ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 85, 86, and 600

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Parts 523, 531, 533, 536, and 537

[EPA–HQ–OAR–2010–0799; FRL–9495–2; NHTSA–2010–0131]

RIN 2060–AQ54; RIN 2127–AK79

2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards

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

ACTION: Proposed rule.

SUMMARY: EPA and NHTSA, on behalf of the Department of Transportation, are issuing this joint proposal to further reduce greenhouse gas emissions and improve fuel economy for light-duty vehicles for model years 2017–2025. This proposal extends the National Program beyond the greenhouse gas and corporate average fuel economy standards set for model years 2012–2016. On May 21, 2010, President Obama issued a Presidential Memorandum requesting that NHTSA and EPA develop through notice and comment rulemaking a coordinated National Program to reduce greenhouse gas emissions of light-duty vehicles for model years 2017–2025. This proposal, consistent with the President's request, responds to the country's critical need to address global climate change and to reduce oil consumption. NHTSA is proposing Corporate Average Fuel Economy standards under the Energy Policy and Conservation Act, as amended by the Energy Independence and Security Act, and EPA is proposing greenhouse gas emissions standards under the Clean Air Act. These standards apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles, and represent a continued harmonized and consistent National Program. Under the National Program for model years 2017–2025, automobile manufacturers would be able to continue building 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. EPA is also proposing a minor change to the regulations applicable to MY 2012–2016, with respect to air conditioner performance and measurement of nitrous oxides.

DATES: *Comments:* Comments must be received on or before January 30, 2012. Under the Paperwork Reduction Act, comments on the information collection provisions must be received by the Office of Management and Budget (OMB) on or before January 3, 2012. See the **SUPPLEMENTARY INFORMATION** section on ''Public Participation'' for more information about written comments.

Public Hearings: NHTSA and EPA will jointly hold three public hearings on the following dates: January 17, 2012, in Detroit, Michigan; January 19, 2012 in Philadelphia, Pennsylvania; and January 24, 2012, in San Francisco, California. EPA and NHTSA will announce the addresses for each hearing location in a supplemental **Federal Register** Notice. The agencies will accept comments to the rulemaking documents, and NHTSA will also accept comments to the Draft Environmental Impact Statement (EIS) at these hearings and to Docket No. NHTSA–2011–0056. The hearings will start at 10 a.m. local time and continue until everyone has had a chance to speak. See the **SUPPLEMENTARY INFORMATION** section on ''Public Participation.'' for more information about the public hearings.

ADDRESSES: Submit your comments, identified by Docket ID No. EPA–HQ–OAR–2010–0799 and/or NHTSA–2010–0131, by one of the following methods:

- *Online: www.regulations.gov:* Follow the on-line instructions for submitting comments.
- *Email: a-and-r-Docket@epa.gov*
- *Fax:* EPA: (202) 566–9744; NHTSA: (202) 493–2251.
- *Mail:*
- *EPA:* Environmental Protection Agency, EPA Docket Center (EPA/DC), Air and Radiation Docket, Mail Code 28221T, 1200 Pennsylvania Avenue NW., Washington, DC 20460, Attention Docket ID No. EPA–HQ–OAR–2010–0799. In addition, please mail a copy of your comments on the information collection provisions to the Office of Information and Regulatory Affairs, Office of Management and Budget (OMB), Attn: Desk Officer for EPA, 725 17th St., NW., Washington, DC 20503.
- *NHTSA:* Docket Management Facility, M–30, U.S. Department of Transportation, West Building, Ground Floor, Rm. W12–140, 1200 New Jersey Avenue SE, Washington, DC 20590.
- *Hand Delivery:*
- *EPA:* Docket Center, (EPA/DC) EPA West, Room B102, 1301 Constitution Ave. NW., Washington, DC, Attention Docket ID No. EPA–HQ–OAR–2010–0799. Such deliveries are only accepted during the Docket's normal hours of operation, and special arrangements should be made for deliveries of boxed information.
- *NHTSA:* West Building, Ground Floor, Rm. W12–140, 1200 New Jersey Avenue SE, Washington, DC 20590, between 9 a.m. and 4 p.m. Eastern Time, Monday through Friday, except Federal Holidays.

Instructions: Direct your comments to Docket ID No. EPA–HQ–OAR–2010–0799 and/or NHTSA–2010–0131. See the **SUPPLEMENTARY INFORMATION** section on ''Public Participation'' for more information about submitting written comments.

Docket: All documents in the dockets are listed in the *http://www.regulations.gov* index. Although listed in the index, some information is not publicly available, *e.g.,* confidential business information (CBI) or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, will be publicly available in hard copy in EPA's docket, and electronically in NHTSA's online docket. Publicly available docket materials are available either electronically in *www.regulations.gov* or in hard copy at the following locations: EPA: EPA Docket Center, EPA/DC, EPA West, Room 3334, 1301 Constitution Ave. NW., Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744. NHTSA: Docket Management Facility, M–30, U.S. Department of Transportation, West Building, Ground Floor, Rm. W12–140, 1200 New Jersey Avenue SE., Washington, DC 20590. The Docket Management Facility is open between 9 a.m. and 5 p.m. Eastern Time, Monday through Friday, except Federal holidays.

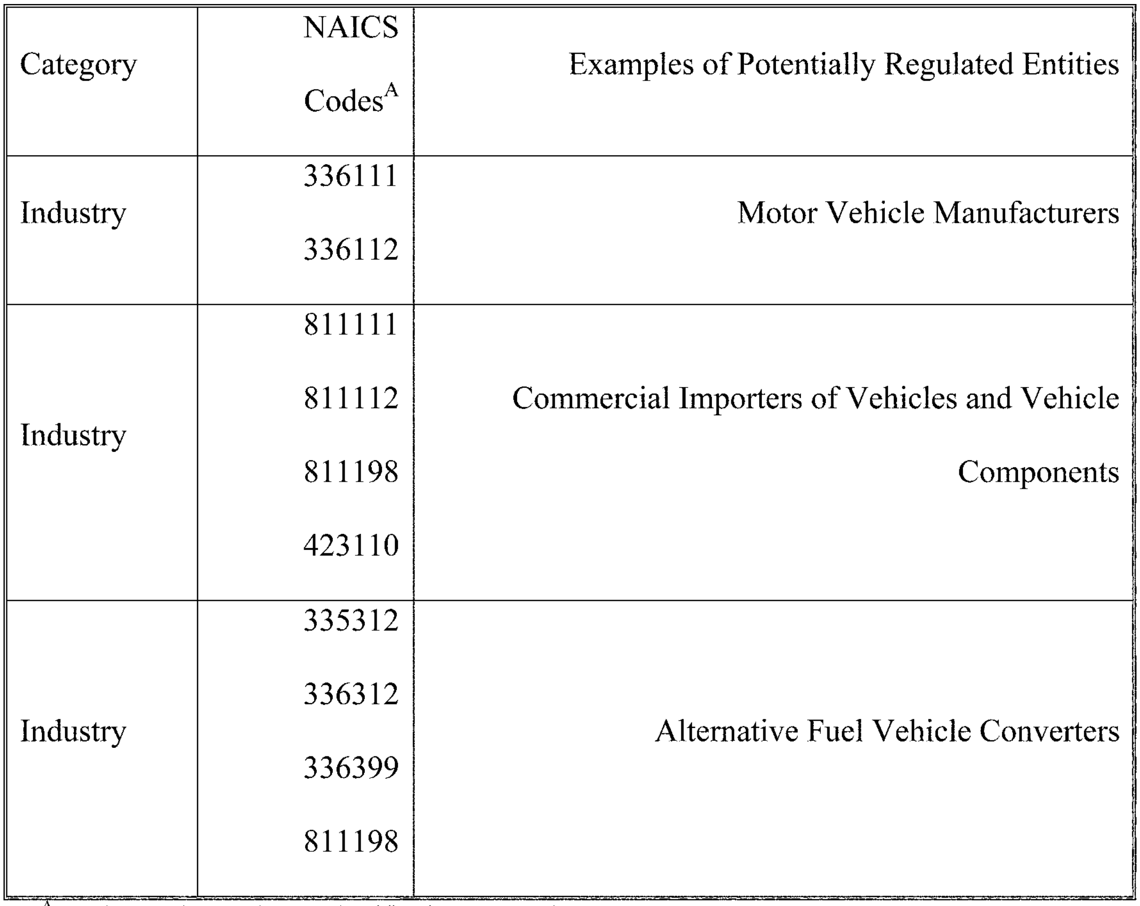
FOR FURTHER INFORMATION CONTACT: *EPA:* Christopher Lieske, Office of Transportation and Air Quality, Assessment and Standards Division, Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; telephone number: (734) 214–4584; fax number: (734) 214–4816; email address: *lieske.christopher@epa.gov*, or contact the Assessment and Standards Division; email address: *otaqpublicweb@epa.gov*. *NHTSA:* Rebecca Yoon, Office of the Chief Counsel, National Highway Traffic Safety Administration, 1200 New Jersey

Avenue SE., Washington, DC 20590. Telephone: (202) 366–2992.

SUPPLEMENTARY INFORMATION:

A. Does this action apply to me?

This action affects companies that manufacture or sell new light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles, as defined under EPA's CAA regulations,[1] 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	811111 811112 811198 423110	Commercial Importers of Vehicles and Vehicle Components
Industry	335312 336312 336399 811198	Alternative Fuel Vehicle Converters

[A] North American Industry Classification System (NAICS)

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

B. Public Participation

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

How do I prepare and submit comments?

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

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

EPA: Direct your comments to Docket ID No EPA–HQ–OAR–2010–0799. EPA's policy is that all comments received will be included in the public docket without change and may be made available online at *http://www.regulations.gov*, including any personal information provided, unless

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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.

the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through *http://www.regulations.gov* or email. The *http://www.regulations.gov* Web site is an ''anonymous access'' system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an email comment directly to EPA without going through *http://www.regulations.gov* your email address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD–ROM you submit. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses. For additional information about EPA's public docket visit the EPA Docket Center homepage at *http://www.epa.gov/epahome/dockets.htm.*

NHTSA: Your comments must be written and in English. To ensure that your comments are correctly filed in the Docket, please include the Docket number NHTSA–2010–0131 in your comments. Your comments must not be more than 15 pages long.[3] NHTSA established this limit to encourage you to write your primary comments in a concise fashion. However, you may attach necessary additional documents to your comments, and there is no limit on the length of the attachments. If you are submitting comments electronically as a PDF (Adobe) file, we ask that the documents submitted be scanned using the Optical Character Recognition (OCR) process, thus allowing the agencies to search and copy certain portions of your submissions.[4] Please note that pursuant to the Data Quality Act, in order for the substantive data to be relied upon and used by the agency, it must meet the information quality standards set forth in the OMB and Department of Transportation (DOT) Data Quality Act guidelines. Accordingly, we encourage you to consult the guidelines in preparing your comments. OMB's guidelines may be accessed at *http://www.whitehouse.gov/omb/fedreg/reproducible.html.* DOT's guidelines may be accessed at *http://www.dot.gov/dataquality.htm.*

Tips for Preparing Your Comments

When submitting comments, please remember to:

- Identify the rulemaking by docket number and other identifying information (subject heading, **Federal Register** date and page number).
- Explain why you agree or disagree, suggest alternatives, and substitute language for your requested changes.
- Describe any assumptions and provide any technical information and/or data that you used.
- If you estimate potential costs or burdens, explain how you arrived at your estimate in sufficient detail to allow for it to be reproduced.
- Provide specific examples to illustrate your concerns, and suggest alternatives.
- Explain your views as clearly as possible, avoiding the use of profanity or personal threats.
- Make sure to submit your comments by the comment period deadline identified in the DATES section above.

How can I be sure that my comments were received?

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

How do I submit confidential business information?

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

EPA: Do not submit CBI to EPA through *http://www.regulations.gov* or email. Clearly mark the part or all of the information that you claim to be CBI. For CBI information in a disk or CD ROM that you mail to EPA, mark the outside of the disk or CD ROM as CBI and then identify electronically within the disk or CD ROM the specific information that is claimed as CBI. In addition to one complete version of the comment that includes information claimed as CBI, a copy of the comment that does not contain the information claimed as CBI must be submitted for inclusion in the public docket. Information so marked will not be disclosed except in accordance with procedures set forth in 40 CFR Part 2.

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

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

Will the agencies consider late comments?

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

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

How can I read the comments submitted by other people?

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

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[3] See 49 CFR 553.21.

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

[5] See 49 CFR part 512.

Management Facility by going to the street addresses given above under **ADDRESSES**.

How do I participate in the public hearings?

NHTSA and EPA will jointly host three public hearings on the dates and locations described in the DATES section above. At all hearings, both agencies will accept comments on the rulemaking, and NHTSA will also accept comments on the EIS.

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

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

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

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I. Overview of Joint EPA/NHTSA Proposed 2017–2025 National Program

Executive Summary

EPA and NHTSA are each announcing proposed rules that call for strong and coordinated Federal greenhouse gas and fuel economy standards for passenger cars, light-duty trucks, and medium-duty passenger vehicles (hereafter light-duty vehicles or LDVs). Together, these vehicle categories, which include passenger cars, sport utility vehicles, crossover utility vehicles, minivans, and pickup trucks, among others, are presently responsible for approximately 60 percent of all U.S. transportation-related greenhouse gas (GHG) emissions and fuel consumption. This proposal would extend the National Program of Federal light-duty vehicle GHG emissions and corporate average fuel economy (CAFE) standards to model years (MYs) 2017–2025. This proposed coordinated program would achieve important reductions in GHG emissions and fuel consumption from the light-duty vehicle part of the transportation sector, based on technologies that either are commercially available or that the agencies project will be commercially available in the rulemaking timeframe and that can be incorporated at a reasonable cost. Higher initial vehicle costs will be more than offset by significant fuel savings for consumers over the lives of the vehicles covered by this rulemaking.

This proposal builds on the success of the first phase of the National Program to regulate fuel economy and GHG emissions from U.S. light-duty vehicles, which established strong and coordinated standards for model years (MY) 2012–2016. As with the first phase of the National Program, collaboration with California Air Resources Board (CARB) and with automobile manufacturers and other stakeholders has been a key element in developing the agencies' proposed rules. Continuing the National Program would ensure that all manufacturers can build a single fleet of U.S. vehicles that would satisfy all requirements under both programs as well as under California's program, helping to reduce costs and regulatory complexity while providing significant energy security and environmental benefits.

Combined with the standards already in effect for MYs 2012–2016, as well as the MY 2011 CAFE standards, the proposed standards would result in MY 2025 light-duty vehicles with nearly double the fuel economy, and approximately one-half of the GHG emissions compared to MY 2010 vehicles—representing the most significant federal action ever taken to reduce GHG emissions and improve fuel economy in the U.S. EPA is proposing standards that are projected to require, on an average industry fleet wide basis, 163 grams/mile of carbon dioxide (CO_2) in model year 2025, which is equivalent to 54.5 mpg if this level were achieved solely through improvements in fuel efficiency.[6] Consistent with its statutory authority, NHTSA is proposing passenger car and light truck standards for MYs 2017–2025 in two phases. The first phase, from MYs 2017–2021, includes proposed standards that are projected to require, on an average industry fleet wide basis, 40.9 mpg in MY 2021. The second phase of the CAFE program, from MYs 2022–2025, represents conditional[7] proposed standards that are projected to require, on an average industry fleet wide basis, 49.6 mpg in model year 2025. Both the EPA and NHTSA standards are projected to be achieved through a range of technologies, including improvements in air conditioning efficiency, which reduces both GHG emissions and fuel consumption; the EPA standards also are projected to be achieved with the use of air conditioning refrigerants with a lower global warming potential (GWP), which reduce GHGs (*i.e.,* hydrofluorocarbons) but do not improve fuel economy. The agencies are proposing separate standards for passenger cars and trucks, based on a vehicle's size or ''footprint.'' For the MYs 2022–2025 standards, EPA and NHTSA are proposing a comprehensive mid-term evaluation and agency decision-making process, given both the long time frame and NHTSA's obligation to conduct a separate rulemaking in order to establish final standards for vehicles for those model years.

From a societal standpoint, this second phase of the National Program is projected to save approximately 4 billion barrels of oil and 2 billion metric tons of GHG emissions over the lifetimes of those vehicles sold in MY 2017–2025. The agencies estimate that fuel savings will far outweigh higher vehicle costs, and that the net benefits to society of the MYs 2017–2025 National Program will be in the range of $311 billion to $421 billion (7 and 3 percent discount rates, respectively) over the lifetimes of those vehicles sold in MY 2017–2025.

These proposed standards would have significant savings for consumers at the pump. Higher costs for new vehicle technology will add, on average, about $2000 for consumers who buy a new vehicle in MY 2025. Those consumers who drive their MY 2025 vehicle for its entire lifetime will save, on average, $5200 to $6600 (7 and 3 percent discount rates, respectively) in fuel savings, for a net lifetime savings of $3000 to $4400. For those consumers who purchase their new MY 2025 vehicle with cash, the discounted fuel savings will offset the higher vehicle cost in less than 4 years, and fuel savings will continue for as long as the consumer owns the vehicle. Those consumers that buy a new vehicle with a typical 5-year loan will benefit from an average monthly cash flow savings of about $12 during the loan period, or about $140 per year, on average. So the consumer would benefit beginning at the time of purchase, since the increased monthly fuel savings would more than offset the higher monthly payment due to the higher incremental vehicle cost.

The agencies have designed the proposed standards to preserve consumer choice—that is, the proposed standards should not affect consumers' opportunity to purchase the size of vehicle with the performance, utility and safety features that meets their needs. The standards are based on a vehicle's size, or footprint—that is, consistent with their general performance and utility needs, larger vehicles have numerically less stringent fuel economy/GHG emissions targets and smaller vehicles have more stringent fuel economy/GHG emissions targets, although since the standards are fleet average standards, no specific vehicle *must* meet a target. Thus, consumers will be able to continue to choose from the same mix of vehicles that are currently in the marketplace.

The agencies' believe there is a wide range of technologies available for manufacturers to consider in reducing GHG emissions and improving fuel economy. The proposals allow for long-term planning by manufacturers and suppliers for the continued development and deployment across their fleets of fuel saving and emissions-reducing technologies. The agencies believe that advances in gasoline engines and transmissions will continue for the foreseeable future, and that there will be continual improvement in other technologies, including vehicle weight reduction, lower tire rolling resistance, improvements in vehicle aerodynamics, diesel engines, and more efficient vehicle accessories. The agencies also expect to see increased electrification of the fleet through the expanded production of stop/start, hybrid, plug-in hybrid and electric vehicles. Finally, the agencies expect that vehicle air conditioners will continue to improve by becoming more efficient and by increasing the use of alternative refrigerants. Many of these technologies are already available today, and manufacturers will be able to meet the standards through significant efficiency improvements in these technologies, as well as a significant penetration of these and other technologies across the fleet. Auto manufacturers may also introduce new technologies that we have not considered for this rulemaking analysis, which could make possible alternative, more cost-effective paths to compliance.

A. Introduction

1. Continuation of the National Program

EPA and NHTSA are each announcing proposed rules that call for strong and coordinated Federal greenhouse gas and fuel economy standards for passenger cars, light-duty trucks, and medium-duty passenger vehicles (hereafter light-duty vehicles or LDVs). Together, these vehicle categories, which include passenger cars, sport utility vehicles, crossover utility vehicles, minivans, and pickup trucks, are presently responsible for approximately 60 percent of all U.S. transportation-related greenhouse gas emissions and fuel consumption. The proposal would extend the National Program of Federal light-duty vehicle greenhouse gas (GHG) emissions and corporate average fuel economy (CAFE) standards to model years (MYs) 2017–2025. The coordinated program being proposed would achieve important reductions of greenhouse gas (GHG) emissions and fuel consumption from the light-duty vehicle part of the

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[6] Real-world CO_2 is typically 25 percent higher and real-world fuel economy is typically 20 percent lower than the CO_2 and CAFE compliance values discussed here. The reference to CO_2 here refers to CO_2 equivalent reductions, as this included some degree of reductions in greenhouse gases other than CO_2, as one part of the air conditioning related reductions.

[7] By ''conditional,'' NHTSA means to say that the proposed standards for MYs 2022–2025 represent the agency's current best estimate of what levels of stringency would be maximum feasible in those model years, but in order for the standards for those model years to be legally binding a subsequent rulemaking must be undertaken by the agency at a later time. *See* Section IV for more information.

transportation sector, based on technologies that either are commercially available or that the agencies project will be commercially available in the rulemaking timeframe and that can be incorporated at a reasonable cost.

In working together to develop the next round of standards for MYs 2017–2025, NHTSA and EPA are building on the success of the first phase of the National Program to regulate fuel economy and GHG emissions from U.S. light-duty vehicles, which established the strong and coordinated standards for model years (MY) 2012–2016. As for the MYs 2012–2016 rulemaking, collaboration with California Air Resources Board (CARB) and with industry and other stakeholders has been a key element in developing the agencies' proposed rules. Continuing the National Program would ensure that all manufacturers can build a single fleet of U.S. vehicles that would satisfy all requirements under both programs as well as under California's program, helping to reduce costs and regulatory complexity while providing significant energy security and environmental benefits.

The agencies have been developing the basis for these joint proposed standards almost since the conclusion of the rulemaking establishing the first phase of the National Program. After much research and deliberation by the agencies, along with CARB and other stakeholders, President Obama announced plans for these proposed rules on July 29, 2011 and NHTSA and EPA issued a Supplemental Notice of Intent (NOI) outlining the agencies' plans for proposing the MY 2017–2025 standards and program.[8] This July NOI built upon the extensive analysis conducted by the agencies over the past year, including an initial technical assessment report and NOI issued in September 2010, and a supplemental NOI issued in December 2010 (discussed further below). The State of California and thirteen auto manufacturers representing over 90 percent of U.S. vehicle sales provided letters of support for the program concurrent with the Supplemental NOI.[9] The United Auto Workers (UAW) also supported the announcement,[10] as well as many consumer and environmental groups. As envisioned in the Presidential announcement and Supplemental NOI, this proposal sets forth proposed MYs 2017–2025 standards as well as detailed supporting analysis for those standards and regulatory alternatives for public review and comment. The program that the agencies are proposing will spur the development of a new generation of clean cars and trucks through innovative technologies and manufacturing that will, in turn, spur economic growth and create high-quality domestic jobs, enhance our energy security, and improve our environment. Consistent with Executive Order 13563, this proposal was developed with early consultation with stakeholders, employs flexible regulatory approaches to reduce burdens, maintains freedom of choice for the public, and helps to harmonize federal and state regulations.

As described below, NHTSA and EPA are proposing a continuation of the National Program that the agencies believe represents the appropriate levels of fuel economy and GHG emissions standards for model years 2017–2025, given the technologies that the agencies anticipate will be available for use on these vehicles and the agencies' understanding of the cost and manufacturers' ability to apply these technologies during that time frame, and consideration of other relevant factors. Under this joint rulemaking, EPA is proposing GHG emissions standards under the Clean Air Act (CAA), and NHTSA is proposing CAFE standards under EPCA, as amended by the Energy Independence and Security Act of 2007 (EISA). This joint rulemaking proposal reflects a carefully coordinated and harmonized approach to implementing these two statutes, in accordance with all substantive and procedural requirements imposed by law.[11]

The proposed approach allows for long-term planning by manufacturers and suppliers for the continued development and deployment across their fleets of fuel saving and emissions-reducing technologies. NHTSA's and EPA's technology assessment indicates there is a wide range of technologies available for manufacturers to consider in reducing GHG emissions and improving fuel economy. The agencies believe that advances in gasoline engines and transmissions will continue for the foreseeable future, which is a view that is supported in the literature and amongst the vehicle manufacturers and suppliers.[12] The agencies also believe that there will be continual improvement in other technologies including reductions in vehicle weight, lower tire rolling resistance, improvements in vehicle aerodynamics, diesel engines, and more efficient vehicle accessories. The agencies also expect to see increased electrification of the fleet through the expanded production of stop/start, hybrid, plug-in hybrid and electric vehicles.[13] Finally, the agencies expect that vehicle air conditioners will continue to improve by becoming more efficient and by increasing the use of alternative refrigerants. Many 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 significant efficiency improvements in these technologies as well as a significant penetration of these and other technologies across the fleet. We project that these potential compliance pathways for manufacturers will result in significant benefits to consumers and to society, as quantified below. Manufacturers may also introduce new technologies that we have not considered for this rulemaking analysis, which could make possible alternative, more cost-effective paths to compliance.

As discussed further below, as with the standards for MYs 2012–2016, the agencies believe that the proposed standards would continue to preserve consumer choice, that is, the proposed standards should not affect consumers' opportunity to purchase the size of vehicle that meets their needs. NHTSA and EPA are proposing to continue standards based on vehicle footprint, where smaller vehicles have relatively more stringent standards, and larger vehicles have less stringent standards, so there should not be a significant effect on the relative availability of different size vehicles in the fleet.

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[8] 76 FR 48758 (August 9, 2011).

[9] Commitment letters are available at *http://www.epa.gov/otaq/climate/regulations.htm* and at *http://www.nhtsa.gov/fuel-economy* (last accessed Aug. 24, 2011).

[10] The UAW's support was expressed in a statement on July 29, 2011, which can be found at *http://www.uaw.org/articles/uaw-supports-administration-proposal-light-duty-vehicle-cafe-and-greenhouse-gas-emissions-r* (last accessed September 19, 2011).

[11] For NHTSA, this includes the requirements of the National Environmental Policy Act (NEPA).

