor determined for NMOG or NMHC emissions according to the provisions of this section.

(4) *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.

■ 19. 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 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.

■ 20. 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 through 2014 model years 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.

* * * * *

■ 21. 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 greenhouse gas exhaust emission standards in § 86.181–12 may be conducted under the provisions of § 600.008–08 of this chapter.

(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 carbon-related exhaust 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 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 exhaust greenhouse gas 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 by doing so will also accept as official the calculated CREE value associated with the lower fuel economy test results.

(ii) The manufacturer shall conduct a second retest of the FTP or highway test if the fuel economy 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 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 exhaust greenhouse gas fleet averaging program) the lowest fuel economy of the original test, the first confirmatory test, and the second confirmatory test fuel economy results, and by doing so will also accept as official the calculated CREE value associated with the lowest fuel economy test results.

(c) * * *

(1) * * *

(ii) Official test results for fuel economy and exhaust CO_2 emission purposes are determined in accordance with the provisions of § 600.008–08 of this chapter.

* * * * *

■ 22. 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.

* * * * *

■ 23. 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 part 600, subpart B of this chapter.

* * * * *

(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 part 600, subpart B of this chapter. 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).

* * * * *

■ 24. 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.

* * * * *

■ 25. 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).

* * * * *

■ 26. 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.

■ 27. 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 emissions.

(c) *Altitude.* Altitude requirements for CO_2 standards are provided in § 86.1810–09(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 greenhouse gas emission standards in § 86.1818–12 according to the provisions of § 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 (j) 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 § 86.1810–09(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 part 600 subpart F (in units of grams per mile rounded to the nearest whole number) become the certification standard for each model type.

(2) Manufacturers must separately calculate production-weighted fleet average carbon-related exhaust emissions levels for the following averaging sets according to the provisions of 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 Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e), if applicable; and

(iv) Light trucks subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e), if applicable.

(j) *Certification compliance and enforcement requirements for CO_2 exhaust emission standards.* (1) Compliance and enforcement requirements are provided in § 86.1864–10 and § 86.1848–10(c)(9).

(2) The certificate issued for each test group requires all model types within that test group to meet the in-use emission standards to which each model type is certified as outlined in § 86.1818–12(d).

(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) 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)(8) 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)(8) of this section). A manufacturer will be subject to penalties on an individual-vehicle basis for sale of vehicles not covered by a certificate.

(iv) EPA will review each manufacturer's production to designate the vehicles that caused the 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)(8) of this section. In a group where only a portion of vehicles would be deemed nonconforming, EPA will determine the actual nonconforming vehicles by counting backwards from the last vehicle produced in that test group. Manufacturers will be liable for penalties for each vehicle sold that is not covered by a certificate.

(k) *Requirements for the CO_2 averaging, banking and trading (ABT) program.* (1) A manufacturer whose CO_2 fleet average emissions exceed the applicable standard must complete the calculation in paragraph (k)(4) of this section to determine the size of its CO_2 deficit. A manufacturer whose CO_2 fleet average emissions are less than the applicable standard 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 and separately for passenger automobiles and light trucks, 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 § 600.511–80 of this chapter; and

Vehicle Lifetime Miles is 195,264 for passenger automobiles and 225,865 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)(8) of this section).

(iii) *Special provisions for manufacturers using the Temporary Leadtime Allowance Alternative Standards.* (A) Credits generated by vehicles subject to the fleet average CO_2 standards specified in § 86.1818–12(c) may only be used to offset a deficit generated by vehicles subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e).

(B) Credits generated by a passenger automobile or light truck averaging set subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e)(4)(i) or (ii) of this section may be used to offset a deficit generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards through the 2015 model year, except that manufacturers qualifying under the provisions of § 86.1818–12(e)(3) may use such credits to offset a deficit generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards through the 2016 model year .

(C) Credits generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e)(4)(i) or (ii) of this section may not be used to offset a deficit generated by an averaging set subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(2) or (3) or otherwise transferred to an averaging set subject to the fleet average CO_2 standards specified in § 86.1818–12(c)(2) or (3).

(D) Credits generated by vehicles subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e)(4)(i) or (ii) may be banked for use in a future model year (to offset a deficit generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards). All such credits shall expire at the end of the 2015 model year, except that manufacturers qualifying under the provisions of § 86.1818–12(e)(3) may use such credits to offset a deficit generated by an averaging set subject to the Temporary Leadtime Allowance Alternative Standards through the 2016 model year.

(E) A manufacturer with any vehicles subject to the Temporary Leadtime Allowance Alternative Standards specified in § 86.1818–12(e)(4)(i) or (ii) of this section in a model year in which that manufacturer also generates credits with vehicles subject to the fleet average CO_2 standards specified in § 86.1818–12(c) may not trade or bank credits earned against the fleet average standards in § 86.1818–12(c) for use in a future model year.

(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 debits were first incurred and round to the nearest whole number to determine the number of vehicles not meeting the fleet average CO_2 standards.

(iii) EPA will determine the vehicles not covered by a certificate because the condition on the certificate was not satisfied by designating vehicles in those test groups with the highest 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) 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 requested by the Administrator. Manufacturers must keep records readily available as EPA may review them at any time.

(iv) The Administrator may require the manufacturer to retain additional records or submit information not specifically required by this section.

(v) Pursuant to a request made by the Administrator, the manufacturer must submit to the Administrator the information that the manufacturer is required to retain.

(vi) EPA may void ab initio a certificate of conformity for vehicles certified to emission standards as set forth or otherwise referenced in this subpart for which the manufacturer fails to retain the records required in this section or to provide such information to the Administrator upon request, or to submit the reports required in this section in the specified time period.

(2) *Reporting.* (i) Each manufacturer must submit an annual report. The annual report must contain for each applicable CO_2 standard, the calculated fleet average CO_2 value, all values required to calculate the CO_2 emissions value, the number of credits generated or debits incurred, all the values required to calculate the credits or debits, and the resulting balance of credits or debits.

(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 § 86.1867–12(b) of this section shall include in the 2012 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 § 86.1867–12(c) shall include in the 2012 report, separately 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 cumulative model year production of eligible vehicles starting with the 2009 model year.

(C) The carbon-related exhaust emission value by model type and model year.

(v) Manufacturers calculating early off-cycle technology credits under paragraph § 86.1867–12(d) shall include in the 2012 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 of this chapter, a manufacturer must submit an annual report for each model year after production ends for all affected vehicles produced by the manufacturer subject to the provisions of this subpart and no later than May 1 of the calendar year following the given model year. Annual reports must be submitted to: Director, Compliance 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 voiding of the certificate under paragraph (l)(1)(vi) of this section will be made only after EPA has offered the affected manufacturer an opportunity for a hearing conducted in accordance with § 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.

■ 28. A new § 86.1866–12 is added to subpart S to read as follows:

§ 86.1866–12 CO_2 fleet average credit programs.

(a) *Incentive for certification of advanced technology vehicles.* Electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles, as those terms are defined in § 86.1803–01, that are certified and produced in the 2012 through 2016 model years may be eligible for a reduced CO_2 emission value under the provisions of this paragraph (a) and under the provisions of part 600 of this chapter.

(1) Electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles may use a value of zero (0) grams/mile of CO_2 to represent the proportion of electric operation of a vehicle that is derived from electricity that is generated from sources that are not onboard the vehicle.

(2) The use of zero (0) grams/mile CO_2 is limited to the first 200,000 combined electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles produced and delivered for sale by a manufacturer in the 2012 through 2016 model years, except that a manufacturer that produces and delivers for sale 25,000 or more such vehicles in the 2012 model year shall be subject to a limitation on the use of zero (0) grams/mile CO_2 to the first 300,000 combined electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles produced and delivered for sale by a manufacturer in the 2012 through 2016 model years.

(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. Manufacturers may also generate early air conditioning refrigerant leakage credits under this paragraph (b) for the 2009 through 2011 model years according to the provisions of § 86.1867–12(b).

(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:

$$\text{Leakage credit} = MaxCredit \times \left[1 - \left(\frac{Leakage}{16.6}\right) \times \left(\frac{GWP_{REF}}{GWP_{HFC134a}}\right)\right]$$

Where:

MaxCredit is 12.6 (grams CO_2-equivalent/mile) for air conditioning systems using HFC–134a, and 13.8 (grams CO_2-equivalent/mile) 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/year (4.1 grams/year for systems using electric compressors) the rate for the purpose of this formula shall be 8.3 grams/year (4.1 grams/year for systems using electric compressors);

The constant 16.6 is the average passenger car impact of air conditioning leakage in units of grams/year;

GWP_{REF} means the global warming potential of the refrigerant as indicated in paragraph (b)(5) of this section or as otherwise determined by the Administrator;

$GWP_{HFC134a}$ means the global warming potential of HFC–134a as indicated in paragraph (b)(5) of this section or as otherwise determined by the Administrator.

(ii) Light trucks:

$$\text{Leakage credit} = MaxCredit \times \left[1 - \left(\frac{Leakage}{20.7}\right) \times \left(\frac{GWP_{REF}}{GWP_{HFC134a}}\right)\right]$$

Where:

MaxCredit is 15.6 (grams CO_2-equivalent/mile) for air conditioning systems using HFC–134a, and 17.2 (grams CO_2-equivalent/mile) 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/year (5.2 grams/year for systems using electric compressors) the rate for the purpose of this formula shall be 10.4 grams/year (5.2 grams/year for systems using electric compressors);

The constant 20.7 is the average passenger car impact of air conditioning leakage in units of grams/year;

GWP_{REF} means the global warming potential of the refrigerant as indicated in paragraph (b)(5) of this section or as otherwise determined by the Administrator;

GWP_{R134a} means the global warming potential of HFC–134a as indicated in paragraph (b)(5) of this section or as otherwise determined 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 195,264 and for light trucks shall be 225,865.