[12] There are a number of competing gasoline engine technologies, with one in particular that the agencies project will be common beyond 2016. This is the gasoline direct injection and downsized engines equipped with turbochargers and cooled exhaust gas recirculation, which has performance characteristics similar to that of larger, less efficient engines. Paired with these engines, the agencies project that advanced transmissions (such as automatic and dual clutch transmissions with eight forward speeds) and higher efficiency gearboxes will provide significant improvements. Transmissions with eight or more speeds can be found in the fleet today in very limited production, and while they are expected to penetrate further by 2016, we anticipate that by 2025 these will be the dominant transmissions in new vehicle sales.

[13] For example, while today less than three percent of annual vehicle sales are strong hybrids, plug-in hybrids and all electric vehicles, by 2025 we estimate these technologies could represent nearly 15 percent of new sales.

Additionally, as with the standards for MYs 2012–2016, the agencies believe that the proposed standards should not have a negative effect on vehicle safety, as it relates to vehicle footprint and mass as described in Section II.C and II.G below, respectively.

We note that as part of this rulemaking, given the long time frame at issue in setting standards for MY 2022–2025 light-duty vehicles, the agencies are discussing a comprehensive mid-term evaluation and agency decision-making process. NHTSA has a statutory obligation to conduct a separate de novo rulemaking in order to establish final standards for vehicles for the 2022–2025 model years and would conduct the mid-term evaluation as part of that rulemaking, and EPA is proposing regulations that address the mid-term evaluation. The mid-term evaluation will assess the appropriateness of the MY 2022–2025 standards considered in this rulemaking, based on an updated assessment of all the factors considered in setting the standards and the impacts of those factors on the manufacturers' ability to comply. NHTSA and EPA fully expect to conduct this mid-term evaluation in coordination with the California Air Resources Board, given our interest in a maintaining a National Program to address GHGs and fuel economy. Further discussion of the mid-term evaluation is found later in this section, as well as in Sections III and IV.

Based on the agencies' analysis, the National Program standards being proposed are currently projected to reduce GHGs by approximately 2 billion metric tons and save 4 billion barrels of oil over the lifetime of MYs 2017–2025 vehicles relative to the MY 2016 standard curves [14] already in place. The average cost for a MY 2025 vehicle to meet the standards is estimated to be about $2,000 compared to a vehicle that would meet the level of the MY 2016 standards in MY 2025. However, fuel savings for consumers are expected to more than offset the higher vehicle costs. The typical driver would save a total of $5,200 to $6,600 (7 percent and 3 percent discount rate, respectively) in fuel costs over the lifetime of a MY 2025 vehicle and, even after accounting for the higher vehicle cost, consumers would save a net $3,000 to $4,400 (7 percent and 3 percent discount rate, respectively) over the vehicle's lifetime. Further, consumers who buy new vehicles with cash would save enough in lower fuel costs after less than 4 years (at either 7 percent or 3 percent discount rate) of owning a MY 2025 vehicle to offset the higher upfront vehicle costs, while consumers who buy with a 5-year loan would save more each month on fuel than the increased amount they would spend on the higher monthly loan payment, beginning in the first month of ownership.

Continuing the National Program has both energy security and climate change benefits. Climate change is widely viewed as a significant long-term threat to the global environment. EPA has found that elevated atmospheric concentrations of six greenhouse gases—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perflurocarbons, and sulfur hexafluoride—taken in combination endanger both the public health and the public welfare of current and future generations. EPA further found that the combined emissions of these greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas air pollution that endangers public health and welfare. 74 FR 66496 (Dec. 15, 2009). As summarized in EPA's Endangerment and Cause or Contribute Findings under Section 202(a) of the Clear 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.[15] 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.[16] Mobile sources addressed in the 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.[17] 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.[18] [19]

Improving our energy and national 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 accounted for approximately 51 percent of U.S. petroleum consumption in 2009.[20] World crude oil production is highly concentrated, exacerbating the risks of supply disruptions and price shocks as the recent unrest in North Africa and the Persian Gulf highlights. Recent tight global oil markets led to prices over $100 per barrel, with gasoline reaching as high as $4 per gallon in many parts of the U.S., causing financial hardship for many families and businesses. The export of U.S. assets for oil imports continues to be an important component of the historically unprecedented U.S. trade deficits. Transportation accounted for about 71 percent of U.S. petroleum consumption in 2009.[21] 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.

The automotive market is becoming increasingly global. The U.S. auto companies and U.S. suppliers produce and sell automobiles and automotive components around the world, and foreign auto companies produce and sell in the U.S. As a result, the industry has become increasingly competitive. Staying at the cutting edge of automotive technology while maintaining profitability and consumer acceptance has become increasingly important for the sustainability of auto companies. The proposed standards cover model years 2017–2025 for passenger cars and light-duty trucks sold in the United States. Many other countries and regions around the world have in place fuel economy or CO_2

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[14] The calculation of GHG reductions and oil savings is relative to a future in which the MY 2016 standards remain in place for MYs 2017–2025 and manufacturers comply on average at those levels.

[15] 74 FR 66,496,–66,518, December 18, 2009; ''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.*

[16] 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.*

[17] 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.*

[18] 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.*

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

[20] Energy Information Administration, ''How dependent are we on foreign oil?'' *Available at http://www.eia.gov/energy_in_brief/foreign_oil_dependence.cfm* (last accessed August 28, 2011).

[21] Energy Information Administration, Annual Energy Outlook 2011, ''Oil/Liquids.'' *Available at http://www.eia.gov/forecasts/aeo/MT_liquidfuels.cfm* (last accessed August 28, 2011).

emission standards for light-duty vehicles. In addition, the European Union is currently discussing more stringent CO_2 standards for 2020, and the Japanese government has recently issued a draft proposal for new fuel efficiency standards for 2020. The overall trend is clear—globally many of the major economic countries are increasing the stringency of their fuel economy or CO_2 emission standards for light-duty vehicles. When considering this common trend, the proposed CAFE and CO_2 standards for MY 2017–2025 may offer some advantages for U.S.-based automotive companies and suppliers. In order to comply with the proposed standards, U.S. firms will need to invest significant research and development dollars and capital in order to develop and produce the technologies needed to reduce CO_2 emissions and improve fuel economy. Companies have limited budgets for research and development programs. As automakers seek greater commonality across the vehicles they produce for the domestic and foreign markets, improving fuel economy and reducing GHGs in U.S. vehicles should have spillovers to foreign production, and vice versa, thus yielding the ability to amortize investment in research and production over a broader product and geographic spectrum. To the extent that the technologies needed to meet the standards contained in this proposal can also be used to comply with the fuel economy and CO_2 standards in other countries, this can help U.S. firms in the global automotive market, as the U.S. firms will be able to focus their available research and development funds on a common set of technologies that can be used both domestically as well as internationally.

2. Additional Background on the National Program

Following the successful adoption of a National Program of federal standards for greenhouse gas emissions (GHG) and fuel economy standards for model years (MY) 2012–2016 light duty vehicles, President Obama issued a Memorandum on May 21, 2010 requesting that the National Highway Traffic Safety Administration (NHTSA), on behalf of the Department of Transportation, and the Environmental Protection Agency (EPA) work together to develop a national program for model years 2017–2025. Specifically, he requested that the agencies develop ''* * * *a coordinated national program under the CAA [Clean Air Act] and the EISA [Energy Independence and Security Act of 2007] to improve fuel efficiency and to reduce greenhouse gas emissions of passenger cars and light-duty trucks of model years 2017–2025.''*[22] The President recognized that our country could take a leadership role in addressing the global challenges of improving energy security and reducing greenhouse gas pollution, stating that *''America has the opportunity to lead the world in the development of a new generation of clean cars and trucks through innovative technologies and manufacturing that will spur economic growth and create high-quality domestic jobs, enhance our energy security, and improve our environment.''*

The Presidential Memorandum stated ''*The program should also seek to achieve substantial annual progress in reducing transportation sector greenhouse gas emissions and fossil fuel consumption, consistent with my Administration's overall energy and climate security goals, through the increased domestic production and use of existing, advanced, and emerging technologies, and should strengthen the industry and enhance job creation in the United States.''* Among other things, the agencies were tasked with researching and then developing standards for MYs 2017 through 2025 that would be appropriate and consistent with EPA's and NHTSA's respective statutory authorities, in order to continue to guide the automotive sector along the road to reducing its fuel consumption and GHG emissions, thereby ensuring corresponding energy security and environmental benefits. During the public comment period for the MY 2012–2016 proposed rulemaking, many stakeholders, including automakers, encouraged NHTSA and EPA to begin working toward standards for MY 2017 and beyond in order to maintain a single nationwide program. Several major automobile manufacturers and CARB sent letters to EPA and NHTSA in support of a MYs 2017 to 2025 rulemaking initiative as outlined in the President's May 21, 2010 announcement.[23]

The President's memo requested that the agencies, ''work with the State of California to develop by September 1, 2010, a technical assessment to inform the rulemaking process * * *.'' As a first step in responding to the President's request, the agencies collaborated with CARB to prepare an Interim Joint Technical Assessment Report (TAR) to inform the rulemaking process and provide an initial technical assessment for that work. NHTSA, EPA, and CARB issued the joint Technical Assessment Report consistent with Section 2(a) of the Presidential Memorandum.[24] In developing the technical assessment, EPA, NHTSA, and CARB held numerous meetings with a wide variety of stakeholders including the automobile original equipment manufacturers (OEMs), automotive suppliers, non-governmental organizations, states and local governments, infrastructure providers, and labor unions. The Interim Joint TAR provided an overview of key stakeholder input, addressed other topics noted in the Presidential memorandum, and EPA's and NHTSA's initial assessment of benefits and costs of a range of stringencies of future standards.

In accordance with the Presidential Memorandum, NHTSA and EPA also issued a joint Notice of Intent to Issue a Proposed Rulemaking (NOI).[25] The September 2010 NOI highlighted the results of the analyses contained in the Interim Joint TAR, provided an overview of key program design elements, and announced plans for initiating the joint rulemaking to improve the fuel efficiency and reduce the GHG emissions of passenger cars and light-duty trucks built in MYs 2017–2025. The agencies requested comments on the September NOI and accompanying Interim Joint TAR.

The Interim Joint TAR contained an initial fleet-wide analysis of improvements in overall average GHG emissions and equivalent fuel economy

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[22] The Presidential Memorandum is found at: *http://www.whitehouse.gov/the-press-office/presidential-memorandum-regarding-fuel-efficiency-standards.* For the reader's reference, the President also requested the Administrators of EPA and NHTSA to issue joint rules under the CAA and EISA to establish fuel efficiency and greenhouse gas emissions standards for commercial medium-and heavy-duty on-highway vehicles and work trucks beginning with the 2014 model year. The agencies recently promulgated final GHG and fuel efficiency standards for heavy duty vehicles and engines for MYs 2014–2018. 76 FR 57106 (September 15, 2011).

[23] These letters of support in response to the May 21, 2010 Presidential Memorandum are available at *http://www.epa.gov/otaq/climate/regulations.htm#prez* and *http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/Stakeholder+Commitment+Letters* (last accessed August 28, 2011).

[24] This Interim Joint Technical Assessment Report (TAR) is available at *http://www.epa.gov/otaq/climate/regulations/ldv-ghg-tar.pdf* and *http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/2017+CAFE–GHG_Interim_TAR2.pdf.*Section 2(a) of the Presidential Memorandum requested that EPA and NHTSA ''Work with the State of California to develop by September 1, 2010, a technical assessment to inform the rulemaking process, reflecting input from an array of stakeholders on relevant factors, including viable technologies, costs, benefits, lead time to develop and deploy new and emerging technologies, incentives and other flexibilities to encourage development and deployment of new and emerging technologies, impacts on jobs and the automotive manufacturing base in the United States, and infrastructure for advanced vehicle technologies.''

[25] 75 FR 62739, October 13, 2010.

levels. For purposes of an initial assessment, this range was intended to represent a reasonably broad range of stringency increases for potential future GHG emissions standards, and was also consistent with the increases suggested by CARB in its letter of commitment in response to the President's memorandum.[26] [27] The TAR evaluated a range of potential stringency scenarios through model year 2025, representing a 3, 4, 5, and 6 percent per year estimated decrease in GHG levels from a model year 2016 fleet-wide average of 250 gram/mile (g/mi). Thus, the model year 2025 scenarios analyzed in the Interim Joint TAR ranged from 190 g/mi on an estimated fleet-wide average (calculated to be equivalent to 47 miles per gallon, mpg, if all improvements were made with fuel economy-improving technologies) under the 3 percent per year reduction scenario, to 143 g/mi on an estimated fleet-wide average (calculated to be equivalent to 62 mpg, if all improvements were made with fuel economy-improving technologies) under the 6 percent per year scenario.[28] For each of these scenarios, the TAR also evaluated four pre-defined ''technological pathways'' by which these levels could be attained. These pathways were meant to represent ways that the industry as a whole could increase fuel economy and reduce greenhouse gas emissions, and did not represent ways that individual manufacturers would be required to or necessarily would employ in responding to future standards. Each defined technology pathway emphasized a different mix of advanced technologies, by assuming various degrees of penetration of advanced gasoline technologies, mass reduction, hybrid electric vehicles (HEVs), plug-in hybrids (PHEVs), and electric vehicles (EVs).

Manufacturers and others commented extensively on the NOI and Interim Joint TAR on a variety of topics, including the stringency of the standards, program design elements, the effect of potential standards on vehicle safety, and the TAR's discussion of technology costs, effectiveness, and feasibility. In response, the agencies and CARB spent the next several months continuing to gather information from the industry and others in response to the agencies' initial analytical efforts. To aid the public's understanding of some of the key issues facing the agencies in developing the proposed rule, EPA and NHTSA also issued a follow-on Supplemental NOI in November 2010.[29] The Supplemental NOI highlighted many of the key comments the agencies received in response to the September NOI and Interim Joint TAR, and summarized some of the key themes from the comments and the additional stakeholder meetings. We note, as highlighted in the November Supplemental NOI, that there continued to be widespread stakeholder support for continuing the National Program for improved fuel economy and greenhouse gas standards for model years 2017–2025. The November Supplemental NOI also provided an overview of many of the key technical analyses the agencies planned in support the proposed rule.

After issuing the November 2010 Supplemental NOI, EPA, NHTSA and CARB continued studies on technology cost and effectiveness and more in-depth and comprehensive analysis of the issues. In addition to this work, the agencies continued meeting with stakeholders, including with manufacturers, manufacturer organizations, automotive suppliers, a labor union, environmental groups, consumer interest groups, and investment organizations. As discussed above, on July 29, 2011 President Obama announced plans for these proposed rules and NHTSA and EPA issued a Supplemental Notice of Intent (NOI) outlining the agencies' plans for proposing the MY 2017–2025 standards and program.

3. California's Greenhouse Gas Program

In 2004, the California Air Resources Board (CARB) approved standards for new light-duty vehicles, regulating the emission of CO_2 and other GHGs. Thirteen states and the District of Columbia, comprising approximately 40 percent of the light-duty vehicle market, adopted California's standards. On June 30, 2009, EPA granted California's request for a waiver of preemption under the CAA with respect to these standards.[30] The granting of the waiver permits California and the other states to proceed with implementing the California emission standards for MYs 2009–2016. After EPA and NHTSA issued their MYs 2012–2016 standards, CARB revised its program such that compliance with the EPA greenhouse gas standards will be deemed to be compliance with California's GHG standards.[31] This facilitates the National Program by allowing manufacturers to meet all of the standards with a single national fleet.

As requested by the President and in the interest of maximizing regulatory harmonization, NHTSA and EPA have worked closely with CARB throughout the development of this proposal to develop a common technical basis. CARB is releasing a proposal for MY 2017–2025 GHG emissions standards which are consistent with the standards being proposed by EPA and NHTSA. CARB recognizes the benefit for the country of continuing the National Program and plans an approach similar to the one taken for MYs 2012–2016. CARB has committed to propose to revise its GHG emissions standards for MY 2017 and later such that compliance with EPA GHG emissions standards shall be deemed compliance with the California GHG emissions standards, as long as EPA's final GHG standards are substantially as described in the July 2011 Supplemental NOI.[32]

4. Stakeholder Engagement

On July 29, 2010, President Obama announced the support of thirteen major automakers to pursue the next phase in the Administration's national vehicle program, increasing fuel economy and reducing GHG emissions for passenger cars and light trucks built in MYs 2017–2025.[33] The President was joined by Ford, GM, Chrysler, BMW, Honda, Hyundai, Jaguar/Land Rover, Kia, Mazda, Mitsubishi, Nissan, Toyota and Volvo, which together account for over 90 percent of all vehicles sold in the United States. The California Air Resources Board (CARB), the United Auto Workers (UAW) and a number of

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[26] 75 FR at 62744–45.

[27] Statement of the California Air Resources Board Regarding Future Passenger Vehicle Greenhouse Gas Emissions Standards, California Air Resources Board, May 21, 2010. Available at: *http://www.epa.gov/otaq/climate/regulations.htm.*

[28] These levels correspond to on-road values of 37 to 50 mpg, respectively, recognizing that on-road fuel economy tends to be about 20 percent worse than calculated mpg values based on the CAFE test cycle. We note, however, that because these mpg values are translated from CO_2e values that include reductions in hydrofluorocarbon (HFC) leakage due to use of advanced refrigerants and leakage improvements, therefore these numbers are not as representative of either CAFE test cycle or real-world mpg.

[29] 75 FR 76337, December 8, 2010.

[30] 74 FR 32744 (July 8, 2009). See also *Chamber of Commerce* v. *EPA,* 642 F.3d 192 (DC Cir. 2011) (dismissing petitions for review challenging EPA's grant of the waiver).

[31] See ''California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles as approved by OAL,'' March 29, 2010. *Available at http://www.arb.ca.gov/regact/2010/ghgpv10/oaltp.pdf* (last accessed August 28, 2011).

[32] See State of California July 28, 2011 letter available at: *http://www.epa.gov/otaq/climate/regulations.htm.*

[33] The President's remarks are available at *http://www.whitehouse.gov/the-press-office/2011/07/29/remarks-president-fuel-efficiency-standards*; see also *http://www.nhtsa.gov/fuel-economy* for more information from the agency about the announcement.

environmental and consumer groups, also announced their support.

On the same day as the President's announcement, the agencies released a second SNOI (published in the **Federal Register** on August 9, 2011) generally describing the joint proposal that the EPA and NHTSA expected to issue to establish the National Program for model years 2017–2025, and which is set forth in this NPRM. The agencies explained that the proposal would be developed based on extensive technical analyses, an examination of the factors required under their respective statutes and discussions with and input from individual motor vehicle manufacturers and other stakeholders. The input of stakeholders, which is encouraged by Executive Order 13563, has been invaluable to the agencies in developing today's NPRM.

For background, as discussed above, after publishing the Supplemental NOI on December 8, 2010 (the December 8 SNOI), NHTSA, EPA and CARB continued studies and conducted more in-depth and comprehensive rulemaking analyses related to technology cost and effectiveness, technological feasibility, reasonable timing for manufacturers to implement technologies, and economic factors, and other relevant considerations. In addition to this ongoing and more in-depth work, the agencies continued meeting with stakeholders and received additional input and feedback to help inform the rulemaking. Meetings were held with and relevant information was obtained from manufacturers, manufacturer organizations, suppliers, a labor union, environmental groups, consumer interest groups, and investment organizations.

This section summarizes NHTSA and EPA stakeholder engagement between December 2010 and July 29, 2011, the date on which President Obama announced the agencies' plans for proposing standards for MY2017–2025, and the support of thirteen major automakers and other stakeholders for these plans.[34] Information that the agencies presented to stakeholders is posted in the docket and referenced in multiple places in this section.

The agencies' engagement with the large and diverse group of stakeholders described above between December 2010 and July 29, 2011 shared the single aim of ensuring that the agencies possessed the most complete and comprehensive set of information possible to inform the proposed rulemaking.

Throughout this period, the stakeholders repeated many of the broad concerns and suggestions described in the TAR, NOI, and December 8 SNOI. For example, stakeholders uniformly expressed interest in maintaining a harmonized and coordinated national program that would be supported by CARB and allow auto makers to build one fleet and preserve consumer choice. The stakeholders also raised concerns about potential stringency levels, consumer acceptance of some advanced technologies and the potential structure of compliance flexibilities available under EPCA (as amended by EISA) and the CAA. In addition, most of the stakeholders wanted to discuss issues concerning technology availability, cost and effectiveness and economic practicability. The auto manufacturers, in particular, sought to provide the agencies with a better understanding of their respective strategies (and associated costs) for improving fuel economy while satisfying consumer demand in the coming years. Additionally, some stakeholders expressed concern about potential safety impacts associated with the standards, consumer costs and consumer acceptance, and potential disparate treatment of cars and trucks. Some stakeholders also stressed the importance of investing in infrastructure to support more widespread deployment of alternative vehicles and fuels. Many stakeholders also asked the agencies to acknowledge prevailing economic uncertainties in developing proposed standards. In addition, many stakeholders discussed the number of years to be covered by the program and what they considered to be important features of a mid-term review of any standards set or proposed for MY 2022–2025. In all of these meetings, NHTSA and EPA sought additional data and information from the stakeholders that would allow them to refine their initial analyses and determine proposed standards that are consistent with the agencies' respective statutory and regulatory requirements. The general issues raised by those stakeholders are addressed in the sections of this NPRM discussing the topics to which the issues pertain (*e.g.,* the form of the standards, technology cost and effectiveness, safety impacts, impact on U.S. vehicle sales and other economic considerations, costs and benefits).

The first stage of the meetings occurred between December 2010 and June 20, 2011. These meetings covered topics that were generally similar to the meetings that were held prior to the publication of the December 8 Supplemental NOI and that were summarized in the Supplemental NOI. The manufacturers provided the agencies with additional information related to their product plans for vehicle models and fuel efficiency improving technologies and associated cost estimates. Detailed product plans generally extend only five or six model years into the future. Manufacturers also provided estimates of the amount of improvement in CAFE and CO_2 emissions they could reasonably achieve in model MYs 2017–2025; feedback on the shape of MY 2012–2016 regulatory stringency curves and curve cut points, regulatory program flexibilities; recommendations for and on the structure of one or more mid-term reviews of the later model year standards; estimates of the cost, effectiveness and availability of some fuel efficiency improving technologies; and feedback on some of the cost and effectiveness assumptions used in the TAR analysis. In addition, manufacturers provided input on manufacturer experience with consumer acceptance of some advanced technologies and raised concerns over consumer acceptance if higher penetration of these technologies were needed in the future, consumer's willingness to pay for improved fuel economy, and ideas on enablers and incentives that would increase consumer acceptance. Many manufacturers stated that technology is available to significantly improve fuel economy and CO_2 emissions; however, they maintained that the biggest challenges relate to the cost of the technologies, consumer willingness to pay and consumer acceptance.

During this first phase NHTSA and EPA continued to meet with other stakeholders, who provided their own perspectives on issues of importance to them. They also provided data to the extent available to them. Information obtained from stakeholders during this phase is contained in the docket.

The second stage of meetings occurred between June 21, 2011 and July 14, 2011, during which time EPA, NHTSA, CARB and several White House Offices kicked-off an intensive series of meetings, primarily with manufacturers, to share tentative regulatory concepts developed by EPA, NHTSA and CARB, which included concept stringency curves and program flexibilities based on the analyses completed by the agencies as of June 21,[35] and requested

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[34] NHTSA has prepared a list of stakeholder meeting dates and participants, found in a memorandum to the docket, titled "2017–2025 CAFE Stakeholders Meetings List," at NHTSA–2010–0131.

[35] The agencies consider a range of standards that may satisfy applicable legal criteria, taking into account the complete record before them . The

feedback.[36] In particular, the agencies requested that the manufacturers provide detailed and reliable information on how they might comply with the concepts and, if they projected they could not comply, information supporting their belief that they would be unable to comply. Additionally, EPA and NHTSA sought detailed input from the manufacturers regarding potential changes to the concept stringency levels and program flexibilities available under EPA's and NHTSA's respective authority that might facilitate compliance. In addition, manufacturers provided input related to consumer acceptance and adoption of some advanced technologies and program costs based on their independent assessments or information previously submitted to the agencies.

In these second stage meetings, the agencies received considerable input from the manufacturers. The agencies carefully considered the manufacturer information along with information from the agencies' independent analyses. The agencies used all available information to refine their assessment of the range of program concept stringencies and provisions that the agencies determined were consistent with their statutory mandates.

The third stage of meetings occurred between July 15, 2011 and July 28, 2011. During this time period the agencies continued to refine concept stringencies and compliance flexibilities based on further consideration of the information available to them. They also met with approximately 13 manufacturers who expressed ongoing interest in engaging with the agencies.[37]

Throughout all three stages, EPA and NHTSA continued to engage other stakeholders to ensure that the agencies were obtaining the most comprehensive and reliable information possible to guide the agencies in developing proposed standards for MY 2017–2025. Many of these stakeholders reiterated comments previously presented to the agencies. For instance, environmental organizations consistently stated that stringent standards are technically achievable and critical to important national interests, such as improving energy independence, reducing climate change, and enabling the domestic automobile industry to remain competitive in the global market. Labor interests stressed the need to carefully consider economic impacts and the opportunity to create and support new jobs, and consumer advocates emphasized the economic and practical benefits to consumers of improved fuel economy and the need to preserve consumer choice. In addition, a number of stakeholders stated that the standards under development should not have an adverse impact on safety.

On July 29, 2011, EPA and NHTSA the agencies issued a new SNOI with concept stringency curves and program provisions based on refined analyses and further consideration of the record before the agencies. The agencies have received letters of support for the concepts laid out in the SNOI from BMW, Chrysler, Ford, General Motors, Global Automakers, Honda, Hyundai, Jaguar Land Rover, Kia, Mazda, Mitsubishi, Nissan, Toyota, Volvo and CARB. Numerous other stakeholders, including labor, environmental and consumer groups, have expressed their support for the agencies' plans to move forward.

The agencies have considered all of this stakeholder input in developing this proposal, and look forward to continuing the productive dialogue through the comment period following this proposal.

B. Summary of the Proposed 2017–2025 National Program

1. Joint Analytical Approach

This proposed rulemaking continues the collaborative analytical effort between NHTSA and EPA, which began with the MYs 2012–2016 rulemaking. NHTSA and EPA have worked together, and in close coordination with CARB, on nearly every aspect of the technical analysis supporting these joint proposed rules. The results of this collaboration are reflected in the elements of the respective NHTSA and EPA proposed rules, as well as in the analytical work contained in the Draft Joint NHTSA and EPA Technical Support Document (Joint TSD). The agencies have continued to develop and refine supporting analyses since issuing the NOI and Interim Joint TAR last September. The Joint TSD, in particular, describes important details of the analytical work that are common, as well as highlighting any key differences in approach. The joint analyses include the build-up of the baseline and reference fleets, the derivation of the shape of the footprint-based attribute curves that define the agencies' respective standards, a detailed description of the estimated costs and effectiveness of the technologies that are available to vehicle manufacturers, the economic inputs used to calculate the costs and benefits of the proposed rules, a description of air conditioner and other off-cycle technologies, and the agencies' assessment of the effects of the proposed standards on vehicle safety. This comprehensive joint analytical approach has provided a sound and consistent technical basis for both agencies in developing their proposed standards, which are summarized in the sections below.

2. Level of the Standards

EPA and NHTSA are each proposing two separate sets of standards, each under its respective statutory authorities. Both the proposed CO_2 and CAFE standards for passenger cars and light trucks would be footprint-based, similar to the standards currently in effect through model year 2016, and would become more stringent on average in each model year from 2017 through 2025. The basis for measuring performance relative to standards would continue to be based predominantly on the EPA city and highway test cycles (2-cycle test). However, EPA is proposing optional air conditioning and off-cycle credits for the GHG program and adjustments to calculated fuel economy for the CAFE programs that would be based on test procedures other than the 2-cycle tests.

EPA is proposing standards that are projected to require, on an average industry fleet wide basis, 163 grams/mile of CO_2 in model year 2025. This is projected to be achieved through improvements in fuel efficiency with some additional reductions achieved through reductions in non-CO_2 GHG emissions from reduced AC system leakage and the use of lower global warming potential (GWP) refrigerants. The level of 163 grams/mile CO_2 would be equivalent on a mpg basis to 54.5 mpg, if this level was achieved solely through improvements in fuel efficiency.[38]

For passenger cars, the CO_2 compliance values associated with the footprint curves would be reduced on average by 5 percent per year from the model year 2016 projected passenger car industry-wide compliance level through model year 2025. In recognition of manufacturers' unique challenges in improving the fuel economy and GHG emissions of full-size pickup trucks as we transition from the MY 2016

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initial concepts shared with stakeholders were within the range the agencies were considering, based on the information then available to the agencies.

[36] "Agency Materials Provided to Manufacturers" Memo to docket NHTSA–2010–0131.

[37] "Agency Materials Provided to Manufacturers" Memo to docket NHTSA–2010–0131.

[38] Real-world CO_2 is typically 25 percent higher and real-world fuel economy is typically 20 percent lower than the CO2 and CAFE values discussed here. The reference to CO_2 here refers to CO_2 equivalent reductions, as this included some degree of reductions in greenhouse gases other than CO_2, as one part of the AC related reductions.

standards to MY 2017 and later, while preserving the utility (*e.g.,* towing and payload capabilities) of those vehicles, EPA is proposing a lower annual rate of improvement for light-duty trucks in the early years of the program. For light-duty trucks, the proposed average annual rate of CO_2 emissions reduction in model years 2017 through 2021 is 3.5 percent per year. EPA is also proposing to change the slopes of the CO_2-footprint curves for light-duty trucks from those in the 2012–2016 rule, in a manner that effectively means that the annual rate of improvement for smaller light-duty trucks in model years 2017 through 2021 would be higher than 3.5 percent, and the annual rate of improvement for larger light-duty trucks over the same time period would be lower than 3.5 percent. For model years 2022 through 2025, EPA is proposing an average annual rate of CO_2 emissions reduction for light-duty trucks of 5 percent per year.

NHTSA is proposing two phases of passenger car and light truck standards in this NPRM. The first phase runs from MYs 2017–2021, with proposed standards that are projected to require, on an average industry fleet wide basis, 40.9 mpg in MY 2021. For passenger cars, the annual increase in the stringency of the target curves between model years 2017 to 2021 is expected to average 4.1 percent. In recognition of manufacturers' unique challenges in improving the fuel economy and GHG emissions of full-size pickup trucks as we transition from the MY 2016 standards to MY 2017 and later, while preserving the utility (*e.g.,* towing and payload capabilities) of those vehicles, NHTSA is also proposing a slower annual rate of improvement for light trucks in the first phase of the program. For light trucks, the proposed annual increase in the stringency of the target curves in model years 2017 through 2021 would be 2.9 percent per year on average. NHTSA is proposing to change the slopes of the fuel economy footprint curves for light trucks from those in the MYs 2012–2016 final rule, which would effectively make the annual rate of improvement for smaller light trucks in MYs 2017–2021 higher than 2.9 percent, and the annual rate of improvement for larger light trucks over that time period lower than 2.9 percent.

The second phase of the CAFE program runs from MYs 2022–2025 and represents conditional[39] proposed standards that are projected to require, on an average industry fleet wide basis, 49.6 mpg in model year 2025. For passenger cars, the annual increase in the stringency of the target curves between model years 2022 and 2025 is expected to average 4.3 percent, and for light trucks, the annual increase during those model years is expected to average 4.7 percent. For the first time, NHTSA is proposing to increase the stringency of standards by the amount (in mpg terms) that industry is expected to improve air conditioning system efficiency, and EPA is proposing, under EPCA, to allow manufacturers to include air conditioning system efficiency improvements in the calculation of fuel economy for CAFE compliance. NHTSA notes that the proposed rates of increase in stringency for CAFE standards are lower than EPA's proposed rates of increase in stringency for GHG standards. As in the MYs 2012–2016 rulemaking, this is for purposes of harmonization and in reflection of several statutory constraints in EPCA/EISA. As a primary example, NHTSA's proposed standards, unlike EPA's, do not reflect the inclusion of air conditioning system refrigerant and leakage improvements, but EPA's proposed standards would allow consideration of such A/C refrigerant improvements which reduce GHGs but do not affect fuel economy.

As with the MYs 2012–2016 standards, NHTSA and EPA's proposed MYs 2017–2025 passenger car and light truck standards are expressed as mathematical functions depending on vehicle footprint.[40] Footprint is one measure of vehicle size, and is determined by multiplying the vehicle's wheelbase by the vehicle's average track width. The standards that must be met by each manufacturer's fleet would be determined by computing the production-weighted average of the targets applicable to each of the manufacturer's fleet of passenger cars and light trucks.[41] Under these footprint-based standards, the average levels required of individual manufacturers will depend, as noted above, on the mix and volume of vehicles the manufacturer produces. The values in the tables below reflect the agencies' projection of the corresponding average fleet levels that will result from these attribute-based curves given the agencies' current assumptions about the mix of vehicles that will be sold in the model years covered by the proposed standards.

As shown in Table I–1, NHTSA's fleet-wide required CAFE levels for passenger cars under the proposed standards are estimated to increase from 40.0 to 56.0 mpg between MY 2017 and MY 2025. Fleet-wide required CAFE levels for light trucks, in turn, are estimated to increase from 29.4 to 40.3 mpg. For the reader's reference, Table I–1 also provides the estimated average fleet-wide required levels for the combined car and truck fleets, culminating in an estimated overall fleet average required CAFE level of 49.6 mpg in MY 2025. Considering these combined car and truck increases, the proposed standards together represent approximately a 4.0 percent annual rate of increase,[42] on average, relative to the MY 2016 required CAFE levels.

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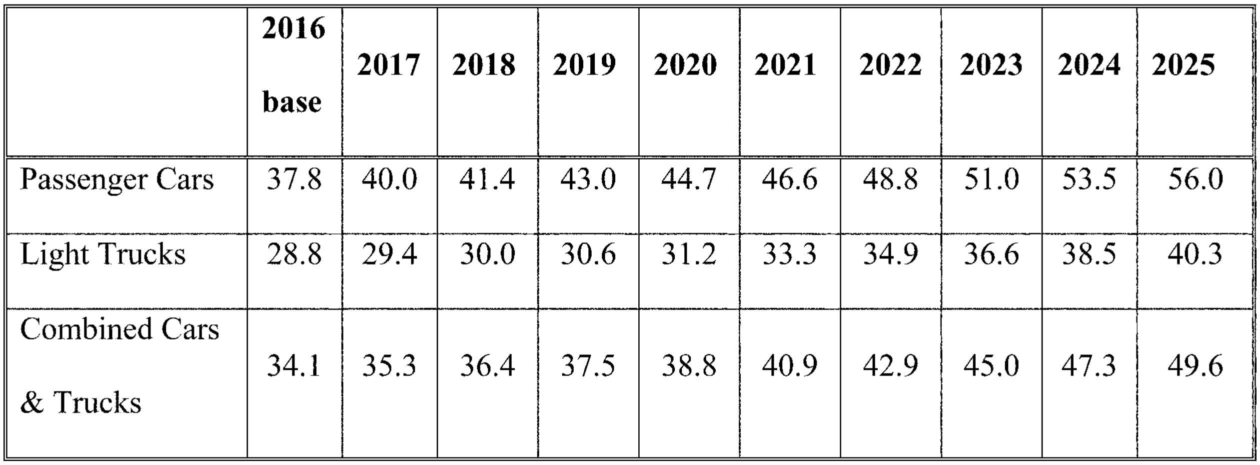
[39] By ''conditional,'' NHTSA means to say that the proposed standards for MYs 2022–2025 represent the agency's current best estimate of what levels of stringency would be maximum feasible in those model years, but in order for the standards for those model years to be legally reviewable a subsequent rulemaking must be undertaken by the agency at a later time. See Section IV for more information.

[40] NHTSA is required to set attribute-based CAFE standards for passenger cars and light trucks. 49 U.S.C. 32902(b)(3).

[41] For CAFE calculations, a harmonic average is used.

[42] This estimated average percentage increase includes the effect of changes in standard stringency and changes in the forecast fleet sales mix.

Table I-1 Estimated Average Required Fleet-Wide Fuel Economy (mpg) under Proposed Footprint-Based CAFE Standards



	2016 base	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger Cars	37.8	40.0	41.4	43.0	44.7	46.6	48.8	51.0	53.5	56.0
Light Trucks	28.8	29.4	30.0	30.6	31.2	33.3	34.9	36.6	38.5	40.3
Combined Cars & Trucks	34.1	35.3	36.4	37.5	38.8	40.9	42.9	45.0	47.3	49.6

The estimated average required mpg levels for cars and trucks under the proposed standards shown in Table I–1 above include the use of A/C efficiency improvements, as discussed above, but do not reflect a number of proposed flexibilities and credits that manufacturers could use for compliance that NHTSA cannot consider in establishing standards based on EPCA/EISA constraints. These flexibilities would cause the actual achieved fuel economy to be lower than the required levels in the table above. The flexibilities and credits that NHTSA cannot consider include the ability of manufacturers to pay civil penalties rather than achieving required CAFE levels, the ability to use FFV credits, the ability to count electric vehicles for compliance, the operation of plug-in hybrid electric vehicles on electricity for compliance prior to MY 2020, and the ability to transfer and carry-forward credits. When accounting for these flexibilities and credits, NHTSA estimates that the proposed CAFE standards would lead to the following average achieved fuel economy levels, based on the projections of what each manufacturer's fleet will comprise in each year of the program:[43]

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[43] The proposed CAFE program includes incentives for full size pick-up trucks that have mild HEV or strong HEV systems, and for full size pick-up trucks that have fuel economy performance that is better than the target curve by more than proposed levels. To receive these incentives, manufacturers must produce vehicles with these technologies or performance levels at volumes that meet or exceed proposed penetration levels (percentage of full size pick-up truck volume). This incentive is described in detail in Section IV.1. The NHTSA estimates in Table I–2 do not account for the reduction in estimated average achieved fleet-wide CAFE fuel economy that would occur if manufacturers use this incentive. NHTSA has conducted a sensitivity study that estimates the effects for manufacturers' potential use of this flexibility in Chapter X of the PRIA.

Table I-2 Estimated Average Achieved Fleet-Wide Fuel Economy (mpg) under Proposed Footprint-Based CAFE Standards

	2016 base	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger Cars	37.5	38.8	40.6	42.7	44.6	46.1	47.2	48.8	50.5	52.7
Light Trucks	28.2	29.0	30.1	31.8	33.0	34.8	35.5	36.3	37.4	38.6
Combined Cars & Trucks	33.4	34.5	36.0	38.0	39.7	41.4	42.4	43.7	45.2	47.0

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 * * *,'' and applies to each manufacturer's fleet of domestically manufactured passenger cars (*i.e.,* like the other CAFE standards, it represents a fleet average requirement, not a requirement for each individual vehicle within the fleet).

Based on NHTSA's current market forecast, the agency's estimates of these proposed minimum standards for domestic passenger cars for MYs 2017–2025 are presented below in Table I–3.

Table I-3 Estimated Minimum Standard for Domestically Manufactured Passenger Cars (mpg)

2017	2018	2019	2020	2021	2022	2023	2024	2025
36.8	38.1	39.6	41.1	42.9	44.9	47.0	49.2	51.5

EPA is proposing GHG emissions standards, and Table I–4 provides estimates of the projected overall fleet-wide CO_2 emission compliance target levels. The values reflected in Table I–4 are those that correspond to the manufacturers' projected CO_2 compliance target levels from the car and truck footprint curves, but do not account for EPA's projection of how manufactures will implement two of the proposed incentive programs (advanced technology vehicle multipliers, and hybrid and performance-based incentives for full-size pickup trucks). EPA's projection of fleet-wide emissions levels that do reflect these incentives is shown in Table I–5 below.

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[44] The projected fleet compliance levels for 2016 are different for trucks and the fleet than were projected in the 2012–2016 rule. Our assessment for this proposal is based on a predicted 2016 truck value of 297 and a projected combined car and truck value of 252 g/mi. That is because the standards are footprint based and the fleet projections, hence the footprint distributions, change slightly with each update of our projections, as described below. In addition, the actual fleet compliance levels for any model year will not be known until the end of that model year based on actual vehicle sales.

Table I-4 Projected Fleet-Wide CO_2 Compliance Targets under the Proposed Footprint-Based CO_2 Standards (g/mi)

	2016 base	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger Cars	225	213	202	192	182	173	165	158	151	144
Light Trucks	298	295	285	277	270	250	237	225	214	203
Combined Cars and Trucks	250[44]	243	232	223	213	200	190	181	172	163

As shown in Table I–4, projected fleet-wide CO_2 emission compliance targets for cars increase in stringency from 213 to 144 g/mi between MY 2017 and MY 2025. Similarly, projected fleet-wide CO_2 equivalent emission compliance targets for trucks increase in stringency from 295 to 203 g/mi. As shown, the overall fleet average CO_2 level targets are projected to increase in stringency from 243 g/mi in MY 2017 to 163 g/mi in MY 2025, which is equivalent to 54.5 mpg if all reductions were made with fuel economy improvements.

EPA anticipates that manufacturers would take advantage of proposed program credits and incentives, such as car/truck credit transfers, air conditioning credits, off-cycle credits, advanced technology vehicle multipliers, and hybrid and performance-based incentives for full size pick-up trucks. Two of these flexibility provisions—advanced technology vehicle multipliers and the full size pick-up hybrid/performance incentives—are expected to have an impact on the fleet-wide emissions levels that manufacturers will actually achieve. Therefore, Table I–5 shows EPA's projection of the achieved emission levels of the fleet for MY 2017 through 2025. The differences between the emissions levels shown in Tables I–4 and I–5 reflect the impact on stringency due to the advanced technology vehicle multipliers and the full size pick-up hybrid/performance incentives, but do not reflect car-truck trading, air conditioning credits, or off-cycle credits, because, while those credit provisions should help reduce manufacturers' costs of the program, EPA believes that they will result in real-world emission reductions that will not affect the achieved level of emission reductions. These estimates are more fully discussed in III.B

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Table I-5 Projected Fleet-Wide Achieved CO_2-equivalent Emission Levels under the Proposed Footprint-Based CO_2 Standards (g/mi)[45]

	2016 base	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger Cars	225	215	205	194	184	174	165	158	151	144
Light Trucks	298	295	285	278	271	251	238	226	214	204
Combined Cars and Trucks	250[46]	245	234	224	214	201	190	181	172	163.6

A more detailed description of how the agencies arrived at the year by year progression of the stringency of the proposed standards can be found in Sections III and IV of this preamble.

Both agencies also considered other alternative standards as part of their respective Regulatory Impact Analyses that span a reasonable range of alternative stringencies both more and less stringent than the standards being proposed. EPA's and NHTSA's analyses of these regulatory alternatives (and explanation of why we are proposing the standards proposed and not the regulatory alternatives) are contained in Sections III and IV of this preamble, respectively, as well as in EPA's DRIA and NHTSA's PRIA.

3. Form of the Standards

As noted, NHTSA and EPA are proposing to continue attribute-based standards for passenger cars and light trucks, as required by EISA and as allowed by the CAA, and continue to use vehicle footprint as the attribute. 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. NHTSA and EPA adopted an attribute-based approach based on vehicle footprint for MYs 2012–2016 light-duty vehicle standards.[47] The agencies continue to believe that footprint is the most appropriate attribute on which to base the proposed standards, as discussed later in this notice and in Chapter 2 of the Joint TSD.

Under the footprint-based standards, the curve defines a GHG or fuel economy performance target for each separate car or truck footprint. Using the curves, each manufacturer thus will have a GHG and CAFE average standard that is unique to each of its fleets, depending on the footprints and production volumes of the vehicle models produced by that manufacturer. A manufacturer will have separate footprint-based standards for cars and for trucks. The curves are mostly sloped, so that generally, larger vehicles (*i.e.,* vehicles with larger footprints) will be subject to less stringent targets (*i.e.,* higher CO_2 grams/mile targets and lower CAFE mpg targets) 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. Although a manufacturer's fleet average standards could be estimated throughout the model year based on projected production volume of its vehicle fleet, the standards to which the manufacturer must comply will be based on its final model year production figures. A manufacturer's calculation of its fleet average standards as well as its fleets' average performance at the end of the model year will thus be based on the production-weighted average target and performance of each model in its fleet.[48]

While the concept is the same, the proposed curve shapes for MYs 2017–2025 are somewhat different from the MYs 2012–2016 footprint curves. The passenger car curves are similar in shape to the car curves for MYs 2012–2016. However, the agencies are proposing more significant changes to the light trucks curves for MYs 2017–2025 compared to the light truck curves for MYs 2012–2016. The agencies are proposing changes to the light-truck curve to increase the slope and to

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[45] Electric vehicles are assumed at 0 gram/mile in this analysis.

[46] The projected fleet compliance levels for 2016 are different for the fleet than were projected in the 2012–2016 rule. Our assessment for this proposal is based on a predicted 2016 truck value of 297 and a projected combined car and truck value of 252 g/mi. That is because the standards are footprint based and the fleet projections, hence the footprint distributions, change slightly with each update of our projections, as described below. In addition, the actual fleet compliance levels for any model year will not be known until the end of that model year based on actual vehicle sales.

[47] NHTSA also uses the footprint attribute in its Reformed CAFE program for light trucks for model years 2008–2011 and passenger car CAFE standards for MY 2011.

[48] As in the MYs 2012–2016 rule, a manufacturer may have some models that exceed their target, and some that are below their target. Compliance with a fleet average standard is determined by comparing the fleet average standard (based on the sales weighted average of the target levels for each model) with fleet average performance (based on the sales weighted average of the performance for each model).

extend the large-footprint cutpoint over time to larger footprints, which we believe represent an appropriate balance of both technical and policy issues, as discussed in Section II.C below and Chapter 2 of the draft Joint TSD.

NHTSA is proposing the attribute curves below for assigning a fuel economy target level to an individual car or truck's footprint value, for model years 2017 through 2025. 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 target curve equation is the same for each vehicle category and each year, the parameters of the curve equation differ for cars and trucks. Each parameter also changes on a model year basis, resulting in the yearly increases in stringency. Figure I–1 below illustrates the passenger car CAFE standard curves for model years 2017 through 2025 while Figure I–2 below illustrates the light truck CAFE standard curves for model years 2017 through 2025.

EPA is proposing the attribute curves shown in Figure I–3 and Figure I–4 below for assigning a CO_2 target level to an individual vehicle's footprint value, for model years 2017 through 2025. These CO_2 values would be production weighted to determine each manufacturer's fleet average standard for cars and trucks. As with the CAFE curves, 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 a model year basis, resulting in the yearly increases in stringency. Figure I–3 below illustrates the CO_2 car standard curves for model years 2017 through 2025 while Figure I–4 shows the CO_2 truck standard curves for model years 2017–2025.