(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).

(5) The following values for refrigerant global warming potential (GWP_{REF}), or alternative values as determined by the Administrator, shall be used in the calculations of this paragraph (b). The Administrator will determine values for refrigerants not included in this paragraph (b)(5) upon request by a manufacturer.

(i) For HFC–134a, GWP_{REF} = 1430;

(ii) For HFC–152a, GWP_{REF} = 124;

(iii) For HFO–1234yf,: GWP_{REF} = 4;

(iv) For CO_2, GWP_{REF} = 1.

(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 (c) for the 2009 through 2011 model years according to the provisions of § 86.1867–12(b). 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 (*e.g.* a compressor that controls displacement based on temperature setpoint and/or cooling demand of the air conditioning system control settings inside the passenger compartment): 1.7 g/mi.

(ii) Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable displacement compressor (*e.g.* a compressor that controls displacement based on conditions within, or internal to, the air conditioning system, such as head pressure, suction pressure, or evaporator outlet temperature): 1.1 g/mi.

(iii) Default to recirculated air with closed-loop control of the air supply (sensor feedback to control interior air quality) whenever the ambient temperature is 75 °F or higher: 1.7 g/mi. Air conditioning systems that operated with closed-loop control of the air supply at different temperatures may receive credits by submitting an engineering analysis to the Administrator for approval.

(iv) Default to recirculated air with open-loop control air supply (no sensor feedback) whenever the ambient temperature is 75 °F or higher: 1.1 g/mi. Air conditioning systems that operate with open-loop control of the air supply at different temperatures may receive credits by submitting an engineering analysis to the Administrator for approval.

(v) Blower motor controls which limit wasted electrical energy (*e.g.* pulse width modulated power controller): 0.9 g/mi.

(vi) Internal heat exchanger (*e.g.* a device that transfers heat from the high-pressure, liquid-phase refrigerant entering the evaporator to the low-pressure, gas-phase refrigerant exiting the evaporator): 1.1 g/mi.

(vii) Improved condensers and/or evaporators with system analysis on the component(s) indicating a coefficient of performance improvement for the system of greater than 10% when compared to previous industry standard designs): 1.1 g/mi.

(viii) Oil separator: 0.6 g/mi. The manufacturer must submit an engineering analysis demonstrating the increased improvement of the system relative to the baseline design, where the baseline component for comparison is the version which a manufacturer most recently had in production on the same vehicle design or in a similar or related vehicle model. The characteristics of the baseline component shall be compared to the new component to demonstrate the improvement.

(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) or (c)(5) of this section, whichever is applicable.

Production = The total number of passenger cars or light trucks, whichever is applicable, produced with the air conditioning system to which to the efficiency credit value from paragraph (c)(2) of this section applies.

VLM = vehicle lifetime miles, which for passenger cars shall be 195,264 and for light trucks shall be 225,865.

(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 21.3 grams per minute.

(A) If the increased CO_2 emissions determined from the Idle Test Procedure in § 86.165–14 is less than or equal to 14.9 grams/minute, the total credit value for use in paragraph (c)(3) of this section shall be as determined in paragraph (c)(2) of this section.

(B) If the increased CO_2 emissions determined from the Idle Test Procedure in § 86.165–14 is greater than 14.9 grams/minute and less than 21.3 grams/minute, the total credit value for use in paragraph (c)(3) of this section shall be as determined according to the following formula:

$$TCV = TCV_1 \times \left[1 - \left(\frac{ITP - 14.9}{6.4}\right)\right]$$

Where:

TCV = The total credit value for use in paragraph (c)(3) of this section;

TCV_1 = The total credit value determined according to paragraph (c)(2) of this section; and

ITP = the increased CO_2 emissions determined from the Idle Test Procedure in § 86.165–14.

(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 and prevent fogging of windows 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 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) *Improved condensers and/or evaporators* 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. The manufacturer must submit an engineering analysis demonstrating the increased improvement of the system relative to the baseline design, where the baseline component(s) for comparison is the version which a manufacturer most recently had in production on the same vehicle design or in a similar or related vehicle model. The dimensional characteristics (*e.g.,* tube configuration/thickness/spacing, and fin density) of the baseline component(s) shall be compared to the new component(s) to demonstrate the improvement in coefficient of performance.

(vi) *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.* With prior EPA approval, 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 criteria in this paragraph (d)(1) must be met as determined by the Administratory:

(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 § 600.114–08 of this chapter.

(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 (rounded to the nearest whole number) 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 195,264 and for light trucks shall be 225,865.

(3) *Notice and opportunity for public comment.* The Administrator will publish a notice of availability in the **Federal Register** notifying the public of a manufacturer's proposed alternative off-cycle credit calculation methodology. The notice will include details regarding the proposed methodology, but will not include any Confidential Business Information. The notice will include instructions on how to comment on the methodology. The Administrator will take public comments into consideration in the final determination, and will notify the public of the final determination. Credits may not be accrued using an approved methodology until the model year following the final approval.

■ 29. 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 EPA approval and 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. The terms "sales" and "sold" as used in this section shall mean vehicles produced and delivered for sale in the states and territories of the United States.

(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 § 600.510–12 of this chapter, 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 § 600.510–12(j)(2)(ii)(B) of this chapter, 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 § 600.510–12(j)(2)(iii)(B) of this chapter, without the use of the 0.15 multiplicative factor.

(D) The average carbon-related exhaust emissions for alcohol dual fueled model types shall be the value measured using gasoline or diesel fuel, as applicable, and shall be calculated according to the provisions of § 600.510–12(j)(2)(vi) of this chapter, 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 the value measured using gasoline or diesel fuel, as applicable, and shall be calculated according to the provisions of § 600.510–12(j)(2)(vii) of this chapter, 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) Carbon-related exhaust emission values for electric, fuel cell, and plug-in hybrid electric model types 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	323	439
2010	301	420
2011	267	390

(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 § 600.511–80 of this chapter; and

Vehicle Lifetime Miles is 195,264 for the LDV/LDT1 averaging set and 225,865 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, and credits earned in the 2009 model year may not be traded to other manufacturers.

(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 California and 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 vehicle emissions from 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, and credits earned in the 2009 model year may not be traded to other manufacturers.

(3) *Pathway 3.* Pathway 3 credits are those credits earned under Pathway 2 as described in paragraph (a)(2) of this section in California 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 California and 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) 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.

(iii) 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.

(iv) Average carbon-related exhaust emission values shall be determined according to the provisions of § 600.510–12 of this chapter, 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 § 600.510–12(j)(2)(ii)(B) of this chapter, 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 § 600.510–12(j)(2)(iii)(B) of this chapter, 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 § 600.510–12(j)(2)(vi) of this chapter, 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 § 600.510–12(j)(2)(vii) of this chapter, without the use of the 0.15 multiplicative factor and with F = 0.

(F) Section 600.510–12(j)(3) of this chapter shall not apply. Electric, fuel cell, 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.

(v) 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.

(vi) 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)(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 § 600.511–80 of this chapter 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 195,264 for the LDV/LDT1 averaging set and 225,865 for the LDT2/HLDT/MDPV averaging set.

(vii) 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, and credits earned in the 2009 model year may not be traded to other manufacturers.

(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 California and 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 § 86.1866–12(b) 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 are required to comply with California greenhouse gas requirements in model years 2009–2011 (for California and section 177 states) may not generate early air conditioning credits for vehicles sold in California and the section 177 states as determined in paragraph (a)(2)(i) of this section.

(c) *Early advanced technology vehicle incentive.* Vehicles eligible for this incentive are electric vehicles, fuel cell 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 vehicles, and plug-in hybrid electric vehicles in their fleet averages calculated under any of the early credit pathways 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 the advanced technology vehicle incentive, the manufacturer will apply the 2009, 2010, and/or 2011 model type sales volumes and their model type emission levels to the manufacturer's fleet average calculation.

(ii) The early advanced technology vehicle incentive 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.

(4) Manufacturers may use zero grams/mile to represent the carbon-related exhaust emission values for the electric operation of 2009 through 2011 model year electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles subject to the limitations in § 86.1866–12(a). The 2009 through 2011 model year vehicles using zero grams per mile shall count against the 200,000 or 300,000 caps on use of this credit value, whichever is applicable under § 86.1866–12(a).

(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) 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.

(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 appropriate averaging sets (*e.g.* LDV/LDT1 and LDT2/HLDT/MDPV averaging sets for pathways 1 and 2; LDV, LDT/2011 MDPV, LDV/LDT1 and LDT2/HLDT/MDPV averaging sets for Pathway 3; LDV and LDT/2011 MDPV averaging sets for Pathway 4):

(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

■ 30. The authority citation for part 600 continues to read as follows:

Authority: 49 U.S.C. 32901–23919q, Pub. L. 109–58.

■ 31. 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

■ 32. The heading for subpart A is revised as set forth above.

■ 33. 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 § 86.1818–12 of this chapter.

■ 34. 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 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."

■ k. By adding the definition for "Track width."

■ l. By adding the definition for "Wheelbase."

§ 600.002–08 Definitions.

* * * * *

Base tire means the tire specified as standard equipment by the manufacturer.

* * * * *

Carbon-related exhaust emissions (CREE) 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 relative to the CO_2 carbon weight fraction, as specified in § 600.113–08. For example, carbon-related exhaust emissions (weighted 55 percent city and 45 percent highway) are used to demonstrate compliance with fleet average CO_2 emission standards outlined in § 86.1818(c) of this chapter.

* * * * *

Electric vehicle has the meaning given in § 86.1803–01 of this chapter.

* * * * *

Footprint has the meaning given in § 86.1803–01 of this chapter.

* * * * *

Fuel cell has the meaning given in § 86.1803–01 of this chapter.