Figure I-1 CAFE Target Curves for Passenger Cars

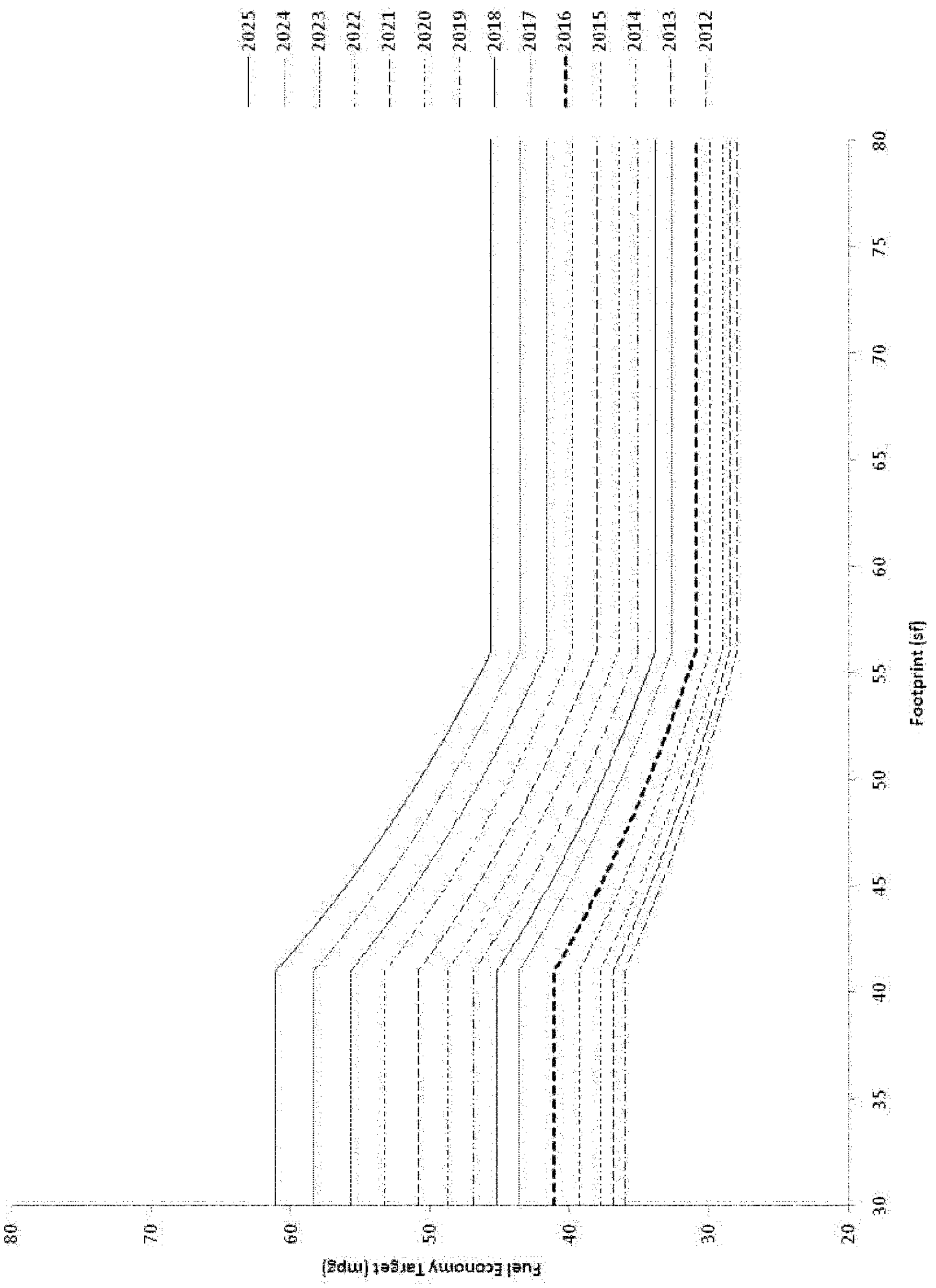


Figure I-2 CAFE Target Curves for Light Trucks

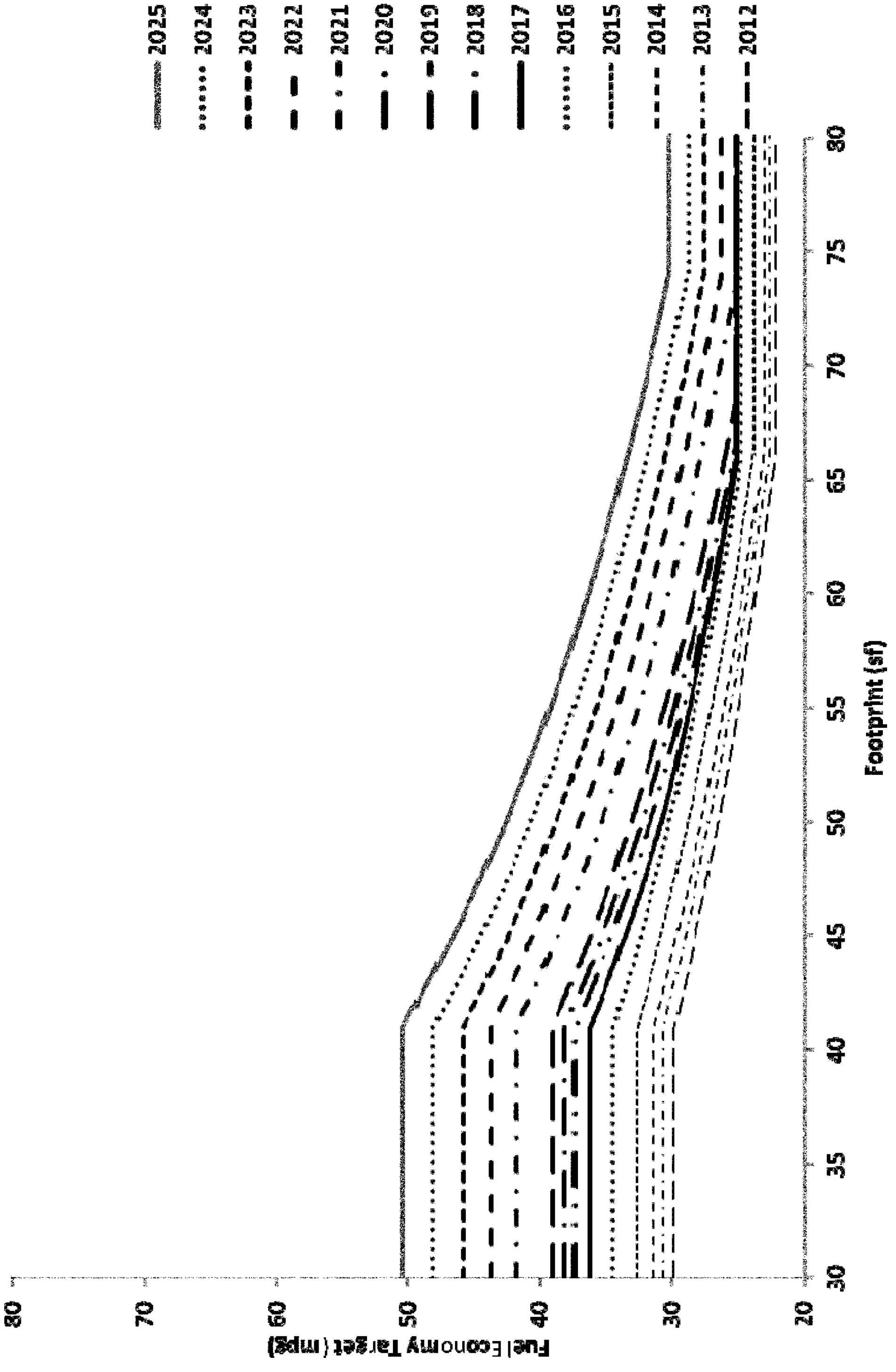
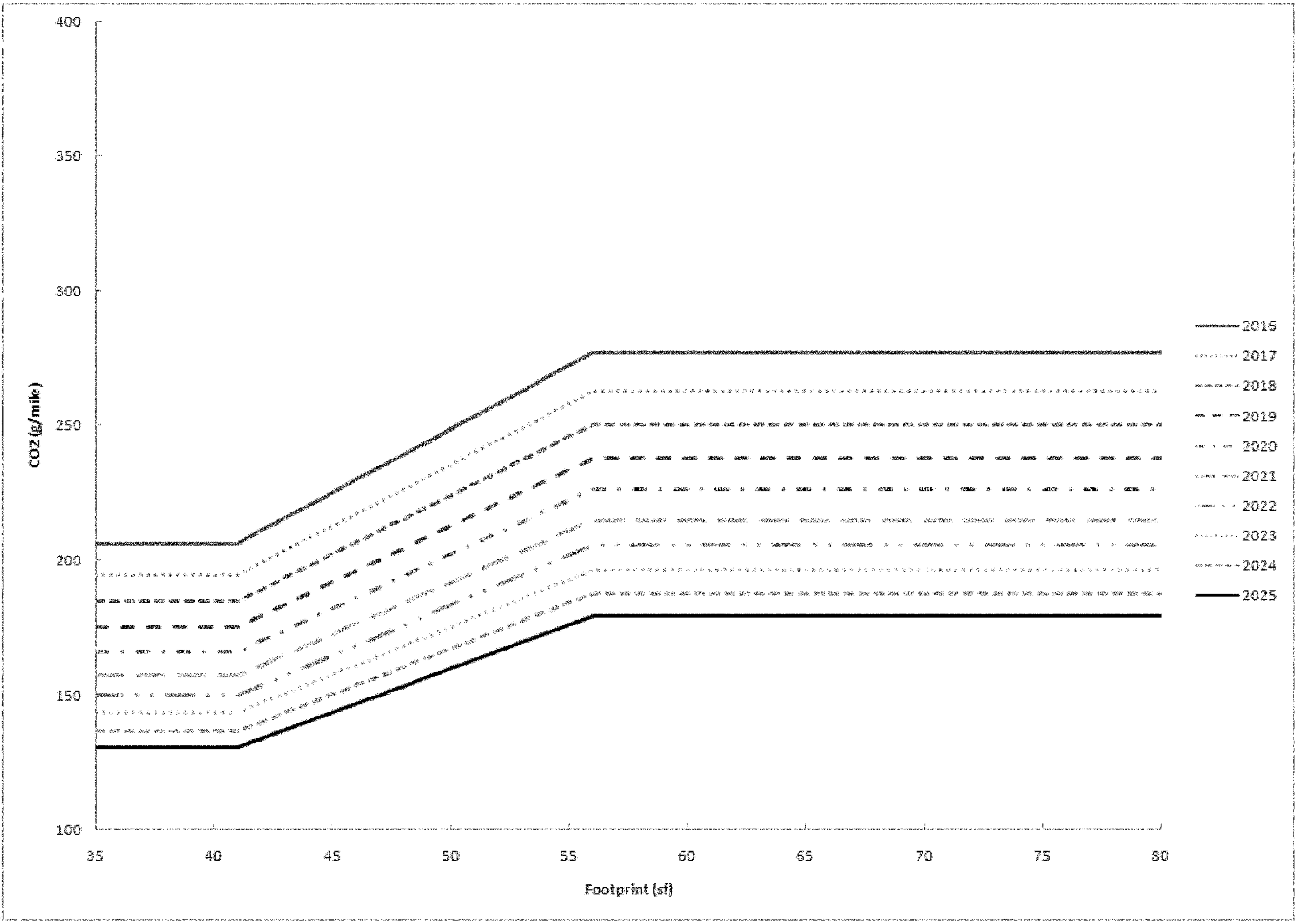


Figure I-3 CO2 (g/mile) Car Standards Curves



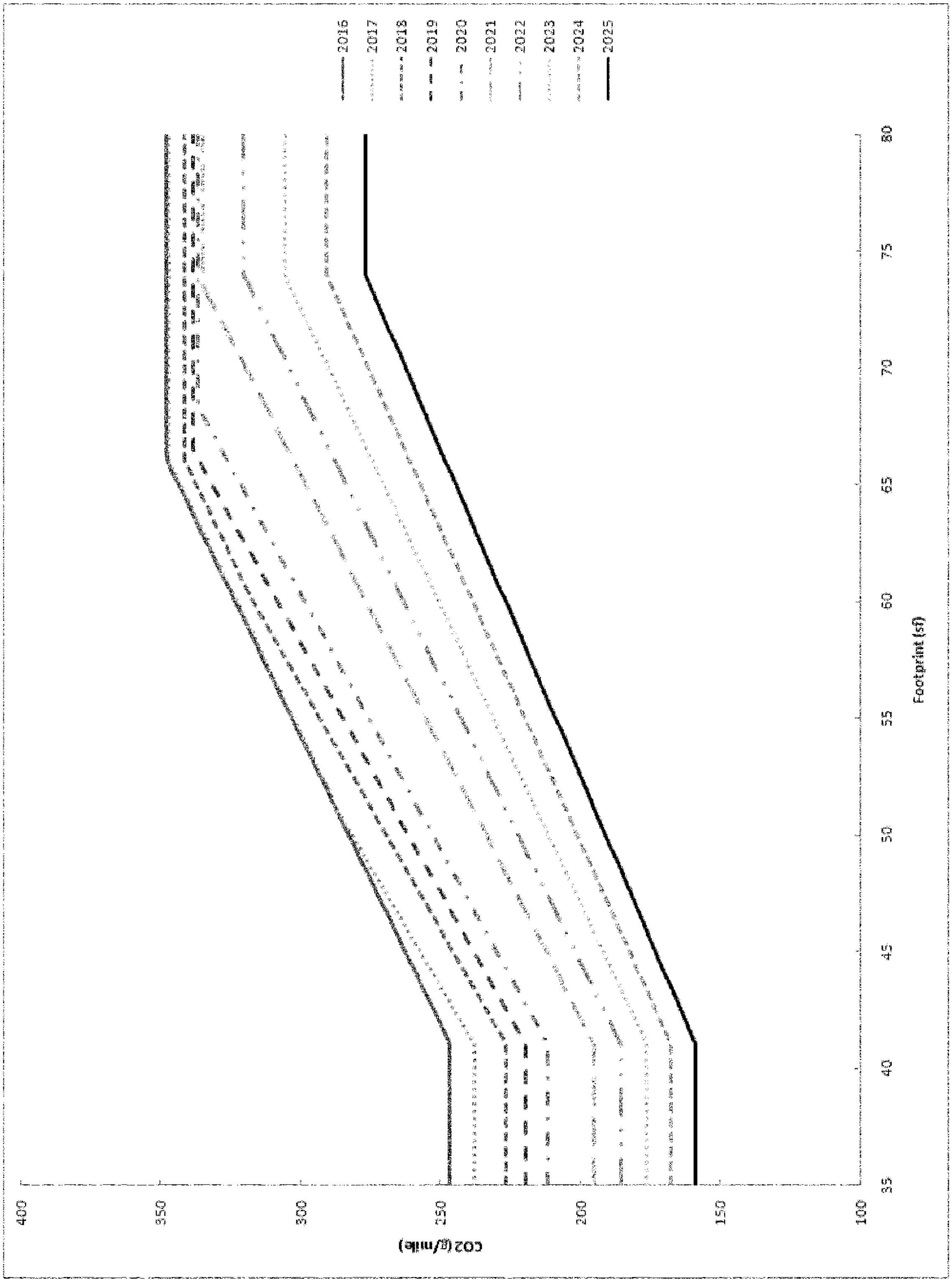


Figure I-4 CO2 (g/mile) Truck Standard Curves

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NHTSA and EPA are proposing to use the same vehicle category definitions for determining which vehicles are subject to the car curve standards versus the truck curve standards as were used for MYs 2012–2016 standards. As in the MYs 2012–2016 rulemaking, 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.[49] This approach of using CAFE definitions allows the CO_2 standards and the CAFE standards to continue to be harmonized across all vehicles for the National Program.

As just explained, generally speaking, a smaller footprint vehicle will tend to have higher fuel economy and lower CO_2 emissions relative to a larger footprint vehicle when both have the same level of fuel efficiency improvement technology. Since the

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[49] See 49 CFR 523 for NHTSA's definitions for passenger car and light truck under the CAFE program.

proposed standards apply to a manufacturer's overall fleet, not to an individual vehicle, if a manufacturer's fleet is dominated by small footprint vehicles, then that fleet will have a higher fuel economy requirement and a lower CO_2 requirement than a manufacturer whose fleet is dominated by large footprint vehicles. Compared to the non-attribute based CAFE standards in place prior to MY 2011, the proposed standards more evenly distribute the compliance burdens of the standards among different manufacturers, based on their respective product offerings. With this footprint-based standard approach, EPA and NHTSA continue to believe that the rules will not create significant incentives to produce vehicles of particular sizes, and thus there should be no significant effect on the relative availability of different vehicle sizes in the fleet due to the proposed standards, which will help to maintain consumer choice during the rulemaking timeframe. Consumers should still be able to purchase the size of vehicle that meets their needs. Table I–6 helps to illustrate the varying CO_2 emissions and fuel economy targets under the proposed standards that different vehicle sizes will have, although we emphasize again that these targets are not actual standards—the proposed standards are manufacturer-specific, rather than vehicle-specific.

Table I-6 Model Year 2025 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)[a]**	**Fuel Economy Target (mpg)[b]**
Example Passenger Cars				
Compact car	Honda Fit	40	131	61.1
Midsize car	Ford Fusion	46	147	54.9
Fullsize car	Chrysler 300	53	170	48.0
Example Light-duty Trucks				
Small SUV	4WD Ford Escape	44	170	47.5
Midsize crossover	Nissan Murano	49	188	43.4
Minivan	Toyota Sienna	55	209	39.2
Large pickup truck	Chevy Silverado	67	252	33.0

[a, b] Real-world CO_2 is typically 25 percent higher and real-world fuel economy is typically 20 percent lower than the CO_2 and fuel economy target values presented here.

4. Program Flexibilities for Achieving Compliance

a. CO_2/CAFE Credits Generated Based on Fleet Average Over-Compliance

The MYs 2012–2016 rules contain several provisions which provide flexibility to manufacturers in meeting standards, many of which the agencies are not proposing to change for MYs 2017 and later. For example, the agencies are proposing to continue allowing manufacturers to generate credits for over-compliance with the CO_2 and CAFE standards.[50] Under the agencies' footprint-based approach to the standards, a manufacturer's ultimate compliance obligations are determined at the end of each model year, when production of the model year is complete. Since the fleet average standards that apply to a manufacturer's car and truck fleets are based on the applicable footprint-based curves, a production volume-weighted fleet average requirement will be calculated for each averaging set (cars and trucks) based on the mix and volumes of the models manufactured for sale by the manufacturer. If a manufacturer's car and/or truck fleet achieves a fleet average CO_2/CAFE level better than the car and/or truck standards, then the manufacturer generates 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). As in the MY 2011 CAFE program under EPCA/EISA, and also in MYs 2012–2016 for the light-duty vehicle GHG and CAFE 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.

Credit ''carry-back'' means that manufacturers are able to use credits to offset a deficit that had accrued in a prior model year, while credit ''carry-forward'' means that manufacturers can bank credits and use them toward compliance in future model years. EPCA, as amended by EISA, requires NHTSA to allow manufacturers to carry-back credits for up to three model years, and to carry-forward credits for up to five model years. EPA's MYs 2012–2016 light duty vehicle GHG program includes the same limitations and EPA is proposing to continue this limitation in the MY 2017–2025 program. To facilitate the transition to the increasingly more stringent standards, EPA is proposing under its CAA authority a one-time CO_2 carry-forward beyond 5 years, such that any credits generated from MY 2010 through 2016 will be able to be used any time through MY 2021. This provision would not apply to early credits generated in MY 2009. NHTSA's program will continue the 5-year carry-forward and 3-year carry-back, as required by statute.

Credit ''transfer'' means the ability of manufacturers to move credits from their passenger car fleet to their light truck fleet, or vice versa. EISA required NHTSA to establish by regulation a CAFE credits transferring program, now codified at 49 CFR part 536, to allow a manufacturer to transfer credits between its car and truck 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. However, EISA imposed a cap on the amount by which a manufacturer could raise its CAFE through transferred credits: 1 mpg for MYs 2011–2013; 1.5 mpg for MYs 2014–2017; and 2 mpg for MYs 2018 and beyond.[51] Under section 202(a) of the CAA, in contrast, there is no statutory limitation on car-truck credit transfers, and EPA's GHG program 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 setting appropriate GHG standards that manufacturers' can comply with in the lead time provided, and will allow the required GHG emissions reductions to be achieved in the most cost effective way. Therefore, EPA did not constrain the magnitude of allowable car-truck credit transfers,[52] as doing so would reduce the flexibility for lead time, and would increase costs with no corresponding environmental benefit. EISA also prohibits the use of transferred credits to meet the minimum domestic passenger car fleet CAFE standard.[53] These statutory limits will necessarily continue to apply to the determination of compliance with the CAFE standards.

Credit ''trading'' means the ability of manufacturers to sell credits to, or purchase credits from, one another. EISA allowed NHTSA to establish by regulation a CAFE credit trading program, also now codified at 49 CFR Part 536, to allow credits to be traded between vehicle manufacturers. EPA also allows credit trading in the light-duty vehicle GHG program. These sorts of exchanges between averaging sets are typically allowed under EPA's current mobile source emission credit programs (as well as EPA's and NHTSA's recently promulgated GHG and fuel efficiency standards for heavy-duty vehicles and engines). EISA also prohibits manufacturers from using traded credits to meet the minimum domestic passenger car CAFE standard.[54]

b. Air Conditioning Improvement Credits/Fuel Economy Value Increases

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). In addition, operation of the A/C system places an additional load on the engine which increases fuel consumption and thus results in additional CO_2 tailpipe emissions (indirect A/C related emissions). In the MYs 2012–2016 program, EPA allows manufacturers to generate credits by reducing either or both types of GHG emissions related to A/C systems. The expected generation of A/C credits is accounted for in setting the level of the overall CO_2 standard. For the current proposal, as with the MYs 2012–2016 program, manufacturers will be able to generate CO_2-equivalent credits to use in complying with the CO_2 standards for improvements in air conditioning (A/C) systems, both for efficiency improvements (reduces tailpipe CO_2 and improves fuel consumption) and for leakage reduction or alternative, lower GWP (global warming potential) refrigerant use (reduces hydrofluorocarbon (HFC) emissions). EPA is proposing that the maximum A/C credit available for cars is 18.8 grams/mile CO_2 and for trucks is 24.4 grams/mile CO_2. The proposed test methods used to calculate these direct and indirect A/C credits are very similar to those of the MYs 2012–2016 program, though EPA is seeking comment on a revised idle test as well as a new test procedure.

For the first time in the current proposal, the agencies are proposing provisions that would account for improvements in air conditioner efficiency in the CAFE program. Improving A/C efficiency leads to real-world fuel economy benefits, because as explained above, A/C operation

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[50] This credit flexibility is required by EPCA/EISA, see 49 U.S.C. 32903, and allowed by the CAA.

[51] 49 U.S.C. 32903(g)(3).

[52] EPA's proposed program will continue to adjust car and truck credits by vehicle miles traveled (VMT), as in the MY 2012–2016 program.

[53] 49 U.S.C. 32903(g)(4).

[54] 49 U.S.C. 32903(f)(2).

represents an additional load on the engine, so more efficient A/C operation imposes less of a load and allows the vehicle to go farther on a gallon of gas. Under EPCA, EPA has authority to adopt procedures to measure fuel economy and calculate CAFE. Under this authority EPA is proposing that manufacturers could generate fuel consumption improvement values for purposes of CAFE compliance based on air conditioning system efficiency improvements for cars and trucks. This increase in fuel economy would be allowed up to a maximum based on 0.000563 gallon/mile for cars and 0.000810 gallon/mile for trucks. This is equivalent to the A/C efficiency CO_2 credit allowed by EPA under the GHG program. The same methods would be used in the CAFE program to calculate the values for air conditioning efficiency improvements for cars and trucks as are used in EPA's GHG program. NHTSA is including in its proposed passenger car and light truck CAFE standards an increase in stringency in each model year from 2017–2025 by the amount industry is expected to improve air conditioning system efficiency in those years, in a manner consistent with EPA's GHG standards. EPA is not proposing to allow generation of fuel consumption improvement values for CAFE purposes, nor is NHTSA proposing to increase stringency of the CAFE standard, for the use of A/C systems that reduce leakage or employ alternative, lower GWP refrigerant, because those changes do not improve fuel economy.

c. Off-cycle Credits/Fuel Economy Value Increases

For MYs 2012–2016, EPA provided an option for manufacturers to generate credits for employing new and innovative technologies that achieve CO_2 reductions that are not reflected on current test procedures. EPA noted in the MYs 2012–2016 rulemaking that examples of such "off-cycle" technologies might include solar panels on hybrids, adaptive cruise control, and active aerodynamics, among other technologies. See generally 75 FR at 25438–39. EPA's current program allows off-cycle credits to be generated through MY 2016.

EPA is proposing that manufacturers may continue to use off-cycle credits for MY 2017 and later for the GHG program. As with A/C efficiency, improving efficiency through the use of off-cycle technologies leads to real-world fuel economy benefits and allows the vehicle to go farther on a gallon of gas. Thus, under its EPCA authority EPA is proposing to allow manufacturers to generate fuel consumption improvement values for purposes of CAFE compliance based on the use of off-cycle technologies. Increases in fuel economy under the CAFE program based on off-cycle technology will be equivalent to the off-cycle credit allowed by EPA under the GHG program, and these amounts will be determined using the same procedures and test methods as are used in EPA's GHG program. For the reasons discussed in sections III and IV of this proposal, the ability to generate off-cycle credits and increases in fuel economy for use in compliance will not affect or change the level of the GHG or CAFE standards proposed by each agency.

Many automakers indicated that they had a strong interest in pursuing off-cycle technologies, and encouraged the agencies to refine and simplify the evaluation process to provide more certainty as to the types of technologies the agencies would approve for credit generation. For 2017 and later, EPA is proposing to expand and streamline the MYs 2012–2016 off-cycle credit provisions, including an approach by which the agencies would provide specified amounts of credit and fuel consumption improvement values for a subset of off-cycle technologies whose benefits are readily quantifiable. EPA is proposing a list of technologies and credit values, where sufficient data is available, that manufacturers could use without going through an advance approval process that would otherwise be required to generate credits. EPA believes that our assessment of off-cycle technologies and associated credit values on this proposed list is conservative, and automakers may apply for additional off-cycle credits beyond the minimum credit value if they have sufficient supporting data. Further, manufacturers may also apply for off-cycle technologies beyond those listed, again, if they have sufficient data.

In addition, EPA is providing additional detail on the process and timing for the credit/fuel consumption improvement values application and approval process. EPA is proposing a timeline for the approval process, including a 60-day EPA decision process from the time a manufacturer submits a complete application. EPA is also proposing a detailed, common, step-by-step process, including a specification of the data that manufacturers must submit. For off-cycle technologies that are both not covered by the pre-approved off-cycle credit/fuel consumption improvement values list and that are not quantifiable based on the 5-cycle test cycle option provided in the 2012–2016 rulemaking, EPA is proposing to retain the public comment process from the MYs 2012–2016 rule.

d. Incentives for Electric Vehicles, Plug-in Hybrid Electric Vehicles, and Fuel Cell Vehicles

To facilitate market penetration of the most advanced vehicle technologies as rapidly as possible, EPA is proposing an incentive multiplier for compliance purposes for all electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs) sold in MYs 2017 through 2021. This multiplier approach means that each EV/PHEV/FCV would count as more than one vehicle in the manufacturer's compliance calculation. EPA is proposing that EVs and FCVs start with a multiplier value of 2.0 in MY 2017, phasing down to a value of 1.5 in MY 2021. PHEVs would start at a multiplier value of 1.6 in MY 2017 and phase down to a value of 1.3 in MY 2021.[55] The multiplier would be 1.0 for MYs 2022–2025.

NHTSA currently interprets EPCA and EISA as precluding the agency from offering additional incentives for EVs, FCVs and PHEVs, except as specified by statute,[56] and thus is not proposing incentive multipliers comparable to the EPA incentive multipliers described above.

For EVs, PHEVs and FCVs, EPA is proposing to set a value of 0 g/mile for the tailpipe compliance value for EVs, PHEVs (electricity usage) and FCVs for MY 2017–2021, with no limit on the quantity of vehicles eligible for 0 g/mi tailpipe emissions accounting. For MY 2022–2025, EPA is proposing that 0 g/mi only be allowed up to a per-company cumulative sales cap, tiered as follows: 1) 600,000 vehicles for companies that sell 300,000 EV/PHEV/FCVs in MYs 2019–2021; 2) 200,000 vehicles for all other manufacturers. EPA believes the industry-wide impact of such a tiered cap will be approximately 2 million vehicles. EPA

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[55] The multipliers for EV/FCV would be: 2017–2019—2.0, 2020—1.75, 2021—1.5; for PHEV: 2017–2019—1.6, 2020—1.45, 2021—1.3.

[56] Because 49 U.S.C. 32904(a)(2)(B) expressly requires EPA to calculate the fuel economy of electric vehicles using the Petroleum Equivalency Factor developed by DOE, which contains an incentive for electric operation already, and because 49 U.S.C. 32905(a) expressly requires EPA to calculate the fuel economy of FCVs using a specified incentive, NHTSA believes that Congress' having provided clear incentives for these technologies in the CAFE program suggests that additional incentives beyond those would not be consistent with Congress' intent. Similarly, because the fuel economy of PHEVs' electric operation must also be calculated using DOE's PEF, the incentive for electric operation appears to already be inherent in the statutory structure.

proposes to phase-in the change in compliance value, from 0 grams per mile to net upstream accounting, for any manufacturer that exceeds its cumulative production cap for EV/PHEV/FCVs. EPA proposes that, starting with MY 2022, the compliance value for EVs, FCVs, and the electric portion of PHEVs in excess of individual automaker cumulative production caps would be based on net upstream accounting.

For EVs and other dedicated alternative fuel vehicles, EPA is proposing to calculate fuel economy for the CAFE program using the same methodology as in the MYs 2012–2016 rulemaking, which aligns with EPCA/EISA statutory requirements. For liquid alternative fuels, this methodology generally counts 15 percent of the volume of fuel used in determine the mpg-equivalent fuel economy. For gaseous alternative fuels, the methodology generally determines a gasoline equivalent mpg based on the energy content of the gaseous fuel consumed, and then adjusts the fuel consumption by effectively only counting 15 percent of the actual energy consumed. For electricity, the methodology generally determines a gasoline equivalent mpg by measuring the electrical energy consumed, and then using a petroleum equivalency factor (PEF) to convert to an mpg-equivalent value. The PEF for electricity includes an adjustment that effectively only counts 15 percent of the actual energy consumed. Counting 15 percent of the volume or energy provides an incentive for alternative fuels in the CAFE program.

The methodology that EPA is proposing for dual fueled vehicles under the GHG program and to calculate fuel economy for the CAFE program is discussed below in subsection I.B.7.a.

e. Incentives for ‘‘Game Changing’’ Technologies Performance for Full-Size Pickup Truck Including Hybridization

The agencies recognize that the standards under consideration for MYs 2017–2025 will be challenging for large trucks, including full size pickup trucks. In order to incentivize the penetration into the marketplace of ‘‘game changing’’ technologies for these pickups, including their hybridization, EPA is proposing a CO_2 credit in the GHG program and an equivalent fuel consumption improvement value in the CAFE program for manufacturers that employ significant quantities of hybridization on full size pickup trucks, by including a per-vehicle CO_2 credit and fuel consumption improvement value available for mild and strong hybrid electric vehicles (HEVs). EPA would provide the incentive for the GHG program under EPA's CAA authority and the incentive for the CAFE program under EPA's EPCA authority. EPA's GHG and NHTSA's CAFE proposed standards are set at levels that take into account this flexibility as an incentive for the introduction of advanced technology. This provides the opportunity to begin to transform the most challenging category of vehicles in terms of the penetration of advanced technologies, which, if successful at incentivizing these ‘‘game changing technologies,’’ should allow additional opportunities to successfully achieve the higher levels of truck stringencies in MYs 2022–2025.

EPA is proposing that access to this credit and fuel consumption improvement value be conditioned on a minimum penetration of the technology in a manufacturer's full size pickup truck fleet, and is proposing criteria for a full size pickup truck (*e.g.,* minimum bed size and minimum towing or payload capability). EPA is proposing that mild HEV pickup trucks would be eligible for a per vehicle credit of 10 g/mi [57] during MYs 2017–2021 if the technology is used on a minimum percentage of a company's full size pickups, beginning with at least 30% of a company's full size pickup production in 2017 and ramping up to at least 80% in MY 2021. Strong HEV pickup trucks would be eligible for a 20 g/mi per [58] vehicle credit during MYs 2017–2025 if the technology is used on at least 10% of the company's full size pickups. These volume thresholds are being proposed in order to encourage rapid penetration of these technologies in this vehicle segment. EPA and NHTSA are proposing specific definitions of mild and strong HEV pickup trucks.

Because there are other technologies besides mild and strong hybrids which can significantly reduce GHG emissions and fuel consumption in pickup trucks, EPA is also proposing a performance-based incentive CO_2 emissions credit and equivalent fuel consumption improvement value for full size pickup trucks that achieve a significant CO_2 reduction below/fuel economy improvement above the applicable target. This would be available for vehicles achieving significant CO_2 reductions/fuel economy improvements through the use of technologies other than hybrid drive systems. EPA is proposing that eligible pickup trucks achieving 15 percent below their applicable CO_2 target would receive a 10 g/mi credit, and those achieving 20 percent below their target would receive a 20 g/mi credit. The 10 g/mi performance-based credit would be available for MYs 2017 to 2021 and a vehicle meeting the requirements would receive the credit until MY 2021 unless its CO_2 level increases. The 20 g/mi performance-based credit would be available for a maximum of 5 years within the model years of 2017 to 2025, provided the CO_2 level does not increase for those vehicles earning the credit. The credits would begin in the model year of the eligible vehicle's introduction, and could not extend past MY 2021 for the 10 g/mi credit and MY 2025 for the 20 g/mi credit.

To avoid double-counting, the same vehicle would not receive credit under both the HEV and the performance based approaches.

5. Mid-Term Evaluation

Given the long time frame at issue in setting standards for MYs 2022–2025, and given NHTSA's obligation to conduct a separate rulemaking in order to establish final standards for vehicles for those model years, EPA and NHTSA are proposing a comprehensive mid-term evaluation and agency decision-making process. As part of this undertaking, both NHTSA and EPA will develop and compile up-to-date information for the evaluation, through a collaborative, robust and transparent process, including public notice and comment. The evaluation will be based on (1) a holistic assessment of all of the factors considered by the agencies in setting standards, including those set forth in the rule and other relevant factors, and (2) the expected impact of those factors on the manufacturers' ability to comply, without placing decisive weight on any particular factor or projection. The comprehensive evaluation process will lead to final agency action by both agencies.

Consistent with the agencies' commitment to maintaining a single national framework for regulation of vehicle emissions and fuel economy, the agencies fully expect to conduct the mid-term evaluation in close coordination with the California Air Resources Board (CARB). Moreover, the agencies fully expect that any adjustments to the GHG standards will be made with the participation of CARB and in a manner that ensures continued harmonization of state and federal vehicle standards.

Further discussion of the mid-term evaluation can be found in section III and IV of the proposal.

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[57] 0.001125 gallon/mile.

[58] 0.00225 gallon/mile.

6. Coordinated Compliance

The MYs 2012–2016 final rules established detailed and comprehensive regulatory provisions for compliance and enforcement under the GHG and CAFE programs. These provisions remain in place for model years beyond MY 2016 without additional action by the agencies and EPA and NHTSA are not proposing any significant modifications to them. In the MYs 2012–2016 final rule, NHTSA and EPA established 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 earlier model year CAFE standards. The certification, testing, reporting, and associated compliance activities established for the GHG program closely track those in previously existing programs 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 also applies the CAA authorities applicable to its separate in-use requirements in this program.

The compliance approach allows manufacturers to satisfy the GHG program requirements in the same general way they comply with previously existing applicable CAA and CAFE requirements. Manufacturers will 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 includes 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. The program also addresses EPA enforcement in cases of noncompliance.

7. Additional Program Elements

a. Treatment of Compressed Natural Gas (CNG), Plug-in Hybrid Electric Vehicles (PHEVs), and Flexible Fuel Vehicles (FFVs)

EPA is proposing that CO_2 compliance values for plug-in hybrid electric vehicles (PHEVs) and bi-fuel compressed natural gas (CNG) vehicles will be based on estimated use of the alternative fuels, recognizing that, once a consumer has paid several thousand dollars to be able to use a fuel that is considerably cheaper than gasoline, it is very likely that the consumer will seek to use the cheaper fuel as much as possible. Accordingly, for CO_2 emissions compliance, EPA is proposing to use the Society of Automotive Engineers ‘‘utility factor’’ methodology (based on vehicle range on the alternative fuel and typical daily travel mileage) to determine the assumed percentage of operation on gasoline and percentage of operation on the alternative fuel for both PHEVs and bi-fuel CNG vehicles, along with the CO_2 emissions test values on the alternative fuel and gasoline.

EPA is proposing to account for E85 use by flexible fueled vehicles (FFVs) as in the existing MY 2016 and later program, based on actual usage of E85 which represents a real-world reduction attributed to alternative fuels. Unlike PHEV and bi-fuel CNG vehicles, there is not a significant cost differential between an FFV and a conventional gasoline vehicle and historically consumers have only fueled these vehicles with E85 a very small percentage of the time.

In the CAFE program for MYs 2017–2019, the fuel economy of dual fuel vehicles will be determined in the same manner as specified in the MY 2012–2016 rule, and as defined by EISA. Beginning in MY 2020, EISA does not specify how to measure the fuel economy of dual fuel vehicles, and EPA is proposing under its EPCA authority to use the ‘‘utility factor’’ methodology for PHEV and CNG vehicles described above to determine how to proportion the fuel economy when operating on gasoline or diesel fuel and the fuel economy when operating on the alternative fuel. For FFVs, EPA is proposing to use the same methodology as it uses for the GHG program to determine how to proportion the fuel economy, which would be based on actual usage of E85. EPA is proposing to continue to use Petroleum Equivalency Factors and the 0.15 divisor used in the MY 2012–2016 rule for the alternative fuels, however with no cap on the amount of fuel economy increase allowed. This issue is discussed further in Section III.B.10.

b. Exclusion of Emergency and Police Vehicles

Under EPCA, manufacturers are allowed to exclude emergency vehicles from their CAFE fleet[59] and all manufacturers have historically done so. In the MYs 2012–2016 program, EPA's GHG program applies to these vehicles. However, after further consideration of this issue, EPA is proposing the same type of exclusion provision for these vehicles for MY 2012 and later because of the unique features of vehicles designed specifically for law enforcement and emergency purposes, which have the effect of raising their GHG emissions and calling into question the ability of manufacturers to sufficiently reduce the emissions from these vehicles without compromising necessary vehicle features or dropping vehicles from their fleets.

c. Small Businesses and Small Volume Manufacturers

EPA is proposing provisions to address two categories of smaller manufacturers. The first category is small businesses as defined by the Small Business Administration (SBA). For vehicle manufacturers, SBA's definition of small business is any firm with less than 1,000 employees. As with the MYs 2012–2016 program, EPA is proposing to continue to exempt small businesses from the GHG standards, for any company that meets the SBA's definition of a small business. EPA believes this exemption is appropriate given the unique challenges small businesses would face in meeting the GHG standards, and since these businesses make up less than 0.1% of total U.S. vehicle sales, and there is no significant impact on emission reductions.

EPA's proposal also addresses small volume manufacturers, with U.S. annual sales of less than 5,000 vehicles. Under the MYs 2012–2016 program, these small volume manufacturers are eligible for an exemption from the CO_2 standards. EPA is proposing to bring small volume manufacturers into the CO_2 program for the first time starting in MY 2017, and allow them to petition EPA for alternative standards.

EPCA provides NHTSA with the authority to exempt from the generally applicable CAFE standards manufacturers that produce fewer than 10,000 passenger cars worldwide in the model year each of the two years prior to the year in which they seek an exemption.[60] If NHTSA exempts a manufacturer, it must establish an alternate standard for that manufacturer for that model year, at the level that the agency decides is maximum feasible for that manufacturer. The exemption and alternative standard apply only if the exempted manufacturer also produces fewer than 10,000 passenger cars

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[59] 49 U.S.C. 32902(e).

[60] 49 U.S.C. 32902(d). Implementing regulations may be found in 49 CFR part 525.

worldwide in the year for which the exemption was granted.

Further, the Temporary Lead-time Allowance Alternative Standards (TLAAS) provisions included in EPA's MYs 2012–2016 program for manufacturers with MY 2009 U.S. sales of less than 400,000 vehicles ends after MY 2015 for most eligible manufacturers.[61] EPA is not proposing to extend or otherwise replace the TLAAS provisions for the proposed MYs 2017–2025 program. However, EPA is inviting comment on whether this or some other form of flexibility is warranted for lower volume, limited line manufacturers, as further discussed in Section III.B.8. With the exception of the small businesses and small volume manufacturers discussed above, the proposed MYs 2017–2025 standards would apply to all manufacturers.

C. Summary of Costs and Benefits for the Proposed National Program

This section summarizes the projected costs and benefits of the proposed CAFE and GHG emissions standards. These projections helped inform the agencies' choices among the alternatives considered and provide further confirmation that the proposed standards are appropriate under their respective statutory authorities. 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. The agencies recognize that there are uncertainties regarding the benefit and cost values presented in this proposal. Some benefits and costs are not quantified. The value of other benefits and costs could be too low or too high.

For several reasons, the estimates for costs and benefits presented by NHTSA and EPA, while consistent, are not directly comparable, and thus should not be expected to be identical. Most important, NHTSA and EPA's standards would require slightly different fuel efficiency improvements. EPA's proposed GHG standard is more stringent in part due to its assumptions about manufacturers' use of air conditioning leakage credits, which result from reductions in air conditioning-related emissions of HFCs. NHTSA is proposing standards at levels of stringency that assume improvements in the efficiency of air conditioning systems, but that do not account for reductions in HFCs, which are not related to fuel economy or energy conservation. In addition, the CAFE and GHG standards offer somewhat different program flexibilities and provisions, and the agencies' analyses differ in their accounting for these flexibilities (examples include the treatment of EVs, dual-fueled vehicles, and civil penalties), primarily because NHTSA is statutorily prohibited from considering some flexibilities when establishing CAFE standards,[62] while EPA is not. These differences contribute to differences in the agencies' respective estimates of costs and benefits resulting from the new standards. Nevertheless, it is important to note that NHTSA and EPA have harmonized the programs as much as possible, and this proposal to continue the National Program would result in significant cost and other advantages for the automobile industry by allowing them to manufacture one fleet of vehicles across the U.S., rather than comply with potentially multiple state standards that may occur in the absence of the National Program.

In summary, the projected costs and benefits presented by NHTSA and EPA are not directly comparable, because the levels being proposed by EPA include air conditioning-related improvements in HFC reductions, and because of the projection by EPA of complete compliance with the proposed GHG standards, whereas NHTSA projects some manufacturers will pay civil penalties as part of their compliance strategy, as allowed by EPCA. It should also be expected that overall EPA's estimates of GHG reductions and fuel savings achieved by the proposed GHG standards will be slightly higher than those projected by NHTSA only for the CAFE standards because of the same reasons described above. For the same reasons, EPA's estimates of manufacturers' costs for complying with the proposed passenger car and light truck GHG standards are slightly higher than NHTSA's estimates for complying with the proposed CAFE standards.

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

In reading the following section, we note that tables are identified as reflecting ''estimated required'' values and ''estimated achieved'' values. When establishing standards, EPCA allows NHTSA to only consider the fuel economy of dual-fuel vehicles (for example, FFVs and PHEVs) when operating on gasoline, and prohibits NHTSA from considering the use of dedicated alternative fuel vehicle credits (including for example EVs), credit carry-forward and carry-back, and credit transfer and trading. NHTSA's primary analysis of costs, fuel savings, and related benefits from imposing higher CAFE standards does not include them. However, EPCA does not prohibit NHTSA from considering the fact that manufacturers may pay civil penalties rather than comply with CAFE standards, and NHTSA's primary analysis accounts for some manufacturers' tendency to do so. The primary analysis is generally identified in tables throughout this document by the term ''*estimated required* CAFE levels.''

To illustrate the effects of the flexibilities and technologies that NHTSA is prohibited from including in its primary analysis, NHTSA performed a supplemental analysis of these effects on benefits and costs of the proposed CAFE standards that helps to demonstrate the real-world impacts. As an example of one of the effects, including the use of FFV credits reduces estimated per-vehicle compliance costs of the program, but does not significantly change the projected fuel savings and CO_2 reductions, because FFV credits reduce the fuel economy levels that manufacturers achieve not only under the proposed standards, but also under the baseline MY 2016 CAFE standards. As another example, including the operation of PHEV vehicles on both electricity and gasoline, and the expected use of EVs for compliance may raise the fuel economy levels that manufacturers achieve under the proposed standards. The supplemental analysis is generally identified in tables throughout this document by the term ''*estimated achieved* CAFE levels.''

Thus, NHTSA's primary analysis shows the estimates the agency considered for purposes of establishing new CAFE standards, and its supplemental analysis including manufacturer use of flexibilities and advanced technologies currently reflects the agency's best estimate of the potential real-world effects of the proposed CAFE standards.

Without accounting for the compliance flexibilities and advanced technologies that NHTSA is prohibited from considering when determining the maximum feasible level of new CAFE standards, since manufacturers' decisions to use those flexibilities and technologies are voluntary, NHTSA estimates that the required fuel economy increases would lead to fuel savings totaling 173 billion gallons throughout the lives of vehicles sold in MYs 2017–2025. At a 3 percent discount rate, the present value of the economic benefits resulting from those fuel

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[61] TLAAS ends after MY 2016 for manufacturers with MY 2009 U.S. sales of less than 50,000 vehicles.

[62] *See* 49 U.S.C. 32902(h).

savings is $451 billion; at a 7 percent private discount rate, the present value of the economic benefits resulting from those fuel savings is $358 billion.

The agency further estimates that these new CAFE standards would lead to corresponding reductions in CO_2 emissions totaling 1.8 billion metric tons during the lives of vehicles sold in MYs 2017–2025. The present value of the economic benefits from avoiding those emissions is $49 billion, based on a global social cost of carbon value of $22 per metric ton (in 2010, and growing thereafter).[63] 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 reductions. The two agencies standards together comprise the National Program, and this discussion of the 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. All costs are in 2009 dollars.

Table I-7 NHTSA's Estimated MYs 2017-2025 Costs, Benefits, and Net Benefits ($Billion) under the CAFE Standards (Estimated Required)

	3% discount rate		7% discount rate	
	Lifetime present value	Annualized value	Lifetime present value	Annualized value
Costs	157	6.3	157	8.5
Benefits	515	31.8	419	36.3
Net benefits	358	25.5	262	27.8

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[63] NHTSA also estimated the benefits associated with three more estimates of a one ton GHG reduction in 2009 ($5, $36, and $67), which will likewise grow thereafter. *See* Section II for a more detailed discussion of the social cost of carbon.

[64] The "Earlier" column shows benefits that NHTSA forecasts manufacturers will implement in model years prior to 2017 that are in response to the proposed MY 2017–2025 standards. The CAFE model forecasts that manufactures will implement some technologies, and achieve benefits during vehicle redesigns that occur prior to MY 2017 in order to comply with MY 2017 and later standards in a cost effective manner.

Table I-8 NHTSA's Estimated Fuel Saved (Billion Gallons and Barrels) and CO_2 Emissions Avoided (mmt) under the CAFE Standards (Estimated Required)

		Earlier[64]	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Passenger Cars	Fuel (billion gallons)	3	2	5	7	9	11	13	15	17	19	104
	Fuel (billion barrels)	0.09	0.06	0.12	0.17	0.22	0.27	0.31	0.36	0.42	0.46	2.47
	CO_2 (mmt)	41	26	52	76	100	122	139	158	184	202	1100
Light Trucks	Fuel (billion gallons)	0	0	2	5	6	9	10	11	12	13	69
	Fuel (billion barrels)	0.01	0.01	0.05	0.11	0.15	0.21	0.24	0.27	0.29	0.32	1.65
	CO_2 (mmt)	4	5	22	49	65	93	108	118	129	141	734
Combined	Fuel (billion gallons)	4	3	7	12	16	20	23	26	30	33	173
	Fuel (billion barrels)	0.10	0.07	0.16	0.28	0.37	0.48	0.55	0.62	0.71	0.78	4.13
	CO_2 (mmt)	45	31	74	124	165	215	246	276	313	343	1834

Considering manufacturers' ability to employ compliance flexibilities and advanced technologies for meeting the standards, NHTSA estimates the following for fuel savings and avoided CO_2 emissions, assuming FFV credits

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[64] The "Earlier" column shows benefits that NHTSA forecasts manufacturers will implement in model years prior to 2017 that are in response to the proposed MY 2017-2025 standards. The CAFE model forecasts that manufactures will implement some technologies, and achieve benefits during vehicle redesigns that occur prior to MY 2017 in order to comply with MY 2017 and later standards in a cost effective manner.

would be used toward both the baseline and final standards:

Table I-9 NHTSA's Estimated Fuel Saved (Billion Gallons and Barrels) and CO_2 Emissions Avoided (mmt) under the CAFE Standards (Estimated Achieved)

		Earlier	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Passenger Cars	Fuel (billion gallons)	4	2	4	6	9	10	12	14	17	20	98
	Fuel (billion barrels)	0.09	0.05	0.10	0.15	0.21	0.25	0.29	0.34	0.40	0.47	2.34
	CO_2 (mmt)	41	23	43	69	93	111	128	151	177	204	1040
Light Trucks	Fuel (billion gallons)	0	1	2	4	6	8	9	10	11	13	65
	Fuel (billion barrels)	0.01	0.02	0.05	0.10	0.14	0.19	0.22	0.24	0.27	0.30	1.54
	CO_2 (mmt)	4	7	22	47	64	89	100	109	123	138	702
Combined	Fuel (billion gallons)	4	3	6	11	14	19	21	24	28	32	163
	Fuel (billion barrels)	0.10	0.07	0.14	0.25	0.34	0.44	0.50	0.58	0.67	0.77	3.88
	CO_2 (mmt)	45	31	65	116	157	200	227	260	300	341	1742

NHTSA estimates that the fuel economy increases resulting from the proposed standards would produce other benefits both to drivers (*e.g.,* reduced time spent refueling) and to the U.S. as a whole (*e.g.,* reductions in the costs of petroleum imports *beyond* the direct savings from reduced oil purchases),[65] as well as some disbenefits (*e.g.,* increased traffic congestion) caused by drivers' tendency to travel more when the cost of driving declines (as it does when fuel economy increases). NHTSA has estimated the total monetary value to society of these benefits and disbenefits, and estimates that the proposed standards will produce significant net benefits to society. Using a 3 percent discount rate, NHTSA estimates that the present value of these benefits would total more than $515 billion over the lives of the vehicles sold during MYs 2017–2025; using a 7 percent discount rate, more than $419 billion. More discussion regarding monetized benefits can be found in Section IV of this notice and in NHTSA's PRIA. Note that the benefit calculation in the following tables includes the benefits of reducing CO_2 emissions,[66] but not the benefits of reducing other GHG emissions.

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[65] We note, of course, that reducing the amount of fuel purchased also reduces tax revenue for the Federal and state/local governments. NHTSA discusses this issue in more detail in Chapter VIII of the PRIA.

[66] CO_2 benefits for purposes of these tables are calculated using the $22/ton SCC values. Note that the net present value of reduced GHG emissions is calculated differently from other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5, 3, and 2.5 percent) is used to calculate net present value of SCC for internal consistency.

Table I-10 NHTSA's Discounted Benefits ($Billion) under the CAFE Standards Using a 3 and 7 Percent Discount Rate

(Estimated Required)

	Earlier	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
3% discount rate											
Passenger cars	11	7	14	21	27	34	39	45	53	59	310
Light trucks	1	1	6	13	18	26	30	33	37	40	206
Combined	12	8	20	34	45	60	69	78	90	100	515
7% discount rate											
Passenger cars	9	6	12	17	22	28	32	37	44	49	254
Light trucks	1	1	5	10	14	21	24	27	30	33	165
Combined	9	7	16	27	37	49	56	64	73	81	419

Considering manufacturers' ability to employ compliance flexibilities and advanced technologies for meeting the standards, NHTSA estimates the present value of these benefits would be reduced as follows:

Table I-11 NHTSA's Discounted Benefits ($Billion) under the CAFE Standards Using a 3 and 7 Percent Discount Rate

(Estimated Achieved)

	Earlier	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
3% discount rate											
Passenger cars	10	6	12	19	26	31	36	43	51	60	293
Light trucks	1	2	6	12	17	24	28	30	35	39	195
Combined	11	8	17	31	43	55	63	74	86	99	488
7% discount rate											
Passenger cars	8	5	9	15	21	25	29	35	42	49	240
Light trucks	1	2	5	10	14	20	22	24	28	32	157
Combined	9	7	14	25	35	45	52	60	70	81	397

NHTSA attributes most of these benefits (about $451 billion at a 3 percent discount rate, or about $358 billion at a 7 percent discount rate, excluding consideration of compliance flexibilities and advanced technologies for meeting the standards) to reductions in fuel consumption, valuing fuel (for societal purposes) at the future pre-tax prices projected in the Energy Information Administration's (EIA) reference case forecast from the Annual Energy Outlook (AEO) 2011. NHTSA's PRIA accompanying this proposal presents a detailed analysis of specific benefits of the rule.

Table I-12 Summary of NHTSA's Fuel Savings and CO_2 Emissions Reduction under the CAFE Standards (Estimated Required)

	Amount	3% discount rate	7% discount rate
Fuel savings	173	451	358
CO_2 emissions reductions	1,834	49	49

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 the incremental costs for achieving the proposed CAFE standards—that is, outlays by vehicle manufacturers over and above those required to comply with the MY 2016 CAFE standards—will total about $157 billion (*i.e.,* during MYs 2017–2025).

Table I-13 NHTSA's Incremental Technology Outlays ($Billion) under the CAFE Standards (Estimated Required)

	Earlier	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Passenger cars	4	2	5	7	9	12	14	17	22	23	113
Light trucks	0	0	1	2	4	5	6	7	8	9	44
Combined	4	3	6	9	13	17	20	24	30	32	157

However, NHTSA estimates that manufacturers employing compliance flexibilities and advanced technologies to meet the standards could significantly reduce these outlays:

Table I-14 NHTSA's Incremental Technology Outlays ($Billion) under the CAFE Standards (Estimated Achieved)

	Earlier	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Passenger cars	1	1	3	5	8	10	12	16	19	22	98
Light trucks	0	0	1	2	3	4	5	6	6	8	35
Combined	1	2	4	7	11	15	17	21	25	30	133

NHTSA 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 less extent, the civil penalties that some manufacturers are expected to pay for non-compliance), the agency estimates that the standards would lead to increase in average new vehicle prices ranging from $161 per vehicle in MY 2017 to $1876 per vehicle in MY 2025:

Table I-15 NHTSA's Incremental Increases in Average New Vehicle Costs ($) under the CAFE Standards (Estimated Required)

	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger cars	228	467	652	885	1,108	1,259	1,536	1,927	2,023
Light trucks	44	187	427	688	965	1,102	1,284	1,428	1,578
Combined	161	365	572	815	1,058	1,205	1,450	1,760	1,876

And as before, NHTSA estimates that manufacturers employing compliance flexibilities and advanced technologies to meet the standards could significantly reduce these increases.