Fuel cell vehicle has the meaning given in § 86.1803–01 of this chapter.

* * * * *

Hybrid electric vehicle (HEV) has the meaning given in § 86.1803–01 of this chapter.

* * * * *

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) has the meaning given in § 86.1803–01 of this chapter.

* * * * *

Track width has the meaning given in § 86.1803–01 of this chapter.

* * * * *

Wheelbase has the meaning given in § 86.1803–01 of this chapter.

* * * * *

■ 35. Section 600.006–08 is amended as follows:

■ a. By revising the section heading.

■ b. By revising paragraph (b)(2)(ii).

■ c. By revising paragraph (b)(2)(iv).

■ d. By revising paragraph (c) introductory text.

■ e. By adding paragraph (c)(5).

■ f. By revising paragraph (e).

■ g. 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) The manufacturer shall submit the following fuel economy data:

* * * * *

(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. Manufacturers incorporating N_2O and CH_4 emissions in their fleet average carbon-related exhaust emissions as allowed under § 86.1818(f)(2) of this chapter shall also submit N_2O and CH_4 emission data where applicable. The fuel economy and CO_2 emission test results shall be adjusted in accordance with paragraph (g) of this section.

* * * * *

(e) In lieu of submitting actual data from a test vehicle, a manufacturer may provide fuel economy and carbon-related exhaust emission 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 and carbon-related exhaust emission 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 carbon-related exhaust emission (CREE) test data generated by vehicles with engine-drive system combinations with more than 6,200 miles by using the following equation:

$$CREE_{4,000mi} = CREE_T[0.979 + 5.25 \times 10^{-6}(mi)]$$

Where:

$CREE_{4,000mi}$ = CREE emission data adjusted to 4,000-mile test point.

$CREE_T$ = Tested emissions value of CREE 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 § 86.1837–01 of this chapter as applicable. CREE values shall be rounded to the nearest gram per mile.

* * * * *

■ 36. 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 § 86.1823–08 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:

* * * * *

■ 37. Section 600.008–08 is amended by revising the section 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 carbon-related exhaust emissions value from the test results associated with the lowest fuel economy results.

* * * * *

■ 38. Section 600.010–08 is amended by revising paragraph (d) to read as follows:

§ 600.010–08 Vehicle test requirements and minimum data requirements.

* * * * *

(d) *Minimum data requirements for the manufacturer's average fuel economy and average carbon-related exhaust emissions.* For the purpose of calculating the manufacturer's average fuel economy and average carbon-related exhaust emissions under § 600.510, the manufacturer shall submit FTP (city) and HFET (highway) test data representing at least 90 percent of the manufacturer's actual model year production, by configuration, for each category identified for calculation under § 600.510–08(a).

■ 39. Section 600.011–93 is amended to read as follows:

§ 600.011–93 Reference materials.

(a) *Incorporation by reference.* The documents referenced in this section have been incorporated by reference in this part. The incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies may be inspected at the U.S. Environmental Protection Agency, Office of Air and Radiation, 1200 Pennsylvania Ave., NW., Washington, DC 20460, phone (202) 272–0167, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html* and is available from the sources listed below:

(b) *ASTM.* The following material is available from the American Society for Testing and Materials. Copies of these materials may be obtained from American Society for Testing and Materials, ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959, phone 610–832–9585. *http://www.astm.org/.*

(1) ASTM E 29–67 (Reapproved 1973) Standard Recommended Practice for Indicating Which Places of Figures Are To Be Considered Significant in Specified Limiting Values, IBR approved for §§ 600.002–93 and 600.002–08.

(2) 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, IBR approved for §§ 600.113–93, 600.510–93, 600.113–08, 600.510–08, and 600.510–12.

(3) ASTM D 3343–90 Standard Test Method for Estimation of Hydrogen Content of Aviation Fuels, IBR approved for §§ 600.113–93 and 600.113–08.

(4) ASTM D 3338–92 Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels, IBR approved for §§ 600.113–93 and 600.113–08.

(5) ASTM D 240–92 Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter, IBR approved for §§ 600.113–93, 600.510–93, 600.113–08, and 600.510–08.

(6) ASTM D975–04c Standard Specification for Diesel Fuel Oils, IBR approved for § 600.107–08.

(7) ASTM D 1945–91 Standard Test Method for Analysis of Natural Gas By Gas Chromatography, IBR approved for §§ 600.113–93, 600.113–08.

(c) *SAE Material.* The following material is available from the Society of

Automotive Engineers. Copies of these materials may be obtained from Society of Automotive Engineers World Headquarters, 400 Commonwealth Dr., Warrendale, PA 15096–0001, phone (877) 606–7323 (U.S. and Canada) or (724) 776–4970 (outside the U.S. and Canada), or at *http://www.sae.org.*

(1) Motor Vehicle Dimensions—Recommended Practice SAE 1100a (Report of Human Factors Engineering Committee, Society of Automotive Engineers, approved September 1973 as revised September 1975), IBR approved for §§ 600.315–08 and 600.315–82.

(2) [Reserved]

Subpart B—Fuel Economy and Carbon-Related Exhaust Emission Regulations for 1978 and Later Model Year Automobiles—Test Procedures

■ 40. The heading for subpart B is revised as set forth above.

■ 41. 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.

■ 42. Section 600.111–08 is amended by revising paragraph (f) to read as follows:

§ 600.111–08 Test procedures.

* * * * *

(f) *Special Test Procedures.* The Administrator may prescribe test procedures, other than those set forth in this Subpart B, for any vehicle which is not susceptible to satisfactory testing and/or testing results by the procedures set forth in this part. For example, special test procedures may be used for advanced technology vehicles, including, but not limited to battery electric vehicles, fuel cell vehicles, plug-in hybrid electric vehicles and vehicles equipped with hydrogen internal combustion engines. Additionally, the Administrator may conduct fuel economy and carbon-related exhaust emission testing using the special test procedures approved for a specific vehicle.

■ 43. A new § 600.113–12 is added to subpart B to read as follows:

§ 600.113–12 Fuel economy and carbon-related exhaust emission 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 and carbon-related exhaust emission 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 manufacturers selecting the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter the calculations of the carbon-related exhaust emissions require the input of grams/mile values for nitrous oxide (N_2O) and methane (CH_4). Emissions shall be determined 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) Calculate the FTP fuel economy.

(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, N_2O 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 separately the grams/mile values for the cold transient phase, stabilized phase and hot transient phase of the FTP test. For vehicles with more than one source of propulsion energy, one of which is a rechargeable energy storage system, or vehicles with special features that the Administrator determines may have a rechargeable energy source, whose charge can vary during the test, calculate separately the grams/mile values for the cold transient phase, stabilized phase, hot transient phase and hot stabilized phase of the FTP test.

(b) Calculate the HFET fuel economy.

(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, N_2O 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, N_2O 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) Calculate the cold temperature FTP fuel economy.

(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, N_2O and CH_4 as specified in § 86.144(b) of this chapter. For 2008 through 2010 diesel-fueled vehicles, HC measurement is optional.

(2) Calculate separately the grams/mile values for the cold transient phase, stabilized phase and hot transient phase of the cold temperature FTP test in § 86.244 of this chapter.

(3) Measure and record the test fuel's properties as specified in paragraph (f) of this section.

(d) Calculate the US06 fuel economy.

(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, N_2O 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, N_2O 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.

(3) Measure and record the test fuel's properties as specified in paragraph (f) of this section.

(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, N_2O 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) *Fuel property determination and analysis.*

(1) Gasoline test fuel properties shall be determined by analysis of a fuel sample taken from the fuel supply. A sample shall be taken after each addition of fresh fuel to the fuel supply. Additionally, the fuel shall be resampled once a month to account for any fuel property changes during storage. Less frequent resampling may be permitted if EPA concludes, on the basis of manufacturer-supplied data, that the properties of test fuel in the manufacturer's storage facility will remain stable for a period longer than one month. The fuel samples shall be analyzed to determine the following fuel properties:

(i) Specific gravity measured using 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" (incorporated by reference at § 600.011–93).

(ii) Carbon weight fraction measured using ASTM D 3343–90 "Standard Test Method for Estimation of Hydrogen Content of Aviation Fuels" (incorporated by reference at § 600.011–93).

(iii) Net heating value (Btu/lb) determined using ASTM D 3338–92 "Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels" (incorporated by reference at § 600.011–93).

(2) Methanol 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" (incorporated by reference at § 600.011–93) for the blend, 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" (incorporated by reference at § 600.011–93) for the gasoline fuel component and also for the methanol fuel component and combining as follows:

$$SG = SGg \times \text{volume fraction gasoline} + SGm \times \text{volume fraction methanol}.$$

(ii)(A) Carbon weight fraction using the following equation:

$$CWF = CWFg \times MFg + 0.375 \times MFm$$

Where:

CWFg = Carbon weight fraction of gasoline portion of blend measured using ASTM D 3343–90 "Standard Test Method for Estimation of Hydrogen Content of Aviation Fuels" (incorporated by reference at § 600.011–93).

MFg = Mass fraction gasoline = $(G \times SGg)/(G \times SGg + M \times SGm)$

MFm = Mass fraction methanol = $(M \times SGm)/(G \times SGg + M \times SGm)$

Where:

G = Volume fraction gasoline.

M = Volume fraction methanol.

SGg = Specific gravity of gasoline as measured using 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" (incorporated by reference at § 600.011–93).

SGm = Specific gravity of methanol as measured using 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" (incorporated by reference at § 600.011–93).

(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).

(3) Natural gas test fuel shall be analyzed to determine the following fuel properties:

(i) Fuel composition measured using ASTM D 1945–91 "Standard Test Method for Analysis of Natural Gas By Gas Chromatography" (incorporated by reference at § 600.011–93).