Table I-16 NHTSA's Incremental Increases in Average New Vehicle Costs ($) under the CAFE Standards (Estimated Achieved)

	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger cars	141	320	529	767	977	1,122	1,424	1,688	1,926
Light trucks	57	178	359	524	755	863	976	1,141	1,348
Combined	110	268	468	681	899	1,032	1,271	1,505	1,735

NHTSA estimates, therefore, that the total benefits of these proposed CAFE standards will be more than 2.5 times the magnitude of the corresponding costs. As a consequence, the proposed CAFE standards would produce net benefits of $358 billion at a 3 percent discount rate (with compliance flexibilities, $355 billion), or $262 billion at a 7 percent discount rate (with compliance flexibilities, $264 billion), over the useful lives of the vehicles sold during MYs 2017–2025.

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

EPA has analyzed in detail the costs and benefits of the proposed GHG standards. Table I–17 shows EPA's estimated lifetime discounted cost, fuel savings, and benefits for all vehicles projected to be sold in model years 2017–2025. The benefits include impacts such as climate-related economic benefits from reducing emissions of CO_2 (but not other GHGs), reductions in energy security externalities caused by U.S. petroleum consumption and imports, the value of certain health benefits, the value of additional driving attributed to the rebound effect, the value of reduced refueling time needed to fill up a more fuel efficient vehicle. The analysis also includes economic impacts stemming from additional vehicle use, such as the economic damages caused by accidents, congestion and noise. Note that benefits depend on estimated values for the social cost of carbon (SCC), as described in Section III.H.

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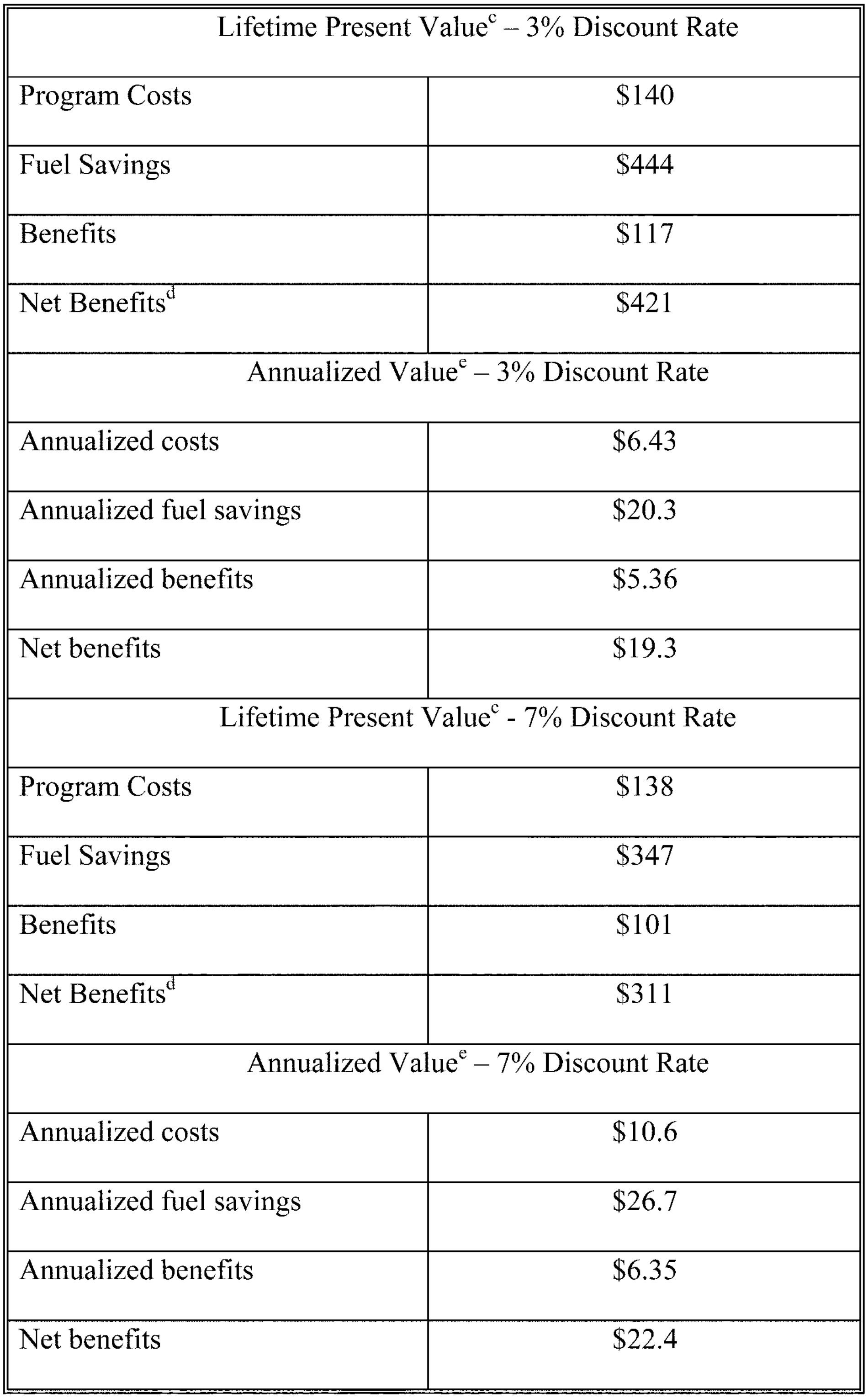
Table I-17 EPA's Estimated 2017-2025 Model Year Lifetime Discounted Costs, Benefits, and Net Benefits assuming the 3% discount rate SCC Value[a,b] (Billions of 2009 dollars)



Lifetime Present Value[c] – 3% Discount Rate	
Program Costs	$140
Fuel Savings	$444
Benefits	$117
Net Benefits[d]	$421
Annualized Value[e] – 3% Discount Rate	
Annualized costs	$6.43
Annualized fuel savings	$20.3
Annualized benefits	$5.36
Net benefits	$19.3
Lifetime Present Value[c] - 7% Discount Rate	
Program Costs	$138
Fuel Savings	$347
Benefits	$101
Net Benefits[d]	$311
Annualized Value[e] – 7% Discount Rate	
Annualized costs	$10.6
Annualized fuel savings	$26.7
Annualized benefits	$6.35
Net benefits	$22.4

Notes:

[a] The agencies estimated the benefits associated with four different values of a one ton CO_2 reduction (model average at 2.5% discount rate, 3%, and 5%; 95th percentile at 3%), which each increase over time. For the purposes of this overview presentation of estimated costs and benefits, however, we are showing the benefits associated with the marginal value deemed to be central by the interagency working group on this topic: the model average at 3% discount rate, in 2009 dollars. Section III.H provides a complete list of values for the 4 estimates.

[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] Present value is the total, aggregated amount that a series of monetized costs or benefits that occur over time is worth in a given year. For this analysis, lifetime present values are calculated for the first year of each model year for MYs 2017-2025 (in year 2009 dollar terms). The lifetime present values shown here are the present values of each MY in its first year summed across MYs.

[d] Net benefits reflect the fuel savings plus benefits minus costs.

[e] The annualized value is the constant annual value through a given time period (the lifetime of each MY in this analysis) whose summed present value equals the present value from which it was derived. Annualized SCC values are calculated using the same rate as that used to determine the SCC value while all other costs and benefits are annualized at either 3% or 7%.

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Table I–18 shows EPA's estimated lifetime fuel savings and CO_2 equivalent emission reductions for all vehicles sold in the model years 2017–2025. The values in Table I–18 are projected lifetime totals for each model year and are not discounted. As documented in EPA's draft 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 proposed GHG standards does not change the fact that both the proposed CAFE and GHG standards, jointly, are the source of the benefits and costs of the National Program. In general though, in addition to the added GHG benefit of HFC reductions from the EPA program, the fuel savings benefit are also somewhat higher than that from CAFE, primarily because of the possibility of paying civil penalties in lieu of applying technology in NHTSA's program, which is required by EPCA.

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Table I-18 EPA's Estimated 2017-2025 Model Year Lifetime Fuel Saved and GHG Emissions Avoided

		2017 MY	2018 MY	2019 MY	2020 MY	2021 MY	2022 MY	2023 MY	2024 MY	2025 MY	Total
Cars	Fuel (billion gallons)	1	3	6	8	11	13	16	19	21	99
	Fuel (billion barrels)	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.5	2.4
	CO_2 EQ (mmt)	17	44	71	101	131	160	186	213	241	1,163
Light Trucks	Fuel (billion gallons)	1	2	3	4	7	9	11	13	15	66
	Fuel (billion barrels)	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	1.6
	CO_2 EQ (mmt)	12	26	38	51	88	113	136	159	181	805
Combined	Fuel (billion gallons)	2	6	9	12	18	23	27	32	37	165
	Fuel (billion barrels)	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.9	3.9
	CO_2 EQ (mmt)	29	70	108	151	220	273	322	372	422	1,967

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Table I–19 shows EPA's estimated lifetime discounted benefits for all vehicles sold in model years 2017–2025. Although EPA estimated the benefits associated with four different values of a one ton GHG reduction ($5, $22 $36, $67 in CY 2010 and in 2009 dollars), for the purposes of this overview presentation of estimated benefits EPA is showing the benefits associated with one of these marginal values, $22 per ton of CO_2, in 2009 dollars and 2010 emissions. Table I–19 presents benefits based on the $22 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 GHG reductions, PM benefits, energy security and other externalities such as reduced refueling time 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–19 do not include costs associated with new technology required to meet the GHG standard and they do not include the fuel savings expected from that technology.

Table I-19 EPA's Estimated 2017-2025 Model Year Lifetime Discounted Benefits Assuming the $22/ton SCC Value[a,b,c,d] (billions of 2009 dollars)

Discount Rate	Model Year									
	2017	2018	2019	2020	2021	2022	2023	2024	2025	Sum of Present Values
3%	$1.62	$3.85	$6.02	$8.51	$12.7	$16.1	$19.3	$22.8	$26.2	$117
7%	$1.39	$3.31	$5.19	$7.34	$11.0	$14.0	$16.8	$19.8	$22.7	$101

[a] The benefits include all benefits considered by EPA 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 proposed 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 $22/ton (2009$) value applies to 2010 emissions and grows larger over time.

[d] Model year values are discounted to the first year of each model year; the "Sum" represents those discounted values summed across model years.

Table I–20 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 fuel savings and CO_2 emission reductions are projected lifetime values for all vehicles sold in the model years 2017–2025. The estimated fuel savings in billions of gallons and the GHG reductions in million metric tons of CO_2 shown in Table I–20 are totals for the nine model years throughout their projected lifetime and are not discounted. The monetized values shown in Table I–20 are the summed values of the discounted monetized fuel savings and monetized CO_2 reductions for the model years 2017–2025 vehicles throughout their lifetimes. The monetized values in Table I–20 reflect both a 3 percent and a 7 percent discount rate as noted.

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Table I-20 EPA's Estimated 2017-2025 Model Year Lifetime Fuel Savings, CO_2 Emission Reductions, and Discounted Monetized SCC Benefits using the $22/ton SCC Value (monetized values in 2009 dollars)

	Amount	$ value (billions)
Fuel savings (3% discount rate)	165 billion gallons (3.9 billion barrels)	$444
Fuel savings (7% discount rate)	165 billion gallons (3.9 billion barrels)	$347
CO_2e emission reductions (CO_2 portion valued assuming $22/ton CO_2 in 2010)	1,967 MMT CO_2e	$46.4[a,b]

[a] $46.4 billion for 1,743 MMT of reduced CO_2 emissions. As noted in Section III.H, the $22/ton (2009$) 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 proposed rule. Although EPA has not monetized the benefits of reductions in these non-CO_2 GHG 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.

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Table I–21 shows EPA's estimated incremental and total technology outlays for cars and trucks for each of the model years 2017–2025. The technology outlays shown in Table I–21 are for the industry as a whole and do not account for fuel savings associated with the program. Table I–22 shows EPA's estimated incremental cost increase of the average new vehicle for each model year 2017–2025. The values shown are incremental to a baseline vehicle and are not cumulative. In other words, the estimated increase for 2017 model year cars is $194 relative to a 2017 model year car meeting the MY 2016 standards. The estimated increase for a 2018 model year car is $353 relative to a 2018 model year car meeting the MY 2016 standards (not $194 plus $353).

Table I-21 EPA's Estimated Incremental Technology Outlays Associated with the Proposed Standards (billions of 2009 dollars)

		2017 MY	2018 MY	2019 MY	2020 MY	2021 MY	2022 MY	2023 MY	2024 MY	2025 MY	Sum of Present Values
3% discount rate	Cars	$1.91	$3.45	$4.71	$6.04	$7.43	$12.3	$16.1	$20.0	$22.1	$94.1
	Trucks	$0.32	$1.11	$1.68	$2.30	$4.28	$6.74	$8.55	$10.26	$11.0	$46.2
	Combined	$2.27	$4.59	$6.41	$8.34	$11.7	$19.1	$24.7	$30.3	$33.1	$140
7% discount rate	Cars	$1.88	$3.38	$4.63	$5.92	$7.29	$12.1	$15.8	$19.7	$21.7	$92.4
	Trucks	$0.31	$1.09	$1.65	$2.26	$4.20	$6.62	$8.39	$10.07	$10.8	$45.4
	Combined	$2.22	$4.50	$6.29	$8.19	$11.5	$18.7	$24.2	$29.7	$32.5	$138

Model year values are discounted to the first year of each model year; the "Sum" represents those discounted values summed across model years

Table I-22 EPA's Estimated Incremental Increase in Average New Vehicle Cost Relative to the Reference Case[a] (2009 dollars per unit)

	2017 MY	2018 MY	2019 MY	2020 MY	2021 MY	2022 MY	2023 MY	2024 MY	2025 MY
Cars	$194	$353	$479	$595	$718	$1,165	$1,492	$1,806	$1,942
Trucks	$55	$198	$305	$417	$764	$1,200	$1,525	$1,834	$1,954
Combined	$146	$299	$418	$533	$734	$1,176	$1,503	$1,815	$1,946

[a] The reference case assumes the 2016MY standards continue indefinitely.

D. Background and Comparison of NHTSA and EPA Statutory Authority

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

1. NHTSA Statutory Authority

NHTSA establishes CAFE standards for passenger cars and light trucks for each model year under EPCA, as amended by EISA. EPCA mandates a motor vehicle fuel economy regulatory program to meet the various facets of the need to conserve energy, including the environmental and foreign policy implications of petroleum use by motor vehicles. 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 individual and 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 separate passenger car and light truck 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 that leads to the maximum feasible standards given the circumstances in each CAFE standard rulemaking.[67] 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. For model years after 2020, standards need simply be set at the maximum feasible level.

Because EPCA states that standards must be set for ''* * * automobiles manufactured by manufacturers,'' and because Congress provided specific direction on how small-volume manufacturers could obtain exemptions from the passenger car standards, NHTSA has long interpreted its authority as pertaining to setting standards for the industry as a whole. Prior to this NPRM, some manufacturers raised with NHTSA the possibility of NHTSA and EPA setting alternate standards for part of the industry that met certain (relatively low) sales volume criteria—specifically, that separate standards be set so that ''intermediate-size,'' limited-line manufacturers do not have to meet the same levels of stringency that larger manufacturers have to meet until several years later. NHTSA seeks comment on whether or how EPCA, as amended by EISA, could be interpreted to allow such alternate standards for certain parts of the industry.

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, a consideration which is particularly relevant for a rulemaking with a timeframe as long as the present one. For this rulemaking, NHTSA has considered all types of technologies that improve real-world fuel economy, including air-conditioner efficiency, due to EPA's proposal to allow generation of fuel consumption improvement values for CAFE purposes based on improvements to air-conditioner efficiency that improves fuel efficiency.

(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.'' [68] The agency has explained in the past that this factor can be especially important during rulemakings in which the automobile industry is facing significantly adverse economic conditions (with corresponding risks to jobs). Consumer acceptability is also an element of economic practicability, one which is particularly difficult to gauge during times of uncertain fuel prices.[69] In a rulemaking such as the present one, looking out into the more distant future, economic practicability is a way to consider the uncertainty surrounding future market conditions and consumer demand for fuel economy in addition to other vehicle attributes. 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 fleet that employ a particular type of fuel-saving technology, the specific fleet mixes of different manufacturers, and assumptions about the cost of the standards to consumers and consumers' valuation of fuel economy, among other things.

It is important to note, however, that 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.'' [70] Instead, NHTSA is compelled ''to weigh the benefits to the nation of a higher fuel economy standard against the difficulties of individual automobile manufacturers.'' [71] 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. NHTSA has long held that the CAFE program is not necessarily intended to maintain the competitive positioning of each particular company. Rather, it is intended to enhance the fuel economy of the vehicle fleet on American roads, while protecting motor vehicle safety and being mindful of the risk 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,

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[67] *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.'').

[68] 67 FR 77015, 77021 (Dec. 16, 2002).

[69] *See, e.g., Center for Auto Safety* v. *NHTSA (CAS),* 793 F.2d 1322 (D.C. Cir. 1986) (Administrator's consideration of market demand as component of economic practicability found to be reasonable); *Public Citizen* v. *NHTSA,* 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).

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

[71] *Id.*

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 [72] until present, the effects of such compliance on fuel economy capability over the history of the CAFE program have been negative ones. For example, safety standards that have the effect of increasing vehicle weight lower vehicle fuel economy capability and thus decrease the level of average fuel economy that the agency can determine to be feasible.

In the wake of *Massachusetts* v. *EPA* and of EPA's endangerment finding, granting of a waiver to California for its motor vehicle GHG standards, and its own establishment of GHG standards, NHTSA is confronted with the issue of how to treat those standards under EPCA/EISA, such as in the context of 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.

Comment is requested on whether and in what way the effects of the California and EPA standards should be considered under EPCA/EISA, *e.g.,* under the ''other motor vehicle standards'' provision, consistent with NHTSA's independent obligation under EPCA/EISA to issue CAFE standards. The agency has already considered EPA's proposal and the harmonization benefits of the National Program in developing its own proposal.

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

''The need of the United States to conserve energy'' means ''the consumer cost, national balance of payments, environmental, and foreign policy implications of our need for large quantities of petroleum, especially imported petroleum.'' [73] Environmental implications principally include reductions in emissions of carbon dioxide and criteria pollutants and air toxics. Prime examples of foreign policy implications are energy independence and security concerns.

(5) 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, which is related to the consumer cost (or rather, benefit) of our need for large quantities of petroleum. In this rule, NHTSA relies on fuel price projections from the U.S. Energy Information Administration's (EIA) most recent Annual Energy Outlook (AEO) for this analysis. Federal government agencies generally use EIA's projections in their assessments of future energy-related policies.

(6) 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.

(7) 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 [74] 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. Reducing 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,[75] 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.'' [76] In 1988, NHTSA included climate change concepts in its CAFE notices and prepared its first environmental assessment addressing that subject.[77] 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.[78] 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 establishing CAFE standards. This practice is recognized approvingly in case law.[79] Under the universal or ''flat''

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[72] 42 FR 63184, 63188 (Dec. 15, 1977). *See also* 42 FR 33534, 33537 (Jun. 30, 1977).

[73] 42 FR 63184, 63188 (1977).

[74] 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.

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

[76] 42 FR 63184, 63188 (Dec. 15, 1977) (emphasis added).

[77] 53 FR 33080, 33096 (Aug. 29, 1988).

[78] 53 FR 39275, 39302 (Oct. 6, 1988).

[79] As the United States Court of Appeals pointed out in upholding NHTSA's exercise of judgment in

CAFE standards that NHTSA was previously authorized to establish, the primary risk to safety came from the possibility that manufacturers would respond to higher standards by building smaller, less safe vehicles in order to ''balance out'' the larger, safer vehicles that the public generally preferred to buy. Under the attribute-based standards being proposed in this action, that risk is reduced because building smaller vehicles tends to raise a manufacturer's overall CAFE obligation, rather than only raising its fleet average CAFE. However, even under attribute-based standards, there is still risk that manufacturers will rely on down-weighting to improve their fuel economy (for a given vehicle at a given footprint target) in ways that may reduce safety.[80]

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. Specifically, in determining the maximum feasible level of fuel economy for passenger cars and light trucks, NHTSA cannot consider the fuel economy benefits of ''dedicated'' alternative fuel vehicles (like battery electric vehicles or natural gas vehicles), must consider dual-fueled automobiles to be operated only on gasoline or diesel fuel, and may not consider the ability of manufacturers to use, trade, or transfer credits.[81] This provision limits, to some extent, the fuel economy levels that NHTSA can find to be ''maximum feasible''—if NHTSA cannot consider the fuel economy of electric vehicles, for example, NHTSA cannot set a standards predicated on manufacturers' usage of electric vehicles to meet the standards.

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.'' [82] 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,'' [83] and as long as that balancing reasonably accommodates ''conflicting policies that were committed to the agency's care by the statute.'' [84] Thus, EPCA does not mandate that any particular number be adopted when NHTSA determines the level of CAFE standards.

v. Other Requirements Related to Standard Setting

The standards for passenger cars and for light trucks must increase ratably each year through MY 2020.[85] 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.[86] Standards after 2020 must simply be set at the maximum feasible level.[87]

The standards for passenger cars and light trucks must also be based on one or more vehicle attributes, like size or weight, which correlate with fuel economy and must be expressed in terms of a mathematical function.[88] Fuel economy targets are set for individual vehicles and increase as the attribute decreases and vice versa. For example, footprint-based standards assign higher fuel economy targets to smaller-footprint vehicles and lower ones to larger footprint-vehicles. The fleetwide average fuel economy that a particular manufacturer is required to achieve depends on the footprint mix of its fleet, *i.e.,* the proportion of the fleet that is small-, medium-, or large-footprint.

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 procedures to measure fuel economy and to calculate CAFE. Current test procedures measure the effects of nearly all fuel saving technologies. EPA is considering revising the procedures for measuring fuel economy and calculating average fuel economy for the CAFE program, however, to account for four impacts on fuel economy not currently included in these procedures—increases in fuel economy because of increases in efficiency of the air conditioning system; increases in fuel economy because of technology improvements that achieve ''off-cycle'' benefits; incentives for use of certain hybrid technologies in a significant percentage of pickup trucks; and incentives for achieving fuel economy levels in a significant percentage pickup trucks that exceeds the target curve by specified amounts, in the form of increased values assigned for fuel economy. NHTSA has taken these proposed changes into account in determining the proposed fuel economy standards. These changes would be the same as program elements that are part of EPA's greenhouse gas performance

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setting the 1987–1989 passenger car standards, ''NHTSA has always examined the safety consequences of the CAFE standards in its overall consideration of relevant factors since its earliest rulemaking under the CAFE program.'' *Competitive Enterprise Institute* v. *NHTSA (CEI I),* 901 F.2d 107, 120 at n.11 (D.C. Cir. 1990).

[80] For example, by reducing the mass of the smallest vehicles rather than the largest, or by reducing vehicle overhang outside the space measured as ''footprint,'' which results in less crush space.

[81] 49 U.S.C. 32902(h). We note, as discussed in greater detail in Section IV, that NHTSA interprets 32902(h) as reflecting Congress' intent that statutorily-mandated compliance flexibilities remain flexibilities. When a compliance flexibility is not statutorily mandated, therefore, or when it ceases to be available under the statute, we interpret 32902(h) as no longer binding the agency's determination of the maximum feasible levels of fuel economy. For example, when the manufacturing incentive for dual-fueled automobiles under 49 U.S.C. 32905 and 32906 expires in MY 2019, there is no longer a flexibility left to protect per 32902(h), so NHTSA considers the calculated fuel economy of plug-in hybrid electric vehicles for purposes of determining the maximum feasible standards in MYs 2020 and beyond.

[82] *Center for Auto Safety* v. *NHTSA,* 793 F.2d 1322, at 1341 (D.C. Cir. 1986).

[83] *CBD* v. *NHTSA,* 538 F.3d at 1195 (9th Cir. 2008).

[84] *Id.*

[85] 49 U.S.C. 32902(b)(2)(C).

[86] *See* 74 FR 14196, 14375–76 (Mar. 30, 2009).

[87] 49 U.S.C. 32902(b)(2)(B).

[88] 49 U.S.C. 32902(b)(3).

standards, discussed in Section III.B.10. As discussed below, these three elements would be implemented in the same manner as in the EPA's greenhouse gas program—a vehicle manufacturer would have the option to generate these fuel economy values for vehicle models that meet the criteria for these elements and to use these values in calculating their fleet average fuel economy. This proposed revision to CAFE calculation is discussed in more detail in Sections III and IV below.

c. Enforcement and Compliance Flexibility

NHTSA determines compliance with the CAFE standards based on measurements of automobile manufacturers' CAFE from EPA. If a manufacturer's passenger car or light truck CAFE level exceeds the applicable standard for that model year, the manufacturer earns credits for over-compliance. 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. As discussed in more detail in Section IV.I, credits can be carried forward for 5 model years or back for 3, and can also be transferred between a manufacturer's fleets or traded to another manufacturer.

If a manufacturer's passenger car or light truck CAFE level does not meet the applicable standard for that model year, NHTSA notifies the manufacturer. The manufacturer may use ''banked'' credits to make up the shortfall, but if there are no (or not enough) credits available, then the manufacturer has the option to 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 shortfall through future over-compliance. 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.[89] 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, which have never been exercised by NHTSA in the history of the CAFE program.

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[90] 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 individual vehicles are not required to meet or exceed those targets. However, as a practical matter, if a manufacturer chooses to design some vehicles that fall below their target levels of fuel economy, it will need to design other vehicles that exceed their targets if the manufacturer's overall fleet average is to meet the applicable standard.

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

2. EPA Statutory Authority

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

Pursuant to Title II of the Clean Air Act, EPA has taken a comprehensive, integrated approach to mobile source emission control that has produced benefits well in excess of the costs of regulation. In developing the Title II program, the Agency's historic, initial focus was on personal vehicles since that category represented the largest source of mobile source emissions. Over time, EPA has established stringent emissions standards for large truck and other heavy-duty engines, nonroad engines, and marine and locomotive engines, as well. The Agency's initial focus on personal vehicles has resulted in significant control of emissions from these vehicles, and also led to technology transfer to the other mobile source categories that made possible the stringent standards for these other categories.

As a result of Title II requirements, new cars and SUVs sold today have emissions levels of hydrocarbons, oxides of nitrogen, and carbon monoxide that are 98–99% lower than new vehicles sold in the 1960s, on a per mile basis. Similarly, standards established for heavy-duty highway and nonroad sources require emissions rate reductions on the order of 90% or more for particulate matter and oxides of nitrogen. Overall ambient levels of automotive-related pollutants are lower now than in 1970, even as economic growth and vehicle miles traveled have nearly tripled. These programs have resulted in millions of tons of pollution reduction and major reductions in pollution-related deaths (estimated in the tens of thousands per year) and illnesses. The net societal benefits of the mobile source programs are large. In its annual reports on federal regulations, the Office of Management and Budget reports that many of EPA's mobile source emissions standards typically have projected benefit-to-cost ratios of 5:1 to 10:1 or more. Follow-up studies show that long-term compliance costs to the industry are typically lower than the

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

[90] 49 U.S.C. 30120, Remedies for defects and noncompliance.

cost projected by EPA at the time of regulation, which result in even more favorable real world benefit-to-cost ratios.[91] Pollution reductions attributable to Title II mobile source controls are critical components to attainment of primary National Ambient Air Quality Standards, significantly reducing the national inventory and ambient concentrations of criteria pollutants, especially PM2.5 and ozone. See *e.g.* 69 FR 38958, 38967–68 (June 29, 2004) (controls on non-road diesel engines expected to reduce entire national inventory of PM2.5 by 3.3% (86,000 tons) by 2020). Title II controls have also made enormous reductions in air toxics emitted by mobile sources. For example, as a result of EPA's 2007 mobile source air toxics standards, the cancer risk attributable to total mobile source air toxics will be reduced by 30% in 2030 and the risk from mobile source benzene (a leukemogen) will be reduced by 37% in 2030. (reflecting reductions of over three hundred thousand tons of mobile source air toxic emissions) 72 FR 8428, 8430 (Feb. 26, 2007).

Title II emission standards have also stimulated the development of a much broader set of advanced automotive technologies, such as on-board computers and fuel injection systems, which are the building blocks of today's automotive designs and have yielded not only lower pollutant emissions, but improved vehicle performance, reliability, and durability.

This proposal implements a specific provision from Title II, section 202(a).[92] Section 202(a)(1) of the Clean Air Act (CAA) states that ''the Administrator shall by regulation prescribe (and from time to time revise) * * * standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles * * *, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' If EPA makes the appropriate endangerment and cause or contribute findings, then section 202(a) authorizes EPA to issue standards applicable to emissions of those pollutants.

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

Although standards under CAA section 202(a)(1) are technology-based, they are not based exclusively on technological capability. EPA has the discretion to consider and weigh various factors along with technological feasibility, such as the cost of compliance (see section 202(a) (2)), lead time necessary for compliance (section 202(a)(2)), safety (see *NRDC,* 655 F. 2d at 336 n. 31) and other impacts on consumers,[93] and energy impacts associated with use of the technology. See *George E. Warren Corp.* v. *EPA,* 159 F.3d 616, 623–624 (DC Cir. 1998) (ordinarily permissible for EPA to consider factors not specifically enumerated in the Act).

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

> While the statutory language of section 231 is not identical to other provisions in title II of the CAA that direct EPA to establish technology-based standards for various types of engines, EPA interprets its authority under section 231 to be somewhat similar to those provisions that require us to identify a reasonable balance of specified emissions reduction, cost, safety, noise, and other factors. See, *e.g., Husqvarna AB* v. *EPA,* 254 F.3d 195 (DC Cir. 2001) (upholding EPA's promulgation of technology-based standards for small non-road engines under section 213(a)(3) of the CAA). However, EPA is not compelled under section 231 to obtain the ''greatest degree of emission reduction achievable'' as per sections 213 and 202 of the CAA, and so EPA does not interpret the Act as requiring the agency to give subordinate status to factors such as cost, safety, and noise in determining what standards are reasonable for aircraft engines. Rather, EPA has greater flexibility under section 231 in determining what standard is most reasonable for aircraft engines, and is not required to achieve a ''technology forcing'' result.[94]

This interpretation was upheld as reasonable in *NACAA* v. *EPA,* (489 F.3d 1221, 1230 (DC Cir. 2007)). CAA section 202(a) does not specify the degree of weight to apply to each factor, and EPA accordingly has discretion in choosing an appropriate balance among factors. See *Sierra Club* v. *EPA,* 325 F.3d 374, 378 (DC Cir. 2003) (even where a provision is technology-forcing, the provision ''does not resolve how the Administrator should weigh all [the statutory] factors in the process of finding the 'greatest emission reduction achievable' ''). Also see *Husqvarna AB* v. *EPA,* 254 F. 3d 195, 200 (DC Cir. 2001) (great discretion to balance statutory factors in considering level of technology-based standard, and statutory requirement ''to [give appropriate] consideration to the cost of applying * * * technology'' does not mandate a specific method of cost analysis); see also *Hercules Inc.* v. *EPA,* 598 F. 2d 91, 106 (DC Cir. 1978) (''In reviewing a numerical standard we must ask whether the agency's numbers are within a zone of reasonableness, not

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[91] OMB, 2011. 2011 Report to Congress on the Benefits and Costs of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities. Office of Information and Regulatory Affairs. June. *http://www.whitehouse.gov/sites/default/files/omb/inforeg/2011_cb/2011_cba_report.pdf.* Web site accessed on October 11, 2011.

[92] 42 U.S.C. 7521 (a)

[93] Since its earliest Title II regulations, EPA has considered the safety of pollution control technologies. See 45 Fed. Reg. 14,496, 14,503 (1980). (''EPA would not require a particulate control technology that was known to involve serious safety problems. If during the development of the trap-oxidizer safety problems are discovered, EPA would reconsider the control requirements implemented by this rulemaking'').

[94] 70 FR 69664, 69676, November 17, 2005.

whether its numbers are precisely right''); *Permian Basin Area Rate Cases,* 390 U.S. 747, 797 (1968) (same); *Federal Power Commission* v. *Conway Corp.,* 426 U.S. 271, 278 (1976) (same); *Exxon Mobil Gas Marketing Co.* v. *FERC,* 297 F. 3d 1071, 1084 (DC Cir. 2002) (same).

a. EPA's Testing Authority

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

Pursuant to EPCA, EPA is required to measure fuel economy for each model and to calculate each manufacturer's average fuel economy.[95] EPA uses the same tests—the FTP and HFET—for fuel economy testing. EPA established the FTP for emissions measurement in the early 1970s. In 1976, in response to the Energy Policy and Conservation Act (EPCA) statute, EPA extended the use of the FTP to fuel economy measurement and added the HFET.[96] The provisions in the 1976 regulation, effective with the 1977 model year, established procedures to calculate fuel economy values both for labeling and for CAFE purposes. Under EPCA, EPA is required to use these procedures (or procedures which yield comparable results) for measuring fuel economy for cars for CAFE purposes, but not for labeling purposes.[97] EPCA does not pose this restriction on CAFE test procedures for light trucks, but EPA does use the FTP and HFET for this purpose. EPA determines fuel economy by measuring the amount of CO_2 and all other carbon compounds (*e.g.* total hydrocarbons (THC) and carbon monoxide (CO)), and then, by mass balance, calculating the amount of fuel consumed. EPA's proposed changes to the procedures for measuring fuel economy and calculating average fuel economy are discussed in section III.B.10.

b. EPA Enforcement Authority

Section 207 of the CAA grants EPA broad authority to require manufacturers to remedy vehicles if EPA determines there are a substantial number of noncomplying vehicles. In addition, section 205 of the CAA authorizes EPA to assess penalties of up to $37,500 per vehicle for violations of various prohibited acts specified in the CAA. In determining the appropriate penalty, EPA must consider a variety of factors such as the gravity of the violation, the economic impact of the violation, the violator's history of compliance, and ''such other matters as justice may require.'' Unlike EPCA, the CAA does not authorize vehicle manufacturers to pay fines in lieu of meeting emission standards.

c. Compliance

EPA oversees testing, collects and processes test data, and performs calculations to determine compliance with both CAA and CAFE standards. CAA standards apply not only at the time of certification but also throughout the vehicle's useful life, and EPA is accordingly is proposing in-use standards as well as standards based on testing performed at time of production. See section II*I.E.* Both the CAA and EPCA provide for penalties should manufacturers fail to comply with their fleet average standards, but, unlike EPCA, there is no option for manufacturers to pay fines in lieu of compliance with the standards. Under the CAA, penalties are typically determined on a vehicle-specific basis by determining the number of a manufacturer's highest emitting vehicles that cause the fleet average standard violation. Penalties under Title II of the CAA are capped at $25,000 per day of violation and apply on a per vehicle basis. CAA section 205 (a).

d. Test Procedures

EPA establishes the test procedures under which compliance with both the CAA GHG standards and the EPCA fuel economy standards are measured. EPA's testing authority under the CAA is flexible, but testing for fuel economy for passenger cars is by statute is limited to the Federal Test procedure (FTP) or test procedures which provide results which are equivalent to the FTP. 49 USC section 32904 and section III.B, below. EPA developed and established the FTP in the early 1970s and, after enactment of EPCA in 1976, added the Highway Fuel Economy Test to be used in conjunction with the FTP for fuel economy testing. EPA has also developed tests with additional cycles (the so-called 5-cycle test) which test is used for purposes of fuel economy labeling and is also used in the EPA program for extending off-cycle credits under both the light-duty and (along with NHTSA) heavy-duty vehicle GHG programs. See 75 FR at 25439; 76 FR at 57252. In this rule, EPA is proposing to retain the FTP and HFET for purposes of testing the fleetwide average standards, and is further proposing modifications to the N2O measurement test procedures and the A/C CO_2 efficiency test procedures EPA initially adopted in the 2012–2016 rule.

3. Comparing the Agencies' Authority

As the above discussion makes clear, there are both important differences between the statutes under which each agency is acting as well as several important areas of similarity. One important difference is that EPA's authority addresses various GHGs, while NHTSA's authority addresses fuel economy as measured under specified test procedures and calculated by EPA. This difference is reflected in this rulemaking in the scope of the two standards: EPA's proposal takes into account reductions of direct air conditioning emissions, as well as proposed standards for methane and N_2O, but NHTSA's does not, because these things do not relate to fuel economy. A second important difference is that EPA is proposing certain compliance flexibilities, such as the multiplier for advanced technology vehicles, and takes those flexibilities into account in its technical analysis and modeling supporting its proposal. EPCA specifies a number of particular compliance flexibilities for CAFE, and expressly prohibits NHTSA from considering the impacts of those statutory compliance flexibilities in setting the CAFE standard so that the manufacturers' election to avail themselves of the permitted flexibilities remains strictly voluntary.[98] The Clean Air Act, on the other hand, contains no such prohibition. These considerations result in some differences in the technical analysis and modeling used to support EPA's and NHTSA's proposed standards.

Another important area where the two agencies' authorities are similar but not identical involves the transfer of credits between a single firm's car and truck fleets. EISA revised EPCA to allow for such credit transfers, but placed a cap on the amount of CAFE credits which can be transferred between the car and

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

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

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

[98] 49 U.S.C. 32902(h).

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

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

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

In this context, it is in the Nation's interest for the two agencies to continue to work together in developing their respective proposed standards, and they have done so. For example, the agencies have committed considerable effort to develop a joint Technical Support Document that provides a technical basis underlying each agency's analyses. The agencies also have worked closely together in developing and reviewing their respective modeling, to develop the best analysis and to promote technical consistency. The agencies have developed a common set of attribute-based curves that each agency supports as appropriate both technically and from a policy perspective. The agencies have also worked closely to ensure that their respective programs will work in a coordinated fashion, and will provide regulatory compatibility that allows auto manufacturers to build a single national light-duty fleet that would comply with both the GHG and the CAFE standards. The resulting overall close coordination of the proposed GHG and CAFE standards should not be surprising, however, as each agency is using a jointly developed technical basis to address the closely intertwined challenges of energy security and climate change.

As set out in detail in Sections III and IV of this notice, both EPA and NHTSA believe the agencies' proposals are fully justified under their respective statutory criteria. The proposed standards are feasible in each model year within the lead time provided, based on the agencies' projected increased use of various technologies which in most cases are already in commercial application in the fleet to varying degrees. Detailed modeling of the technologies that could be employed by each manufacturer supports this initial conclusion. The agencies also carefully assessed the costs of the proposed rules, both for the industry as a whole and per manufacturer, as well as the costs per vehicle, and consider these costs to be reasonable during the rulemaking time frame and recoverable (from fuel savings). The agencies recognize the significant increase in the application of technology that the proposed standards would require across a high percentage of vehicles, which will require the manufacturers to devote considerable engineering and development resources before 2017 laying the critical foundation for the widespread deployment of upgraded technology across a high percentage of the 2017–2025 fleet. This clearly will be challenging for automotive manufacturers and their suppliers, especially in the current economic climate, and given the stringency of the recently-established MYs 2012–2016 standards. However, based on all of the analyses performed by the agencies, our judgment is that it is a challenge that can reasonably be met.

The agencies also evaluated the impacts of these standards with respect to the expected reductions in GHGs and oil consumption and, found them to be very significant in magnitude. The agencies considered other factors such as the impacts on noise, energy, and vehicular congestion. The impact on safety was also given careful consideration. Moreover, the agencies quantified the various costs and benefits of the proposed standards, to the extent practicable. The agencies' analyses to date indicate that the overall quantified benefits of the proposed standards far outweigh the projected costs. All of these factors support the reasonableness of the proposed standards. See section III (proposed GHG standards) and section IV (proposed CAFE standards) for a detailed discussion of each agency's basis for its selection of its proposed standards.

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

II. Joint Technical Work Completed for This Proposal

A. Introduction

In this section, NHTSA and EPA discuss several aspects of their joint technical analyses. These analyses are common to the development of each agency's 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 technologies the agencies evaluated and their costs and effectiveness, the economic assumptions the agencies included in their analyses, a description of the air conditioning and off-cycle technology (credit) programs, as well as the effects of the proposed standards on vehicle safety. The Joint Technical Support Document (TSD) discusses the agencies' joint technical work in more detail.

The agencies have based today's proposal on a very significant body of data and analysis that we believe is the best information currently available on the full range of technical and other inputs utilized in our respective analyses. As noted in various places throughout this preamble, the draft Joint TSD, the NHTSA preliminary RIA, and the EPA draft RIA, we expect new information will become available between the proposal and final rulemaking. This new information will come from a range of sources: some is based on work the agencies have underway (*e.g.,* work on technology costs and effectiveness, potentially updating our baseline year from model year 2008 to model year 2010); other sources are those we expect to be released by others (*e.g.,* the Energy Information Agency's Annual Energy Outlook, which is published each year, and the most recent available version of which we expect to use for the final rule); and other information that will likely come from the public comment process. The agencies intend to evaluate all such new information as it becomes available, and where appropriate to update their analysis based on such information for purposes of the final rule. In addition, the agencies may make new information and/or analyses available in the agencies' respective public dockets for this rulemaking prior to the final rule, where that is appropriate, in order to facilitate public comment. We encourage all stakeholders to periodically check the two agencies' dockets between the proposal and final rules for any potential new docket submissions from the agencies.

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 2012–2016 light duty vehicle rulemaking, 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. This baseline includes vehicle sales volumes, GHG/fuel economy performance, and contains a listing of the base technologies on every 2008 vehicle sold. The second step was to project that baseline fleet volume into model years 2017–2025. The vehicle volumes projected out to MY 2025 is referred to as the reference fleet volumes. The third step was to modify that MY 2017–2025 reference fleet such that it reflects technology manufacturers could apply if MY 2016 standards are extended without change through MY 2025.[99] Each agency used its modeling system to develop a modified or final reference fleet, or adjusted baseline, for use in its analysis of regulatory alternatives, as discussed below and in Chapter 1 of the EPA draft RIA. All of the agencies' estimates of emission reductions, fuel economy improvements, costs, and societal impacts are developed in relation to the respective reference fleets. This section discusses the first two steps, development of the baseline fleet and the reference fleet.

EPA and NHTSA used a transparent approach to developing the baseline and reference fleets, largely working from publicly available data. Because both input and output sheets from our modeling are public, stakeholders can verify and check EPA's and NHTSA's modeling, and perform their own analyses with these datasets.[100]

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

NHTSA and EPA developed a baseline fleet comprised of model year 2008 data gathered from EPA's emission and fuel economy database. This baseline fleet was originally developed by EPA and NHTSA for the 2012–2016 final rule, and was updated for this proposal.[101] The new fleet has the model year 2008 vehicle's volumes and attributes along with the addition of projected volumes from 2017 to 2025. It also has some expanded footprint data for pickup trucks that was needed for a more detailed analysis of the truck curve.

In this proposed rulemaking, the agencies are again choosing to use model year 2008 vehicle data to be the basis of the baseline fleet, but for different reasons than in the 2012–2016 final rule. Model year 2008 is now the most recent model year for which the industry had normal sales. Model year 2009 data is available, but the agencies believe that model year was disrupted by the economic downturn and the bankruptcies of both General Motors and Chrysler resulting in a significant reduction in the number of vehicles sold by both companies and the industry as a whole. These abnormalities led the agencies to conclude that 2009 data was not representative for projecting the future fleet. Model Year 2010 data was not complete because not all manufacturers have yet submitted it to EPA, and was thus not available in time for it to be used for this proposal. Therefore, the agencies chose to use model year 2008 again as the baseline since it was the latest complete representative and transparent data set available. However, the agencies will consider using Model Year 2010 for the final rule, based on availability and an

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[99] EPA's MY 2016 GHG standards under the CAA continue into the future until they are changed. While NHTSA must actively promulgate standards in order for CAFE standards to extend past MY 2016, the agency has, as in all recent CAFE rulemakings, defined a no-action (i.e., baseline) regulatory alternative as an indefinite extension of the last-promulgated CAFE standards for purposes of the main analysis of the standards in this preamble.

[100] EPA's Omega Model and input sheets are available at *http://www.epa.gov/oms/climate/models.htm*; DOT/NHTSA's CAFE Compliance and Effects Modeling System (commonly known as the ''Volpe Model'') and input and output sheets are available at *http://www.nhtsa.gov/fuel-economy*.

[101] Further discussion of the development of the 2008 baseline fleet for the MY2012–2016 rule can be found at 75 Fed. Reg. 25324, 25349 (May 7, 2010).

analysis of the data representativeness. To the extent the MY 2010 data becomes available during the comment period the agencies will place a copy of this data in our respective dockets. We request comments on the relative merits of using MY 2008 and MY 2010 data, and whether one provides a better foundation than the other for purposes of using such data as the foundation for a market forecast extending through MY 2025.

The baseline fleet reflects all fuel economy technologies in use on MY 2008 light duty vehicles. The 2008 emission and fuel economy database included data on vehicle production volume, fuel economy, engine size, number of engine cylinders, transmission type, fuel type, etc., however it did not contain complete information on technologies. Thus, the agencies relied on publicly available data like the more complete technology descriptions from Ward's Automotive Group.[102] 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.[103] A description of all of the technologies used in modeling the 2008 vehicle fleet and how it was constructed are available in Chapter 1 of the Joint Draft TSD.

Footprint data for the baseline fleet came mainly from internet searches, though detailed information about the pickup truck footprints with volumes was not available online. Where this information was lacking, the agencies used manufacturer product plan data for 2008 model year to find out the correct number footprint and distribution of footprints. The footprint data for pickup trucks was expanded from the original data used in the previous rulemaking. The agencies obtained this footprint data from MY 2008 product plans submitted by the various manufacturers, which can be made public at this time because by now all MY 2008 vehicle models are already in production, which makes footprint data about them essentially public information. A description of exactly how the agencies obtained all the footprints is available in Chapter 1 of the TSD.

3. How Did the Agencies Develop the Projected MY 2017–2025 Vehicle Reference Fleet?

As in the 2012–2016 light duty vehicle rulemaking, EPA and NHTSA have based the projection of total car and total light truck sales for MYs 2017–2025 on projections made by the Department of Energy's Energy Information Administration (EIA). See 75 FR at 25349. 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. EIA published its Early Annual Energy Outlook for 2011 in December 2010. EIA released updated data to NHTSA in February (Interim AEO). The final release of AEO for 2011 came out in May 2011, but by that time EPA/NHTSA had already prepared modeling runs for potential 2017–2025 standards using the interim data release to NHTSA. EPA and NHTSA are using the interim data release for this proposal, but intend to use the newest version of AEO available for the FRM.

The agencies used the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) to estimate the future relative market shares of passenger cars and light trucks. However, NEMS methodology includes shifting vehicle sales volume, starting after 2007, away from fleets with lower fuel economy (the light-truck fleet) towards vehicles with higher fuel economies (the passenger car fleet) in order to facilitate projected compliance with CAFE and GHG standards. Because we use our market projection as a baseline relative to which we measure the effects of new standards, and we attempt to estimate the industry's ability to comply with new standards without changing product mix (*i.e.,* we analyze the effects of the proposed rules assuming manufacturers will not change fleet composition as a compliance strategy, as opposed to changes that might happen due to market forces), the Interim AEO 2011-projected shift in passenger car market share as a result of required fuel economy improvements creates a circularity. Therefore, for the current analysis, the agencies developed a new projection of passenger car and light truck sales shares by running scenarios from the Interim AEO 2011 reference case that first deactivate the above-mentioned sales-volume shifting methodology and then hold post-2017 CAFE standards constant at MY 2016 levels. As discussed in Chapter 1 of the agencies' joint Technical Support Document, incorporating these changes reduced the NEMS-projected passenger car share of the light vehicle market by an average of about 5% during 2017–2025.

In the AEO 2011 Interim data, EIA projects that total light-duty vehicle sales will gradually recover from their currently depressed levels by around 2013. In 2017, car sales are projected to be 8.4 million (53 percent) and truck sales are projected to be 7.3 million (47 percent). Although the total level of sales of 15.8 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 assumed higher fuel prices. Sales projections of cars and trucks for future model years can be found in Chapter 1 of the joint TSD.

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 utility vehicles (CUVs), which offer much of the utility of sport utility vehicles (SUVs) but use more car-like designs. The AEO 2011 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 used CSM Worldwide (CSM) as they did in the 2012–2016 rulemaking analysis. EPA and NHTSA believe that CSM is the best source available for a long range forecast for 2017–2025, though when EPA and NHTSA contacted several forecasting firms none of them offered comparably-detailed forecasting for that time frame. NHTSA and EPA decided to use the forecast from CSM for several reasons presented in the Joint TSD chapter I.

The long range forecast from CSM Worldwide is a custom forecast covering the years 2017–2025 which the agencies purchased from CSM in December of 2009. CSM provides quarterly sales forecasts for the automotive industry, and updates their data on the industry quarter. For the public's reference, a copy of CSM's long range forecast has been placed in the docket for this rulemaking.[104] EPA and NHTSA hope to purchase and use an updated forecast,

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

[103] Motortrend.com and Edmunds.com are free, no-fee internet sites.

[104] The CSM Sales Forecast Excel file ("CSM North America Sales Forecasts 2017–2025 for the Docket") is available in the docket (Docket EPA–HQ–OAR–2010–0799).

whether from CSM or other appropriate sources, before the final rulemaking. To the extent that such a forecast becomes available during the comment period the agencies will place a copy in our respective dockets.

The next step was to project the CSM forecasts for relative sales of cars and trucks by manufacturer and by market segment onto the total sales estimates of AEO 2011. Table II–1 and Table II–2 show the resulting projections for the reference 2025 model year and compare these to actual sales that occurred in the baseline 2008 model year. Both tables show sales using the traditional definition of cars and light trucks.