(ii) Specific gravity measured as based on fuel composition per ASTM D 1945–91 "Standard Test Method for Analysis of Natural Gas by Gas Chromatography" (incorporated by reference at § 600.011–93).

(iii) Carbon weight fraction, based on the carbon contained only in the hydrocarbon constituents of the fuel. This equals the weight of carbon in the hydrocarbon constituents divided by the total weight of fuel.

(iv) Carbon weight fraction of the fuel, which equals the total weight of carbon in the fuel (i.e, includes carbon contained in hydrocarbons and in CO_2) divided by the total weight of fuel.

(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" (incorporated by reference at § 600.011–93) for the blend. 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" (incorporated by reference at § 600.011–93) for the gasoline fuel component and also for the methanol fuel component and combining as follows.

$$SG = SGg \times \text{volume fraction gasoline} + SGm \times \text{volume fraction ethanol}.$$

(ii)(A) Carbon weight fraction using the following equation:

$$CWF = CWFg \times MFg + 0.521 \times MFe$$

Where:

CWFg = Carbon weight fraction of gasoline portion of blend measured using ASTM D 3343–90 "Standard Test Method for Estimation of Hydrogen Content of Aviation Fuels" (incorporated by reference at § 600.011–93).

MFg = Mass fraction gasoline = $(G \times SGg)/(G \times SGg + E \times SGm)$

MFe = Mass fraction ethanol = $(E \times SGm)/(G \times SGg + E \times SGm)$

Where:

G = Volume fraction gasoline.

E = Volume fraction ethanol.

SGg = Specific gravity of gasoline as measured using 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" (incorporated by reference at § 600.011–93).

SGm = Specific gravity of ethanol as measured using 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" (incorporated by reference at § 600.011–93).

(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).

(g) Calculate separate FTP, highway, US06, SC03 and Cold temperature FTP fuel economy and carbon-related exhaust emissions from the grams/mile values for total HC, CO, CO_2 and, where applicable, CH_3OH, C_2H_5OH, C_2H_4O, HCHO, NMHC, N_2O, 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) *Emission values for fuel economy calculations.* The emission values (obtained per paragraph (a) through (e) of this section, as applicable) used in the calculations of fuel economy in 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 fuel economy in this section shall be rounded to the nearest gram/mile.

(2) Emission values for carbon-related exhaust emission calculations.

(i) 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 § 86.1823–08 of this chapter, then these test values shall be used in the calculations of carbon-related exhaust emissions in this section.

(ii) 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 § 86.1823–08 of this chapter, then these test values shall be adjusted by the appropriate deterioration factor determined according to § 86.1823–08 of this chapter before being used in the calculations of carbon-related exhaust emissions in this section. For vehicles within a test group, the appropriate NMOG deterioration factor may be used in lieu of the deterioration factors for CH_3OH, C_2H_5OH, and/or C_2H_4O emissions.

(iii) The emission values determined in paragraph (g)(2)(A) or (B) 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 carbon-related exhaust emissions in this section shall be rounded to the nearest gram/mile.

(iv) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter, N_2O and CH_4 emission values for use in the calculation of carbon-related exhaust emissions in this section shall be the values determined according to paragraph (g)(2)(iv)(A), (B), or (C) of this section.

(A) The FTP and HFET test values as determined for the emission data vehicle according to the provisions of § 86.1835–01 of this chapter. These values shall apply to all vehicles tested under this section that are included in the test group represented by the emission data vehicle and shall be adjusted by the appropriate deterioration factor determined according to § 86.1823–08 of this chapter before being used in the calculations of carbon-related exhaust emissions in this section.

(B) The FTP and HFET test values as determined according to testing conducted under the provisions of this subpart. These values shall be adjusted by the appropriate deterioration factor determined according to § 86.1823–08 of this chapter before being used in the calculations of carbon-related exhaust emissions in this section.

(C) For the 2012 through 2014 model years only, manufacturers may use an assigned value of 0.010 g/mi for N_2O FTP and HFET test values. This value is not required to be adjusted by a deterioration factor.

(3) 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.

(4) For the purpose of determining the applicable in-use emission standard under § 86.1818–12(d) of this chapter, the combined city/highway carbon-related exhaust emission value for a vehicle subconfiguration is calculated by arithmetically averaging the FTP-based city and HFET-based highway carbon-related exhaust emission values, as determined in § 600.113(a) and (b) of this section for the subconfiguration, weighted 0.55 and 0.45 respectively, and rounded to the nearest tenth of a gram per mile.

(h)(1) For gasoline-fueled automobiles tested on test fuel specified in § 86.113–04(a) of this chapter, 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)(i) For 2012 and later model year gasoline-fueled automobiles tested on test fuel specified in § 86.113–04(a) of this chapter, 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:

$$CREE = (CWF/0.273 \times HC) + (1.571 \times CO) + CO_2$$

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.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter, the carbon-related exhaust emissions in grams per mile for 2012 and later model year gasoline-fueled automobiles tested on test fuel specified in § 86.113–04(a) of this chapter is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = [(CWF/0.273) \times NMHC] + (1.571 \times CO) + CO_2 + (298 \times N_2O) + (25 \times CH_4)$$

Where:

CREE means the carbon-related exhaust emissions as defined in § 600.002–08.
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.
N_2O = Grams/mile N_2O as obtained in paragraph (g) of this section.
CH_4 = Grams/mile CH_4 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)(i) 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:

$$CREE = (3.172 \times HC) + (1.571 \times CO) + CO_2$$

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.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter, the carbon-related exhaust emissions in grams per mile for 2012 and later model year diesel-fueled automobiles is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = (3.172 \times NMHC) + (1.571 \times CO) + CO_2 + (298 \times N_2O) + (25 \times CH_4)$$

Where:

CREE means the carbon-related exhaust emissions as defined in § 600.002–08.
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.
N_2O = Grams/mile N_2O as obtained in paragraph (g) of this section.
CH_4 = Grams/mile CH_4 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 paragraph (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 CO2 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)(i) 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:

$$CREE = (CWF_{exHC}/0.273 \times HC) + (1.571 \times CO) + (1.374 \times CH_3OH) + (1.466 \times HCHO) + CO_2$$

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.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter, the carbon-related exhaust emissions in grams per mile for 2012 and later model year methanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and methanol is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = [(CWF_{exHC}/0.273) \times NMHC] + (1.571 \times CO) + (1.374 \times CH_3OH) + (1.466 \times HCHO) + CO_2 + (298 \times N_2O) + (25 \times CH_4)$$

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).
NMHC = 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 CO2 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.
N_2O = Grams/mile N_2O as obtained in paragraph (g) of this section.
CH_4 = Grams/mile CH_4 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:

$$FC_{NG} = \frac{(0.749 \times CH_4) + (CWF_{NMHC} \times NMHC) + (0.429 \times CO) + (0.273 \times CO_2)}{CWF_{NG} \times D_{NG}}$$

= cubic feet of natural gas fuel consumed per mile

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" (incorporated by reference at § 600.011–93).

(2)(i) 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:

$$CREE = 2.743 \times CH_4 + CWF_{NMHC}/0.273 \times NMHC + 1.571 \times CO + CO_2$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002–08.

CH_4 = Grams/mile CH_4 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.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter, the carbon-related exhaust emissions in grams per mile for 2012 and later model year automobiles fueled with natural gas is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = (25 \times CH_4) + [(CWF_{NMHC}/0.273) \times NMHC] + (1.571 \times CO) + CO_2 + (298 \times N_2O)$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002–08.

CH_4 = Grams/mile CH_4 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.

N_2O = Grams/mile N_2O as obtained in paragraph (g) 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 C_2H_5OH (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)(i) 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:

$$CREE = (CWF_{exHC}/0.273 \times HC) + (1.571 \times CO) + (1.374 \times CH_3OH) + (1.466 \times HCHO) + (1.911 \times C_2H_5OH) + (1.998 \times C_2H_4O) + CO_2$$

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 CO2 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 C_2H_5OH (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.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter, the carbon-related exhaust emissions in grams per mile for 2012 and later model year ethanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and ethanol is to be calculated using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = [(CWF_{exHC}/0.273) \times NMHC] + (1.571 \times CO) + (1.374 \times CH_3OH) + (1.466 \times HCHO) + (1.911 \times C_2H_5OH) + (1.998 \times C_2H_4O) + CO_2 + (298 \times N_2O) + (25 \times CH_4)$$

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 paragraph (f)(4) of this section.

NMHC = 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 CO2 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 C_2H_5OH (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.

N_2O = Grams/mile N_2O as obtained in paragraph (g) of this section.

CH_4 = Grams/mile CH_4 as obtained in paragraph (g) of this section.

(m) *Carbon-related exhaust emissions for electric vehicles, fuel cell vehicles and plug-in hybrid electric vehicles.* Manufacturers shall determine carbon-related exhaust emissions for electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles according to the provisions of this paragraph (m). Subject to the limitations described in § 86.1866–12(a) of this chapter, the manufacturer may be allowed to use a value of 0 grams/mile to represent the emissions of fuel cell vehicles and the proportion of electric operation of electric vehicles and plug-in hybrid electric vehicles that is derived from electricity that is generated from sources that are not onboard the vehicle, as described in paragraphs (m)(1) through (3) of this section.

(1) For 2012 and later model year electric vehicles, but not including fuel cell vehicles, the carbon-related exhaust emissions in grams per mile is to be calculated using the following equation and rounded to the nearest one gram per mile:

$$CREE = CREE_{UP} - CREE_{GAS}$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002–08, which may be set equal to zero for eligible 2012 through 2016 model year electric vehicles as described in § 86.1866–12(a) of this chapter.

$CREE_{UP} = 0.7670 \times EC$, and
$CREE_{GAS} = 0.2485 \times TargetCO_2$,

Where:

EC = The vehicle energy consumption in watt-hours per mile, determined according to procedures established by the Administrator under § 600.111–08(f).

$TargetCO_2$ = The CO_2 Target Value determined according to § 86.1818–12(c)(2) of this chapter for passenger automobiles and according to § 86.1818–12(c)(3) of this chapter for light trucks.

(2) For 2012 and later model year plug-in hybrid electric vehicles, the carbon-related exhaust emissions in grams per mile is to be calculated using the following equation and rounded to the nearest one gram per mile:

$$CREE = CREE_{CD} + CREE_{CS},$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002–08.

$CREE_{CS}$ = The carbon-related exhaust emissions determined for charge-sustaining operation according to procedures established by the Administrator under § 600.111–08(f); and

$CREE_{CD} = (ECF \times CREE_{CDEC}) + [(1 - ECF) \times CREE_{CDGAS}]$

Where:

$CREE_{CD}$ = The carbon-related exhaust emissions determined for charge-depleting operation determined according to the provisions of this section for the applicable fuel and according to procedures established by the Administrator under § 600.111–08(f);

$CREE_{CDEC}$ = The carbon-related exhaust emissions determined for electricity consumption during charge-depleting operation, which shall be determined using the method specified in paragraph (m)(1) of this section and according to procedures established by the Administrator under § 600.111–08(f), and which may be set equal to zero for eligible 2012 through 2016 model year vehicles as described in § 86.1866–12(a) of this chapter;

$CREE_{CDGAS}$ = The carbon-related exhaust emissions determined for charge-depleting operation determined according to the provisions of this section for the applicable fuel and according to procedures established by the Administrator under § 600.111–08(f); and

ECF = Electricity consumption factor as determined by the Administrator under § 600.111–08(f).

(3) For 2012 and later model year fuel cell vehicles, the carbon-related exhaust emissions in grams per mile shall be calculated using the method specified in paragraph (m)(1) of this section, except that $CREE_{UP}$ shall be determined according to procedures established by the Administrator under § 600.111–08(f). As described in § 86.1866–12(a) of this chapter the value of CREE may be set equal to zero for eligible 2012 through 2016 model year fuel cell vehicles.

(n) 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 for fuel economy and carbon-related exhaust emissions may be used in lieu of the methods described in this section if shown to yield equivalent or superior results and if approved in advance by the Administrator.

■ 44. Section 600.114–08 is amended as follows:

■ a. By revising the section 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 chapter.

* * * * *

(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:

$StartCREE_X = 3.6 \times (Bag1CREE_X - Bag3CREE_X)$

Where:

Bag Y $CREE_X$ = 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 =

$0.82 \times [(0.48 \times Bag2_{75}CREE) + (0.41 \times BAG3_{75}CREE) + (0.11 \times US06\ CityCREE)]$ +
$0.18 \times [(0.5 \times Bag2_{20}CREE) + (0.5 \times Bag3_{20}CREE)]$ +
$0.144 \times [SC03\ CREE - ((0.61 \times Bag3_{75}CREE) + (0.39 \times Bag2_{75}CREE))]$

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.* 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 =

$$0.33\times\left(\frac{\left(0.76\times \text{StartCREE}_{75}+0.24\times \text{StartCREE}_{20}\right)}{60}\right)$$

Where:

$\text{StartCREE}_X = 3.6 \times (\text{BagCREE}_X - \text{Bag3CREE}_X)$

(2) Running CREE =

$1.007 \times [(0.79 \times US06\ Highway\ CREE) + (0.21 \times HFET\ CREE)] + 0.045 \times [SC03\ CREE - ((0.61 \times Bag3_{75}CREE) + (0.39 \times Bag2_{75}CREE))]$

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 =

$$0.33\times\left(\frac{\left(0.76\times \text{StartCREE}_{75}+0.24\times \text{StartCREE}_{20}\right)}{4.1}\right)$$

Where:

(*1*) $StartCREE_{75}$ =

$3.6 \times (\text{Bag1}CREE_{75} - Bag3CREE_{75}) + 3.9 \times (Bag2CREE_{75} - Bag4CREE_{75})$

and

(*2*) StartCREE_{20} =

$3.6 \times (Bag1CREE_{20} - Bag3CREE_{20})$

(B) RunningCREE =

$0.82 \times [(0.48 \times Bag4_{75}CREE) + (0.41 \times Bag3_{75}CREE) + (0.11 \times US06\ City\ CREE)] + 0.18 \times [(0.5 \times Bag2_{20}CREE) + (0.5 \times Bag3_{20}CREE)] + 0.144 \times [SC03\ CREE - ((0.61 \times Bag3_{75}CREE) + (0.39 \times Bag4_{75}CREE))]$

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 =

$$0.33\times\left(\frac{\left(0.76\times \text{StartCREE}_{75}+0.24\times \text{StartCREE}_{20}\right)}{60}\right)$$

Where:

$\text{StartCREE}_{75} = 3.6 \times (\text{Bag1CREE}_{75} - \text{Bag3CREE}^{75}) + 3.9 \times (\text{Bag2CREE}_{75} - \text{Bag4CREE}_{75})$

and

$\text{StartCREE}_{20} = 3.6 \times (\text{Bag1CREE}_{20} - \text{Bag3CREE}_{20})$

(B) RunningCREE =

$1.007 \times [(0.79 \times US06\ Highway\ CREE) + (0.21 \times HFET\ CREE)] + 0.045 \times [SC03\ CREE - ((0.61 \times Bag3_{75}CREE) + (0.39 \times Bag4_{75}CREE))]$

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:

Start $CREE_{75}$ = 3.6 × (Bag ½ $CREE_{75}$ − Bag ¾ $CREE_{75}$)

and

Start $CREE_{20}$ = 3.6 × (Bag1$CREE_{20}$ − Bag3$CREE_{20}$)

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 phases 3 and 4 of the FTP test conducted at an ambient temperature of 75 °F.

(B) RunningCREE =

0.82 × [(0.90 × Bag¾$_{75}$CREE) + (0.10 × US06 City CREE)] + 0.18 × [(0.5 × Bag2$_{20}$CREE) + (0.5 × Bag3$_{20}$CREE)] + 0.144 × [SC03 CREE − (Bag¾$_{75}$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 phases 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:

Start $CREE_{75}$ = 7.5 × (Bag½$CREE_{75}$ − Bag¾$CREE_{75}$)

and

Start $CREE_{20}$ = 3.6 × (Bag1$CREE_{20}$ − Bag3$CREE_{20}$)

(B) RunningCREE =

1.007 × [(0.79 × US06 Highway CREE) + (0.21 × HFET CREE)] + 0.045 × [SC03 CREE − Bag¾$_{75}$CREE]

Where:

US06 Highway 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 gram 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 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 phases 1 and 2 or phases 3 and 4 of the FTP test conducted at an ambient temperature of 75 °F.

Subpart C—Procedures for Calculating Fuel Economy and Carbon-Related Exhaust Emission Values for 1977 and Later Model Year Automobiles

■ 45. The heading for subpart C is revised as set forth above.

■ 46. 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.

■ 47. 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 § 600.208–12(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 paragraph (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 paragraph (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.

(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.

■ 48. 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 § 600.206–12(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 of this chapter.

(4) Vehicle configuration fuel economy and carbon-related exhaust emission values, as determined in § 600.206–12 (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 § 600.206–12 (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—[Amended]

■ 49. 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

■ 50. The heading for subpart F is revised as set forth above.

■ 51. 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. The provisions of this subpart are applicable to medium-duty passenger vehicles and to manufacturers of such vehicles.

■ 52. 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, 86.082–34, or 86.1842–01 of this chapter, 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 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 § 600.208–12(a)(2), the manufacturer shall submit fuel economy and carbon-related exhaust emissions data for each subconfiguration added by a running change.

■ 53. 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.

■ 54. 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 categories 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 as determined by the Secretary of Transportation. For example, categories may include, but are not limited to domestically manufactured and/or non-domestically manufactured passenger automobiles as determined by the Secretary of Transportation.

(ii) [Reserved]

(iii) An average fuel economy calculation will be made for the category of trucks as determined by the Secretary of Transportation. For example, categories may include, but are not limited to domestically manufactured trucks, non-domestically manufactured trucks, light-duty trucks, medium-duty passenger vehicles, and/or heavy-duty trucks as determined by the Secretary of Transportation.

(iv) [Reserved]

(2) Average carbon-related exhaust emissions will be calculated to the nearest one gram per mile for the categories 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 § 600.208–12 of this section except that:

(i) Separate fuel economy values will be calculated for model types and base levels associated with car lines for each category of passenger automobiles and light trucks as determined by the Secretary of Transportation pursuant to paragraph (a)(1) of this section.

(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 § 600.208–12(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 for each category of passenger automobiles and light trucks as determined by the Secretary of Transportation pursuant to paragraph (a)(1) of this section.

(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)(1) 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 § 600.208–12(b)(5)(i); and

(B) The combined model type fuel economy value for operation on alcohol fuel as determined in § 600.208–12(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 § 600.208–12(b)(5)(i); and

(B) The combined model type fuel economy value for operation on natural gas as determined in § 600.208–12(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 automobile categories identified in paragraph (a)(1) 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 premeasured using a test method which has been approved in advance by the Administrator.

(B) The density for alcohol fuels shall be premeasured using 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" (incorporated by reference at § 600.011–93).

(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) For model years 1993 and later, and for each category of automobile identified in paragraph (a)(1) of this section, the maximum increase in average fuel economy 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 increase (mpg)
1993–2014	1.2
2015	1.0
2016	0.8
2017	0.6
2018	0.4
2019	0.2
2020 and later	0.0

(1) The Administrator shall calculate the increase in average fuel economy to determine if the maximum increase provided in paragraph (h) of this section has been reached. The Administrator shall calculate the average fuel economy for each category of automobiles specified in paragraph (a)(1) of this section by subtracting the average fuel economy values calculated in accordance with this section by assuming all alcohol dual fuel and natural gas dual fuel automobiles are operated exclusively on gasoline (or diesel) fuel from the average fuel economy values determined in paragraph (c) of this section. The difference is limited to the maximum increase specified in paragraph (h) of this section.

(2) [Reserved]

(i) For model years 2012 through 2015, and for each category of automobile identified in paragraph (a)(1) of this section, the maximum decrease in average carbon-related exhaust emissions determined in paragraph (j) of this section attributable to alcohol dual fuel automobiles and natural gas dual fuel automobiles shall be calculated using the following formula, and rounded to the nearest tenth of a gram per mile:

$$\text{Maximum Decrease} = \frac{8887}{\left[\dfrac{8887}{FltAvg} - MPG_{MAX}\right]} - FltAvg$$

Where:

FltAvg = The fleet average CREE value for passenger automobiles or light trucks determined for the applicable model year according to paragraph (j) of this section, except by assuming all alcohol dual fuel and natural gas dual fuel automobiles are operated exclusively on gasoline (or diesel) fuel.

MPG_{MAX} = The maximum increase in miles per gallon determined for the appropriate model year in paragraph (h) of this section.

(1) The Administrator shall calculate the decrease in average carbon-related exhaust emissions to determine if the maximum decrease provided in this paragraph (i) has been reached. The Administrator shall calculate the average carbon-related exhaust emissions for each category of automobiles specified in paragraph (a) of this section by subtracting the average carbon-related exhaust emission values determined in paragraph (j) 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)(1) 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, except that manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter must perform this calculation such that N_2O and CH_4 values are not multiplied by 0.15; 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, except that manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter must perform this calculation such that N_2O and CH_4 values are not multiplied by 0.15; 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 § 600.208–12(b)(5)(i); and

(B) The combined model type carbon-related exhaust emissions value for operation on alcohol fuel as determined in § 600.208–12(b)(5)(ii) multiplied by 0.15 provided the requirements of paragraph (g) of this section are met, except that manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter must perform this calculation such that N_2O and CH_4 values are not multiplied by 0.15; 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 § 600.208–12(b)(5)(i); and

(B) The combined model type carbon-related exhaust emissions value for operation on natural gas as determined in § 600.208–12(b)(5)(ii) multiplied by 0.15 provided the requirements of paragraph (g) of this section are met, except that manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818–12(f)(2) of this chapter must perform this calculation such that N_2O and CH_4 values are not multiplied by 0.15.

(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 § 600.208–12(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 § 600.208–12(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 § 600.208–12(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 § 600.208–12(b)(5)(i).

(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.

■ 55. 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.

(8) For 2008–2010 light truck model year reports, the average fuel economy standard or the "required fuel economy level" pursuant to 49 CFR part 533, as applicable. Model year reports for light trucks meeting required fuel economy levels pursuant to 49 CFR 533.5(g) and (h) shall include information in sufficient detail to verify the accuracy of the calculated required fuel economy level. Such information is expected to include but is not limited to, production information for each unique footprint within each model type contained in the model year report and the formula used to calculate the required fuel economy level. Model year reports for required fuel economy levels shall include a statement that the method of measuring vehicle track width, measuring vehicle wheelbase and calculating vehicle footprint is accurate and complies with applicable Department of Transportation requirements.

(9) For 2011 and later model year reports, the "required fuel economy level" pursuant to 49 CFR parts 531 or 533, as applicable. Model year reports shall include information in sufficient detail to verify the accuracy of the calculated required fuel economy level, including but is not limited to, production information for each unique footprint within each model type contained in the model year report and the formula used to calculate the required fuel economy level. Model year reports shall include a statement that the method of measuring vehicle track

width, measuring vehicle wheelbase and calculating vehicle footprint is accurate and complies with applicable Department of Transportation requirements.

(10) For 2012 and later model year reports, the "required fuel economy level" pursuant to 49 CFR parts 531 or 533 as applicable, and the applicable fleet average CO_2 emission standards. Model year reports shall include information in sufficient detail to verify the accuracy of the calculated required fuel economy level and fleet average CO_2 emission standards, including but is not limited to, production information for each unique footprint within each model type contained in the model year report and the formula used to calculate the required fuel economy level and fleet average CO_2 emission standards. Model year reports shall include a statement that the method of measuring vehicle track width, measuring vehicle wheelbase and calculating vehicle footprint is accurate and complies with applicable Department of Transportation and EPA requirements.

(11) For 2012 and later model year reports, a detailed (but easy to understand) list of vehicle models and the applicable in-use CREE emission standard. The list of models shall include the applicable carline/subconfiguration parameters (including carline, equivalent test weight, road-load horsepower, axle ratio, engine code, transmission class, transmission configuration and basic engine); the test parameters (ETW and a, b, c, dynamometer coefficients) and the associated CREE emission standard. The manufacturer shall provide the method of identifying EPA engine code for applicable in-use vehicles.

■ 56. 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 model year, each manufacturer shall submit a pre-model year report.

(2) The pre-model year report required by this section for each model year must be submitted before the model year begins and before the certification of any test group, no later than December 31 of the calendar year two years before the model year. For example the pre-model year report for the 2012 model year must be submitted no later than December 31, 2010.

(3) Each report required by this section must:

(i) Identify the report as a pre-model year report;

(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) Be based upon all information and data available to the manufacturer approximately 30 days before the report is submitted to the Administrator.

(b) *Content of pre-model year reports.* (1) Each pre-model year report must include the following information for each compliance category for the applicable future model year and to the extent possible, two model years into the future:

(i) The manufacturer's estimate of its footprint-based fleet average CO_2 standards (including temporary lead time allowance alternative standards, if applicable);

(ii) Projected total and model-level production volumes for each applicable standard category;

(iii) Projected fleet average CO_2 compliance level for each applicable standard category; and the model-level CO_2 emission values which form the basis of the projection;

(iv) Projected fleet average CO_2 credit/debit status for each applicable standard category;

(v) A description of the various credit, transfer and trading options that will be used to comply with each applicable standard category, including the amount of credit the manufacturer intends to generate for air conditioning leakage, air conditioning efficiency, off-cycle technology, and various early credit programs;

(vi) A description of the method which will be used to calculate the carbon-related exhaust emissions for any electric vehicles, fuel cell vehicles and plug-in hybrid vehicles;

(vii) A summary by model year (beginning with the 2009 model year) of the number of electric vehicles, fuel cell vehicles and plug-in hybrid vehicles using (or projected to use) the advanced technology vehicle incentives program;

(viii) The methodology which will be used to comply with N_2O and CH_4 emission standards; and

(ix) Other information requested by the Administrator.

(2) Manufacturers must submit, in the pre-model year report for each model year in which a credit deficit is generated (or projected to be generated), a compliance plan demonstrating how the manufacturer will comply with the fleet average CO_2 standard by the end of the third year after the deficit occurred.

Department of Transportation

49 CFR Chapter V

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 amends 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 as follows:

■ a. By revising paragraph (a) introductory text.

■ b. By revising paragraph (c).

■ c. By redesignating paragraph (d) as paragraph (e).

■ d. By adding a new paragraph (d).

§ 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.

$$\textbf{Figure 2:} \quad CAFE_{required} = \frac{\sum_i Production_i}{\sum_i \frac{Production_i}{TARGET_i}}$$

Where:

$CAFE_{required}$ is the required level for a given fleet (domestic passenger automobiles or import passenger automobiles),

Subscript i is a designation of multiple groups of automobiles, where each group's designation, *i.e.,* i = 1, 2, 3, etc., represents automobiles that share a unique model type and footprint within the applicable fleet, either domestic passenger automobiles or import passenger automobiles.

$Production_i$ is the number of passenger automobiles produced for sale in the United States within each ith designation, *i.e.,* which shares the same model type and footprint.

$TARGET_i$ is the fuel economy target in miles per gallon (mpg) applicable to the footprint of passenger automobiles within each ith designation, *i.e.,* which shares the same model type and footprint, calculated according to Figure 3 and rounded to the nearest hundredth of a mpg, *i.e.,* 35.455 = 35.46 mpg, and the summations in the numerator and denominator are both performed over all models in the fleet in question.

$$\textbf{Figure 3:} \quad TARGET = \frac{1}{MIN\left[MAX\left(c \times FOOTPRINT + d, \frac{1}{a}\right), \frac{1}{b}\right]}$$

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	35.95	27.95	0.0005308	0.006057
2013	36.80	28.46	0.0005308	0.005410
2014	37.75	29.03	0.0005308	0.004725
2015	39.24	29.90	0.0005308	0.003719
2016	41.09	30.96	0.0005308	0.002573

(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	27.8
2012	30.7
2013	31.4
2014	32.1
2015	33.3
2016	34.7

* * * * *

■ 3. Add Appendix A to Part 531 to read as follows:

Appendix A to Part 531—Example of Calculating Compliance Under § 531.5(c)

Assume a hypothetical manufacturer (Manufacturer X) produces a fleet of domestic passenger automobiles in MY 2012 as follows:

Appendix A, Table 1

Model type				Description	Actual measured fuel economy (mpg)	Volume
Group	Carline name	Basic engine (L)	Transmission class			
1	PC A FWD	1.8	A5	2-door sedan	34.0	1,500
2	PC A FWD	1.8	M6	2-door sedan	34.6	2,000
3	PC A FWD	2.5	A6	4-door wagon	33.8	2,000
4	PC A AWD	1.8	A6	4-door wagon	34.4	1,000
5	PC A AWD	2.5	M6	2-door hatchback	32.9	3,000
6	PC B RWD	2.5	A6	4-door wagon	32.2	8,000
7	PC B RWD	2.5	A7	4-door sedan	33.1	2,000
8	PC C AWD	3.2	A7	4-door sedan	30.6	5,000
9	PC C FWD	3.2	M6	2-door coupe	28.5	3,000
Total						27,500

Note to Appendix A, Table 1. Manufacturer X's required corporate average fuel economy level standard under § 531.5(c) would first be calculated by determining the fuel economy targets applicable to each unique model type and footprint combination for model type groups 1–9 as illustrated in Appendix A, Table 2:

Appendix A, Table 2

Manufacturer X calculates a fuel economy target standard for each unique model type and footprint combination.

Model type				Description	Base tire size	Wheel-base (inches)	Track width F&R average (inches)	Footprint (ft^2)	Volume	Fuel economy target standard (mpg)
Group	Carline name	Basic engine (L)	Trans-mission class							
1a	PC A FWD	1.8	A5	2-door sedan	205/75R14	99.8	61.2	42.4	900	35.01
1b	PC A FWD	1.8	A5	2-door sedan	215/70R15	99.8	60.9	42.2	600	35.14
2	PC A FWD	1.8	M6	2-door sedan	215/70R15	99.8	60.9	42.2	2,000	35.14
3	PC A FWD	2.5	A6	4-door wagon	215/70R15	100.0	60.9	42.3	2,000	35.08
4	PC A AWD	1.8	A6	4-door wagon	235/60R15	100.0	61.2	42.5	1,000	35.95
5	PC A AWD	2.5	M6	2-door hatchback.	225/65R16	99.6	59.5	41.2	3,000	35.81
6a	PC B RWD	2.5	A6	4-door wagon	235/65R16	109.2	67.2	51.0	4,000	30.19
6b	PC B RWD	2.5	A6	4-door wagon	265/55R18	109.2	66.8	50.7	4,000	30.33
7	PC B RWD	2.5	A7	4-door sedan	235/65R17	109.2	67.8	51.4	2,000	29.99
8	PC C AWD	3.2	A7	4-door sedan	265/55R18	111.3	67.8	52.4	5,000	29.52
9	PC C FWD	3.2	M6	2-door coupe	225/65R16	111.3	67.2	51.9	3,000	29.76
Total									27,500	

Note to Appendix A, Table 2. With the appropriate fuel economy targets determined for each unique model type and footprint combination, Manufacturer X's required fuel economy target standard would be calculated as illustrated in Appendix A, Figure 1.

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Appendix A, Figure 1

Calculation of Manufacturer X's target fuel economy standard

(Manufacturer's Domestic Passenger Automobile Production for Applicable Model Year)

/ ((Group 1a Volume / Group 1a Target) + ((Group 1b Volume / Group 1b Target) + … +

(Group 9 Volume / Group 9 Target)) =

27500 / (900/35.01 + 600/35.14 + 2000/35.14 + 2000/35.08 + 1000/34.95 + 3000/35.81 +

4000/30.19 + 4000/30.33 + 2000/29.99 + 5000/25.52 + 3000/29.76) = 31.6

$$\frac{\text{Manufacturer's Domestic Passenger Automobile Production for Applicable Model Year}}{\left[\frac{\begin{matrix}\text{Group1a}\\\text{Volume}\end{matrix}}{\begin{matrix}\text{Group1a}\\\text{Target}\end{matrix}}+\frac{\begin{matrix}\text{Group1b}\\\text{Volume}\end{matrix}}{\begin{matrix}\text{Group1b}\\\text{Target}\end{matrix}}+\frac{\begin{matrix}\text{Group2}\\\text{Volume}\end{matrix}}{\begin{matrix}\text{Group2}\\\text{Target}\end{matrix}}+\frac{\begin{matrix}\text{Group3}\\\text{Volume}\end{matrix}}{\begin{matrix}\text{Group3}\\\text{Target}\end{matrix}}+\cdots+\frac{\begin{matrix}\text{Group7}\\\text{Volume}\end{matrix}}{\begin{matrix}\text{Group7}\\\text{Target}\end{matrix}}+\frac{\begin{matrix}\text{Group8}\\\text{Volume}\end{matrix}}{\begin{matrix}\text{Group8}\\\text{Target}\end{matrix}}+\frac{\begin{matrix}\text{Group9}\\\text{Volume}\end{matrix}}{\begin{matrix}\text{Group9}\\\text{Target}\end{matrix}}\right]}$$

$$\frac{27{,}500}{\left[\frac{900}{35.27}+\frac{600}{35.40}+\frac{2000}{35.40}+\frac{2000}{35.35}+\frac{1000}{35.21}+\frac{3000}{36.12}+\frac{4000}{30.40}+\frac{4000}{30.55}+\frac{2000}{30.18}+\frac{5000}{29.71}+\frac{3000}{29.93}\right]}$$

Fleet's target fuel economy standard = 31.6 mpg

Appendix A, Figure 2

Calculation of Manufacturer X's actual fuel economy value.

(Manufacturer's Domestic Passenger Automobile Production for Applicable Model Year)

/ ((Group 1 Volume / Group 1 Fuel Economy) + ((Group 2 Volume / Group 2 Fuel

Economy) + … + (Group 9 Volume / Group 9 Fuel Economy)) =

27500 / (1500/34.0 + 2000/34.6 + 2000/33.8 + 1000/34.4 + 3000/32.9 + 8000/32.2 +

2000/33.1 + 5000/30.6 + 3000/28.5) = 32.0

$$\frac{\text{Manufacturer's Domestic Passenger Automobile Production for Applicable Model Year}}{\left[\frac{\text{Group1 Volume}}{\text{Group1 FuelEcon}}+\frac{\text{Group2 Volume}}{\text{Group2 FuelEcon}}+\frac{\text{Group3 Volume}}{\text{Group3 FuelEcon}}+\frac{\text{Group4 Volume}}{\text{Group4 FuelEcon}}+\frac{\text{Group5 Volume}}{\text{Group5 FuelEcon}}+\frac{\text{Group6 Volume}}{\text{Group6 FuelEcon}}+\frac{\text{Group7 Volume}}{\text{Group7 FuelEcon}}+\frac{\text{Group8 Volume}}{\text{Group8 FuelEcon}}+\frac{\text{Group9 Volume}}{\text{Group9 FuelEcon}}\right]}$$

$$\frac{27{,}500}{\left[\frac{1500}{34.0}+\frac{2000}{34.6}+\frac{2000}{33.8}+\frac{1000}{34.4}+\frac{3000}{32.9}+\frac{8000}{32.2}+\frac{2000}{33.1}+\frac{5000}{30.6}+\frac{3000}{28.5}\right]}$$

Fleet's actual fuel economy = 32.0 mpg

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Note to Appendix A, Figure 2. Since the actual average fuel economy of Manufacturer X's fleet is 32.0 mpg, as compared to its required fuel economy level of 31.8 mpg, Manufacturer X complied with the CAFE standard for MY 2012 as set forth in § 531.5(c).

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: $$CAFE_{required} = \frac{\sum_i Production_i}{\sum_i \frac{Production_i}{TARGET_i}}$$

Where:

$CAFE_{required}$ is the required level for a given fleet,

Subscript i is a designation of multiple groups of light trucks, where each group's designation, *i.e.,* i = 1, 2, 3, etc., represents light trucks that share a unique model type and footprint within the applicable fleet.

Production$_i$ is the number of units of light trucks produced for sale in the United States within each ith designation, *i.e.,* which share the same model type and footprint.

TARGET$_i$ is the fuel economy target in miles per gallon (mpg) applicable to the footprint of light trucks within each ith designation, *i.e.,* which shares the same model type and footprint, calculated according to Figure 3 and rounded to the nearest hundredth of a mpg, *i.e.,* 35.455 = 35.46 mpg, 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	29.82	22.27	0.0004546	0.014900
2013	30.67	22.74	0.0004546	0.013968
2014	31.38	23.13	0.0004546	0.013225
2015	32.72	23.85	0.0004546	0.011920
2016	34.42	24.74	0.0004546	0.010413

* * * * *

(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. Amend Appendix A to Part 533 by revising Tables 1 and 2 and Figures 1 and 2 to read as follows:

Appendix A to Part 533—Example of Calculating Compliance Under § 533.5(i)

Assume a hypothetical manufacturer (Manufacturer X) produces a fleet of light trucks in MY 2012 as follows:

Appendix A, Table 1

Model type				Description	Actual measured fuel economy (mpg)	Volume
Group	Carline name	Basic engine (L)	Transmission class			
1	Pickup A 2WD	4	A5	Reg cab, MB	27.1	800
2	Pickup B 2WD	4	M5	Reg cab, MB	27.6	200
3	Pickup C 2WD	4.5	A5	Reg cab, LB	23.9	300
4	Pickup C 2WD	4	M5	Ext cab, MB	23.7	400
5	Pickup C 4WD	4.5	A5	Crew cab, SB	23.5	400
6	Pickup D 2WD	4.5	A6	Crew cab, SB	23.6	400
7	Pickup E 2WD	5	A6	Ext cab, LB	22.7	500
8	Pickup E 2WD	5	A6	Crew cab, MB	22.5	500
9	Pickup F 2WD	4.5	A5	Reg cab, LB	22.5	1,600
10	Pickup F 4WD	4.5	A5	Ext cab, MB	22.3	800
11	Pickup F 4WD	4.5	A5	Crew cab, SB	22.2	800
Total						6,700

Note to Appendix A, Table 1. Manufacturer X's required corporate average fuel economy level under § 533.5(i) would first be calculated by determining the fuel economy targets applicable to each unique model type and footprint combination for model type groups (1–11) illustrated in Appendix A, Table 2:

Appendix A, Table 2

Manufacturer X calculates a fuel economy target standard value for each unique model type and footprint combination.

Model type				Description	Base tire size	Wheel-base (inches)	Track width F&R average (inches)	Footprint (ft^2)	Volume	Fuel economy target standard (mpg)
Group	Carline name	Basic engine (L)	Transmission class							
1	Pickup A 2WD	4	A5	Reg cab, MB	235/75R15	100.0	68.8	47.8	800	27.30
2a	Pickup B 2WD	4	M5	Reg cab, MB	235/75R15	100.0	68.2	47.4	100	27.44
2b	Pickup B 2WD	4	M5	Reg cab, MB	235/70R16	100.0	68.4	47.5	100	27.40
3	Pickup C 2WD	4.5	A5	Reg cab, LB	255/70R17	125.0	68.8	59.7	300	23.79
4	Pickup C 2WD	4	M5	Ext cab, MB	255/70R17	125.0	68.8	59.7	400	23.79
5	Pickup C 4WD	4.5	A5	Crew cab, SB	275/70R17	150.0	69.0	71.9	400	22.27
6a	Pickup D 2WD	4.5	A6	Crew cab, SB	255/70R17	125.0	68.8	59.7	200	23.79
6b	Pickup D 2WD	4.5	A6	Crew cab, SB	285/70R17	125.0	69.2	60.1	200	23.68
7	Pickup E 2WD	5	A6	Ext cab, LB	255/70R17	125.0	68.8	59.7	500	23.79
8	Pickup E 2WD	5	A6	Crew cab, MB.	285/70R17	125.0	69.2	60.1	500	23.68
9	Pickup F 2WD	4.5	A5	Reg cab, LB	255/70R17	125.0	68.9	59.8	1,600	23.76
10	Pickup F 4WD	4.5	A5	Ext cab, MB	275/70R17	150.0	69.0	71.9	800	22.27
11	Pickup F 4WD	4.5	A5	Crew cab, SB	285/70R17	150.0	69.2	72.1	800	22.27
Total									6,700	

Note to Appendix A, Table 2. With the appropriate fuel economy targets determined for each unique model type and footprint combination, Manufacturer X's required fuel economy target standard would be calculated as illustrated in Appendix A, Figure 1.

BILLING CODE 6560–50–P

Appendix A, Figure 1

Calculation of Manufacturer X's target fuel economy standard value.

(Manufacturer's Light Truck Production for Applicable Model Year) / ((Group 1 Volume / Group 1 Target) + ((Group 2a Volume / Group 2a Target) + … + (Group 11 Volume / Group 11 Target)) =

6700/ (800/27.30 + 100/27.44 + 100/27.40 + 300/23.79 + 400/23.79 + 400/22.27 + 200/23.79 + 200/23.68 + 500/23.79 + 500/23.68 + 1600/23.76 + 800/22.27 + 800/22.27)

= 23.7

$$\frac{\text{Manufacturer's Light Truck Production for Applicable Model Year}}{\left[\frac{\text{Group1 Volume}}{\text{Group1 Target}}+\frac{\text{Group2a Volume}}{\text{Group2a Target}}+\frac{\text{Group2b Volume}}{\text{Group2b Target}}+\frac{\text{Group3 Volume}}{\text{Group3 Target}}+\cdots+\frac{\text{Group9 Volume}}{\text{Group9 Target}}+\frac{\text{Group10 Volume}}{\text{Group10 Target}}+\frac{\text{Group11 Volume}}{\text{Group11 Target}}\right]}$$

$$\frac{6{,}700}{\left[\frac{800}{26.99}+\frac{100}{27.13}+\frac{100}{27.08}+\frac{300}{23.54}+\frac{400}{23.54}+\frac{400}{22.06}+\frac{200}{23.54}+\frac{200}{23.45}+\frac{500}{23.54}+\frac{500}{23.45}+\frac{1600}{23.52}+\frac{800}{22.06}+\frac{800}{22.06}\right]}$$

Fleet's target fuel economy standard = 23.7 mpg

Appendix A, Figure 2

Calculation of Manufacturer X's actual fuel economy value.

(Manufacturer's Light Truck Production for Applicable Model Year) / ((Group 1 Volume / Group 1 Fuel Economy) + ((Group 2 Volume / Group 2 Fuel Economy) + … + (Group 11 Volume / Group 11 Fuel Economy)) =

6700 / (800/27.1 + 200/27.6 + 300/23.9 + 400/23.7 + 400/23.5 + 400/23.6 + 500/22.7 + 500/22.5 + 1600/22.5 + 800/22.3 + 800/22.2) = 23.3

$$\frac{\text{Manufacturer's Light Truck Production for Applicable Model Year}}{\left[\frac{\text{Group1 Volume}}{\text{Group1 FuelEcon}}+\frac{\text{Group2 Volume}}{\text{Group2 FuelEcon}}+\frac{\text{Group3 Volume}}{\text{Group3 FuelEcon}}+\frac{\text{Group4 Volume}}{\text{Group4 FuelEcon}}+\frac{\text{Group5 Volume}}{\text{Group5 FuelEcon}}+\frac{\text{Group6 Volume}}{\text{Group6 FuelEcon}}+\frac{\text{Group7 Volume}}{\text{Group7 FuelEcon}}+\frac{\text{Group8 Volume}}{\text{Group8 FuelEcon}}+\frac{\text{Group9 Volume}}{\text{Group9 FuelEcon}}+\frac{\text{Group10 Volume}}{\text{Group10 FuelEcon}}+\frac{\text{Group11 Volume}}{\text{Group11 FuelEcon}}\right]}$$

$$\frac{6{,}700}{\left[\frac{800}{27.1}+\frac{200}{27.6}+\frac{300}{23.9}+\frac{400}{23.7}+\frac{400}{23.5}+\frac{400}{23.6}+\frac{500}{22.7}+\frac{500}{22.5}+\frac{1600}{22.5}+\frac{800}{22.3}+\frac{800}{22.2}\right]}$$

Fleet's actual fuel economy value = 23.3 mpg

BILLING CODE 6560–50–C

Note to Appendix A, Figure 2. Since the actual average fuel economy of Manufacturer X's fleet is 23.3 mpg, as compared to its required fuel economy level of 23.5 mpg, Manufacturer X did not comply with the CAFE standard for MY 2012 as set forth in section 533.5(i).

PART 536—TRANSFER AND TRADING OF FUEL ECONOMY CREDITS

■ 7. The authority citation for part 563 continues to read as follows:

Authority: Sec. 104, Pub. L. 110–140 (49 U.S.C. 32903); delegation of authority at 49 CFR 1.50.

■ 8. Amend § 536.3 by revising the definition of "Transfer" in paragraph (b) to read as follows:

§ 536.3 Definitions.

* * * * *

(b) * * *

Transfer means the application by a manufacturer of credits earned by that manufacturer in one compliance category or credits acquired be trade (and originally earned by another manufacturer in that category) to achieve compliance with fuel economy standards with respect to a different compliance category. For example, a manufacturer may purchase light truck credits from another manufacturer, and transfer them to achieve compliance in the manufacturer's domestically manufactured passenger car fleet. Subject to the credit transfer limitations of 49 U.S.C. 32903(g)(3), credits can also be transferred across compliance categories and banked or saved in that category to be carried forward or backwards later to address a credit shortfall.

* * * * *

■ 9. Amend § 536.4 by revising the values for the terms *VMTe* and *VMTu* in paragraph (c) to read as follows:

§ 536.4 Credits.

* * * * *

(c) * * *

VMTe = Lifetime vehicle miles traveled as provided in the following table for the model year and compliance category in which the credit was earned.

VMTu = Lifetime vehicle miles traveled as provided in the following table for the model year and compliance category in which the credit is used for compliance.

Model year	Lifetime Vehicle Miles Traveled (VMT)				
	2012	2013	2014	2015	2016
Passenger Cars	177,238	177,366	178,652	180,497	182,134
Light Trucks	208,471	208,537	209,974	212,040	213,954

* * * * *

PART 537—AUTOMOTIVE FUEL ECONOMY REPORTS

■ 10. 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.

■ 11. 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.

* * * * *

§ 537.6 [Amended]

■ 12. Amend § 537.6 by removing paragraph (c)(1) and redesignating paragraph (c)(2) as paragraph (c).

■ 13. 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,

* * * * *

■ 14. Amend § 537.8 by revising paragraph (c)(1) and removing and reserving paragraph (c)(2) to read as follows:

§ 537.8 Supplementary reports.

* * * * *

(c)(1) Each report required by paragraph (a)(1), (2), or (3) of this section must be submitted in accordance with § 537.5(c) not more than 45 days after the date on which the manufacturer determined, or could have determined with reasonable diligence, that a report is required under paragraph (a)(1), (2), or (3) of this section.

(2) [Reserved]

* * * * *

■ 15. Amend § 537.9 by revising paragraph (c) to read as follows:

§ 537.9 Determination of fuel economy values and average fuel economy.

* * * * *

(c) *Average fuel economy.* Average fuel economy must be based upon fuel economy values calculated under paragraph (b) of this section for each model type and must be calculated in accordance with subpart F of 40 CFR part 600, except that fuel economy values for running changes and for new base levels are required only for those changes made or base levels added before the average fuel economy is required to be submitted under this part.

* * * * *

PART 538—MANUFACTURING INCENTIVES FOR ALTERNATIVE FUEL VEHICLES

■ 16. 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.

■ 17. 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.

■ 18. 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 natural gas.

■ 19. Amend § 538.7 by revising paragraph (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: April 1, 2010.

Ray LaHood,

Secretary, Department of Transportation.

Dated: April 1, 2010.

Lisa P. Jackson,

Administrator, Environmental Protection Agency.

[FR Doc. 2010–8159 Filed 5–6–10; 8:45 am]

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