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Table II-1 Annual Sales of Light-Duty Vehicles by Manufacturer in 2008 and Estimated for 2025

	Cars		Light Trucks		Total	
	2008 MY	2025 MY	2008 MY	2025 MY	2008 MY	2025 MY
Aston Martin	1,370	1,182	0	0	1,370	1,182
BMW	291,796	405,256	61,324	145,409	353,120	550,665
Chrysler/Fiat	703,158	436,479	956,792	331,762	1,659,950	768,241
Daimler	208,195	340,719	79,135	101,067	287,330	441,786
Ferrari	1,450	7,658	0	0	1,450	7,658
Ford	956,699	1,540,109	814,194	684,476	1,770,893	2,224,586
Geely/Volvo	65,649	101,107	32,748	42,588	98,397	143,696
GM	1,587,391	1,673,936	1,507,797	1,524,008	3,095,188	3,197,943
Honda	1,006,639	1,340,321	505,140	557,697	1,511,779	1,898,018
Hyundai	337,869	677,250	53,158	168,136	391,027	845,386
Kia	221,980	362,783	59,472	97,653	281,452	460,436
Lotus	252	316	0	0	252	316
Mazda	246,661	306,804	55,885	61,368	302,546	368,172
Mitsubishi	85,358	73,305	15,371	36,387	100,729	109,692
Nissan	717,869	1,014,775	305,546	426,454	1,023,415	1,441,229
Porsche	18,909	40,696	18,797	11,219	37,706	51,915
Spyker/Saab	21,706	23,130	4,250	3,475	25,956	26,605

Subaru	116,035	256,970	82,546	74,722	198,581	331,692
Suzuki	79,339	103,154	35,319	21,374	114,658	124,528
Tata/JLR	9,596	65,418	55,584	56,805	65,180	122,223
Tesla	800	31,974	0	0	800	31,974
Toyota	1,260,364	2,108,053	951,136	1,210,016	2,211,500	3,318,069
Volkswagen	291,483	630,163	26,999	154,284	318,482	784,447
Total	8,230,568	11,541,560	5,621,193	5,708,899	13,851,761	17,250,459

Table II-2 Annual Sales of Light-Duty Vehicles by Market Segment in 2008 and Estimated for 2025

Cars			Light Trucks		
	2008 MY	2025 MY		2008 MY	2025 MY
Full-Size Car	829,896	245,355	Full-Size Pickup	1,332,335	1,002,806
Luxury Car	1,048,341	1,637,410	Mid-Size Pickup	452,013	431,272
Mid-Size Car	2,103,108	2,713,078	Full-Size Van	33,384	88,572
Mini Car	617,902	1,606,114	Mid-Size Van	719,529	839,452
Small Car	1,912,736	2,826,190	Mid-Size MAV*	110,353	548,457
Specialty Car	469,324	808,183	Small MAV	231,265	239,065
			Full-Size SUV*	559,160	46,978
			Mid-Size SUV	436,080	338,849

			Small SUV	196,424	71,827
			Full-Size CUV*	264,717	671,665
			Mid-Size CUV	923,165	1,259,483
			Small CUV	1,612,029	1,875,703
Total Sales**	6,981,307	9,836,330		6,870,454	7,414,129

* MAV – Multi-Activity Vehicle, or a vehicle with a tall roof and elevated seating positions such as a Mazda5SUV

– Sport Utility Vehicle, CUV – Crossover Utility Vehicle

**Total Sales are based on the classic Car/Truck definition.

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As mentioned previously, NHTSA has changed the definition of a truck for 2011 model year and beyond. The new definition has moved some 2 wheel drive SUVs and CUVs to the car category. Table II–3 shows the different volumes for car and trucks based on the new and old NHTSA definition. The table shows the difference in 2008, 2021, and 2025 to give a feel for how the change in definition changes the car/truck split.

Table II-3 New and Old Car and Truck definition in 2008, 2016, 2021, and 2025

Vehicle Type	2008	2016	2021	2025
Old Cars Definition	6,981,307	8,576,717	8,911,173	9,836,330
New Cars Definition	8,230,568	7,618,459	10,505,165	11,541,560
Old Truck Definition	6,870,454	10,140,463	7,277,894	7,414,129
New Truck Definition	5,621,193	6,054,713	5,683,902	5,708,899

The CSM forecast provides estimates of car and truck sales by segment and by manufacturer separately. The forecast was broken up into two tables. One table with manufacturer volumes by year and the other with vehicle segments percentages by year. Table II–4 and Table II–5 are examples of the data received from CSM. The task of estimating future sales using these tables is complex. We used the same methodology as in the previous rulemaking. A detailed description of how the projection process was done is found in Chapter 1 of the TSD.

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Table II-4 CSM Manufacturer Volumes in 2016, 2021, and 2025

	2016	2021	2025
BMW	328,220	325,231	317,178
Chrysler/Fiat	391,165	346,960	316,043
Daimler	298,676	272,049	271,539
Ford*	971,617	893,528	858,215
Subaru	205,486	185,281	181,062
General Motors	1,309,246	1,192,641	1,135,305
Honda	1,088,449	993,318	984,401
Hyundai	429,926	389,368	377,500
Kia	234,246	213,252	205,473
Mazda	215,117	200,003	199,193
Mitsubishi	47,414	42,693	42,227
Spyker/Saab	6	6	6
Tesla	800	800	800
Aston Martin	1,370	1,370	1,370
Lotus	252	252	252
Porsche	12	12	12
Nissan	803,177	729,723	707,361
Suzuki	88,142	81,042	76,873
Tata/JLR	58,594	53,143	52,069
Toyota	1,751,661	1,576,499	1,564,975
Volkswagen	578,420	530,378	494,596

*Ford volumes include Volvo in this table.

Table II-5 CSM Segment Percentages in 2016, 2021, and 2025

	2016	2021	2025
Full-Size CUV	3.66%	8.34%	9.06%
Full-Size Pickup	19.39%	15.42%	13.53%
Full-Size SUV	3.27%	0.90%	0.63%
Full-Size Van	0.92%	1.29%	1.19%
Mid-Size CUV	19.29%	16.88%	16.99%
Mid-Size MAV	1.63%	5.93%	7.40%
Mid-Size Pickup	4.67%	5.74%	5.82%
Mid-Size SUV	2.28%	4.73%	4.57%
Mid-Size Van	11.80%	11.63%	11.32%
Small CUV	30.67%	25.06%	25.30%
Small MAV	0.88%	2.98%	3.22%
Small Pickup	0.00%	0.00%	0.00%
Small SUV	1.53%	1.12%	0.97%

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The overall result was a projection of car and truck sales for model years 2017–2025—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 are shown in Table II–6 below.

Table II-6 Car and Truck Volumes and Split Based on NHTSA New Truck Definition

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Car Volume*	10,140	9,988	9,905	9,996	10,292	10,505	10,736	10,968	11,258	11,542
Truck Volume*	6,054	5,819	5,671	5,583	5,604	5,684	5,704	5,687	5,676	5,709
Car Split	62.6%	63.2%	63.6%	64.2%	64.7%	64.9%	65.3%	65.9%	66.5%	66.9%
Truck Split	37.4%	36.8%	36.4%	35.8%	35.3%	35.1%	34.7%	34.1%	33.5%	33.1%

*in thousands

Given publicly- and commercially-available sources that can be made equally transparent to all reviewers, the forecast described above represents the agencies' best technical judgment regarding the likely composition direction of the fleet. EPA and NHTSA recognize that it is impossible to predict with certainty how manufacturers' product offerings and sales volumes will evolve through MY 2025 under baseline conditions—that is, without further changes in standards after MY 2016. The agencies have not developed alternative market forecasts to examine corresponding sensitivity of analytical results discussed below, and have not varied the market forecast when conducting probabilistic uncertainty analysis discussed in NHTSA's preliminary Regulatory Impact Analysis. The agencies invite comment regarding alternative methods or projections to inform forecasts of the future fleet at the level of specificity and technical completeness required by the agencies' respective modeling systems.

The final step in the construction of the final reference fleet involves applying additional technology to individual vehicle models—that is, technology beyond that already present in MY 2008—reflecting already-promulgated standards through MY 2016, and reflecting the assumption that MY 2016 standards would apply through MY 2025. A description of the agencies' modeling work to develop their respective final reference (or adjusted baseline) fleets appear below in Sections III and IV of this preamble.

C. Development of Attribute-Based Curve Shapes

1. Why are standards attribute-based and defined by a mathematical function?

As in the MYs 2012–2016 CAFE/GHG rules, and as NHTSA did in the MY 2011 CAFE rule, NHTSA and EPA are proposing to set attribute-based CAFE and CO_2 standards that are 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.[105] The CAA has no such requirement, although such an approach is permissible under section 202 (a) and EPA has used the attribute-based approach in issuing standards under analogous provisions of the CAA (*e.g.,* criteria pollutant standards for non-road diesel engines using engine size as the attribute,[106] in the recent GHG standards for heavy duty pickups and vans using a work factor attribute,[107] and in the MYs 2012–2016 GHG rule itself which used vehicle footprint as the attribute). Public comments on the MYs 2012–2016 rulemaking widely supported attribute-based standards for both agencies' standards.

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 this proposal, footprint, as discussed below). Each manufacturers' fleet average standard is determined by the production-weighted[108] average (for CAFE, harmonic average) of those targets.

The agencies believe that an attribute-based standard is preferable to a single-industry-wide average standard in the context of CAFE and CO_2 standards for several reasons. First, if the shape is chosen properly, every manufacturer is more likely to be required to continue adding more fuel efficient technology each year across their fleet, because the stringency of the compliance obligation will depend on the particular product mix of each manufacturer. Therefore a maximum feasible attribute-based standard will tend to require greater fuel savings and CO_2 emissions reductions overall than would a maximum feasible flat standard (that is, a single mpg or CO_2 level applicable to every manufacturer).

Second, depending on the attribute, attribute-based standards reduce the incentive for manufacturers to respond to CAFE and CO_2 standards in ways harmful to safety.[109] Because each vehicle model has its own target (based on the attribute chosen), properly fitted attribute-based standards provide little, if any, incentive to build smaller vehicles simply to meet a fleet-wide average, because the smaller vehicles will be subject to more stringent compliance targets.[110]

Third, attribute-based standards provide a more equitable regulatory framework for different vehicle manufacturers.[111] A single industry-wide average standard imposes disproportionate cost burdens and compliance difficulties on the manufacturers that need to change their product plans to meet the standards, and puts no obligation on those manufacturers that have no need to change their plans. As discussed above, attribute-based standards help to spread the regulatory cost burden for fuel economy more broadly across all of the vehicle manufacturers within the industry.

Fourth, attribute-based standards better respect economic conditions and consumer choice, as compared to single-value standards. A flat, or single value standard, encourages a certain vehicle size fleet mix by creating incentives for manufacturers to use vehicle downsizing as a compliance strategy. Under a footprint-based standard, manufacturers are required to invest in technologies that improve the fuel economy of the vehicles they sell rather than shifting the product mix, because reducing the size of the vehicle is generally a less viable compliance strategy given that smaller vehicles have more stringent regulatory targets.

2. What attribute are the agencies proposing to use, and why?

As in the MYs 2012–2016 CAFE/GHG rules, and as NHTSA did in the MY 2011 CAFE rule, NHTSA and EPA are proposing to set CAFE and CO_2 standards that are based on vehicle footprint, which has an observable correlation to fuel economy and emissions. There are several policy and technical reasons why NHTSA and EPA believe that footprint is the most appropriate attribute on which to base the standards, even though some other vehicle attributes (notably curb weight) are better correlated to fuel economy and emissions.

First, in the agencies' judgment, from the standpoint of vehicle safety, it is important that the CAFE and CO_2 standards be set in a way that does not encourage manufacturers to respond by selling vehicles that are in any way less safe. While NHTSA's research of historical crash data also indicates that reductions in vehicle mass that are accompanied by reductions in vehicle footprint tend to compromise vehicle safety, footprint-based standards provide an incentive to use advanced lightweight materials and structures that would be discouraged by weight-based

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[105] 49 U.S.C. 32902(a)(3)(A).

[106] 69 FR 38958 (June 29, 2004).

[107] 76 FR 57106, 57162–64, (Sept. 15, 2011).

[108] Production for sale in the United States.

[109] 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 2002 NAS Report at 5, finding 12. Ensuing analyses, including by NHTSA, support the fundamental conclusion that standards structured to minimize incentives to downsize all but the largest vehicles will tend to produce better safety outcomes than flat standards.

[110] Assuming that the attribute is related to vehicle size.

[111] *Id.* at 4–5, finding 10.

standards, because manufacturers can use them to improve a vehicle's fuel economy and CO_2 emissions without their use necessarily resulting in a change in the vehicle's fuel economy and emissions targets.

Further, although we recognize that weight is better correlated with fuel economy and CO_2 emissions than is footprint, we continue to believe that there is less risk of ''gaming'' (changing 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 continue to agree with concerns raised in 2008 by some commenters on the MY 2011 CAFE rulemaking that there would be greater potential for gaming under multi-attribute standards, such as those that also depend on weight, torque, power, towing capability, and/or off-road capability. The agencies agree with the assessment first presented in NHTSA's MY 2011 CAFE final rule [112] 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 more complex, but by providing degrees of freedom with respect to more easily-adjusted attributes, they could make it less certain that the future fleet would actually achieve the average fuel economy and CO_2 reduction 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 proposed rule. The agencies also recognize that some international attribute-based standards use attributes other than footprint and that there could be benefits for a number of manufacturers if there was greater international harmonization of fuel economy and GHG standards for light-duty vehicles, but this is largely a question of how stringent standards are and how they are tested and 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 address these issues in a way that least burdens manufacturers while respecting each country's need to meet its own particular challenges.

The agencies continue to find that footprint is the most appropriate attribute upon which to base the proposed standards, but recognizing strong public interest in this issue, we seek comment on whether the agencies should consider setting standards for the final rule based on another attribute or another combination of attributes. If commenters suggest that the agencies should consider another attribute or another combination of attributes, the agencies specifically request 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.

3. What mathematical functions have the agencies previously used, and why?

a. NHTSA in MY 2008 and MY 2011 CAFE (constrained logistic)

For the MY 2011 CAFE rule, NHTSA estimated fuel economy levels after normalization for differences in technology, but did not make adjustments to reflect other vehicle attributes (*e.g.,* power-to-weight ratios).[113] Starting with the technology adjusted passenger car and light truck fleets, NHTSA used minimum absolute deviation (MAD) regression without sales weighting to fit a logistic form as a starting point to develop mathematical functions defining the standards. NHTSA then identified footprints at which to apply minimum and maximum values (rather than letting the standards extend without limit) and transposed these functions vertically (*i.e.,* on a gpm basis, uniformly downward) to produce the promulgated standards. In the preceding rule, for MYs 2008–2011 light truck standards, NHTSA examined a range of potential functional forms, and concluded that, compared to other considered forms, the constrained logistic form provided the expected and appropriate trend (decreasing fuel economy as footprint increases), but avoided creating ''kinks'' the agency was concerned would provide distortionary incentives for vehicles with neighboring footprints.[114]

b. MYs 2012–2016 Light Duty GHG/CAFE (constrained/piecewise linear)

For the MYs 2012–2016 rules, NHTSA and EPA re-evaluated potential methods for specifying mathematical functions to define fuel economy and GHG standards. The agencies concluded that the constrained logistic form, if applied to post-MY 2011 standards, would likely contain a steep mid-section that would provide undue incentive to increase the footprint of midsize passenger cars.[115] The agencies judged that a range of methods to fit the curves would be reasonable, and used a minimum absolute deviation (MAD) regression without sales weighting on a technology-adjusted car and light truck fleet to fit a linear equation. This equation was used as a starting point to develop mathematical functions defining the standards as discussed above. The agencies then identified footprints at which to apply minimum and maximum values (rather than letting the standards extend without limit) and transposed these constrained/piecewise linear functions vertically (*i.e.,* on a gpm or CO_2 basis, uniformly downward) to produce the fleetwide fuel economy and CO_2 emission levels for cars and light trucks described in the final rule.[116]

4. How have the agencies changed the mathematical functions for the proposed MYs 2017–2025 standards, and why?

By requiring NHTSA to set CAFE standards that are attribute-based and defined by a mathematical function, Congress appears to have wanted the post-EISA standards to be data-driven—a mathematical function defining the standards, in order to be ''attribute-based,'' should reflect the observed relationship in the data between the

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

[113] *See* 74 FR 14196, 14363–14370 (Mar. 30, 2009) for NHTSA discussion of curve fitting in the MY 2011 CAFE final rule.

[114] *See* 71 FR 17556, 17609–17613 (Apr. 6, 2006) for NHTSA discussion of ''kinks'' in the MYs 2008–2011 light truck CAFE final rule (there described as ''edge effects''). A ''kink,'' as used here, is a portion of the curve where a small change in footprint results in a disproportionally large change in stringency.

[115] 75 FR at 25362.

[116] *See generally* 74 FR at 49491–96; 75 FR at 25357–62.

attribute chosen and fuel economy.[117] EPA is also proposing to set attribute-based CO_2 standards defined by similar mathematical functions, for the reasonable technical and policy grounds discussed below and in section II of the preamble to the proposed rule, and which supports a harmonization with the CAFE standards.

The relationship between fuel economy (and GHG emissions) and footprint, though directionally clear (*i.e.,* fuel economy tends to decrease and CO_2 emissions tend to increase with increasing footprint), is theoretically vague and quantitatively uncertain; in other words, not so precise as to *a priori* yield only a single possible curve.[118] There is thus a range of legitimate options open to the agencies in developing curve shapes. The agencies may of course consider statutory objectives in choosing among the many reasonable alternatives. For example, curve shapes that might have some theoretical basis could lead to perverse outcomes contrary to the intent of the statutes to conserve energy and protect human health and the environment.[119] Thus, the decision of how to set the target curves cannot always be just about most ''clearly'' using a mathematical function to define the relationship between fuel economy and the attribute; it often has to have a normative aspect, where the agencies adjust the function that would define the relationship in order to avoid perverse results, improve equity of burden across manufacturers, preserve consumer choice, etc. This is true both for the decisions that guide the mathematical function defining the sloped portion of the target curves, and for the separate decisions that guide the agencies' choice of ''cutpoints'' (if any) that define the fuel economy/CO_2 levels and footprints at each end of the curves where the curves become flat. Data informs these decisions, but how the agencies define and interpret the relevant data, and then the choice of methodology for fitting a curve to the data, must include a consideration of both technical data and policy goals.

The next sections examine the policy concerns that the agencies considered in developing the proposed target curves that define the proposed MYs 2017–2025 CAFE and CO_2 standards, new technical work (expanding on similar analyses performed by NHTSA when the agency proposed MY 2011–2015 standards, and by both agencies during consideration of options for MY 2012–2016 CAFE and GHG standards) that was completed in the process of reexamining potential mathematical functions, how the agencies have defined the data, and how the agencies explored statistical curve-fitting methodologies in order to arrive at proposed curves.

5. What are the agencies proposing for the MYs 2017–2025 curves?

The proposed mathematical functions for the proposed MYs 2017–2025 standards are somewhat changed from the functions for the MYs 2012–2016 standards, in response to comments received from stakeholders and in order to address technical concerns and policy goals that the agencies judge more significant in this 9-year rulemaking than in the prior one, which only included 5 years. This section discusses the methodology the agencies selected as, at this time, best addressing those technical concerns and policy goals, given the various technical inputs to the agencies' current analyses. Below the agencies discuss how the agencies determined the cutpoints and the flat portions of the MYs 2017–2025 target curves. We also note that both of these sections address only how the target curves were fit to fuel consumption and CO_2 emission values determined using the city and highway test procedures, and that in determining respective regulatory alternatives, the agencies made further adjustments to the resultant curves in order to account for adjustments for improvements to mobile air conditioners.

Thus, recognizing that there are many reasonable statistical methods for fitting curves to data points that define vehicles in terms of footprint and fuel economy, the agencies have chosen for this proposed rule to fit curves using an ordinary least-squares formulation, on sales-weighted data, using a fleet that has had technology applied, and after adjusting the data for the effects of weight-to-footprint, as described below. This represents a departure from the statistical approach for fitting the curves in MYs 2012–2016, as explained in the next section. The agencies considered a wide variety of reasonable statistical methods in order to better understand the range of uncertainty regarding the relationship between fuel consumption (the inverse of fuel economy), CO_2 emission rates, and footprint, thereby providing a range within which decisions about standards would be potentially supportable.

a. What concerns were the agencies looking to address that led them to change from the approach used for the MYs 2012–2016 curves?

During the year and a half since the MYs 2012–2016 final rule was issued, NHTSA and EPA have received a number of comments from stakeholders on how curves should be fitted to the passenger car and light truck fleets. Some limited-line manufacturers have argued that curves should generally be flatter in order to avoid discouraging small vehicles, because steeper curves tend to result in more stringent targets for smaller vehicles. Most full-line manufacturers have argued that a passenger car curve similar in slope to the MY 2016 passenger car curve would be appropriate for future model years, but that the light truck curve should be revised to be less difficult for manufacturers selling the largest full-size pickup trucks. These manufacturers argued that the MY 2016 light truck curve was not ''physics-based,'' and that in order for future tightening of standards to be feasible for full-line manufacturers, the truck curve for later model years should be steeper and extended further (*i.e.,* made less stringent) into the larger footprints. The agencies do not agree that the MY 2016 light truck curve was somehow deficient in lacking a ''physics basis,'' or that it was somehow overly stringent for manufacturers selling large pickups—manufacturers making these arguments presented no ''physics-based'' model to explain how fuel economy should depend on footprint.[120] The same manufacturers indicated that they believed that the light truck standard should be somewhat steeper after MY 2016, primarily because, after more than ten years of progressive increases in the stringency of applicable CAFE standards, large pickups would be less capable of achieving further

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[117] A mathematical function can be defined, of course, that has nothing to do with the relationship between fuel economy and the chosen attribute—the most basic example is an industry-wide standard defined as the mathematical function *average required fuel economy = X,* where X is the single mpg level set by the agency. Yet a standard that is simply defined as a mathematical function that is not tied to the attribute(s) would not meet the requirement of EISA.

[118] In fact, numerous manufacturers have confidentially shared with the agencies what they describe as ''physics based'' curves, with each OEM showing significantly different shapes, and footprint relationships. The sheer variety of curves shown to the agencies further confirm the lack of an underlying principle of ''fundamental physics'' driving the relationship between CO_2 emission or fuel consumption and footprint, and the lack of an underlying principle to dictate any outcome of the agencies' establishment of footprint-based standards.

[119] For example, if the agencies set weight-based standards defined by a steep function, the standards might encourage manufacturers to keep adding weight to their vehicles to obtain less stringent targets.

[120] See footnote 118.

improvements without compromising load carrying and towing capacity.

In developing the curve shapes for this proposed rule, the agencies were aware of the current and prior technical concerns raised by OEMs concerning the effects of the stringency on individual manufacturers and their ability to meet the standards with available technologies, while producing vehicles at a cost that allowed them to recover the additional costs of the technologies being applied. Although we continue to believe that the methodology for fitting curves for the MY2012–2016 standards was technically sound, we recognize manufacturers' technical concerns regarding their abilities to comply with a similarly shallow curve after MY2016 given the anticipated mix of light trucks in MYs 2017–2025. As in the MYs 2012–2016 rules, the agencies considered these concerns in the analysis of potential curve shapes. The agencies also considered safety concerns which could be raised by curve shapes creating an incentive for vehicle downsizing, as well as the potential loss to consumer welfare should vehicle upsizing be unduly disincentivized. In addition, the agencies sought to improve the balance of compliance burdens among manufacturers. Among the technical concerns and resultant policy trade-offs the agencies considered were the following:

- Flatter standards (*i.e.,* curves) increase the risk that both the weight and size of vehicles will be reduced, compromising highway safety.
- Flatter standards potentially impact the utility of vehicles by providing an incentive for vehicle downsizing.
- Steeper footprint-based standards may incentivize vehicle upsizing, thus increasing the risk that fuel economy and greenhouse gas reduction benefits will be less than expected.
- Given the same industry-wide average required fuel economy or CO_2 standard, flatter standards tend to place greater compliance burdens on full-line manufacturers.
- Given the same industry-wide average required fuel economy or CO_2 standard, steeper standards tend to place greater compliance burdens on limited-line manufacturers (depending of course, on which vehicles are being produced).
- If cutpoints are adopted, given the same industry-wide average required fuel economy, moving small-vehicle cutpoints to the left (*i.e.,* up in terms of fuel economy, down in terms of CO_2 emissions) discourages the introduction of small vehicles, and reduces the incentive to downsize small vehicles in ways that would compromise highway safety.
- If cutpoints are adopted, given the same industry-wide average required fuel economy, moving large-vehicle cutpoints to the right (*i.e.,* down in terms of fuel economy, up in terms of CO_2 emissions) better accommodates the unique design requirements of larger vehicles—especially large pickups—and extends the size range over which downsizing is discouraged.

All of these were policy goals that required trade-offs, and in determining the curves they also required balance against the comments from the OEMs discussed in the introduction to this section. Ultimately, the agencies do not agree that the MY 2017 target curves for this proposal, on a relative basis, should be made significantly flatter than the MY 2016 curve,[121] as we believe that this would undo some of the safety-related incentives and balancing of compliance burdens among manufacturers—effects that attribute-based standards are intended to provide.

Nonetheless, the agencies recognize full-line OEM concerns and have tentatively concluded that further increases in the stringency of the light truck standards will be more feasible if the light truck curve is made steeper than the MY 2016 truck curve and the right (large footprint) cut-point is extended over time to larger footprints. This conclusion is supported by the agencies' technical analyses of regulatory alternatives defined using the curves developed in the manner described below.

b. What methodologies and data did the agencies consider in developing the 2017–2025 curves?

In considering how to address the various policy concerns discussed in the previous sections, the agencies revisited the data and performed a number of analyses using different combinations of the various statistical methods, weighting schemes, adjustments to the data and the addition of technologies to make the fleets less technologically heterogeneous. As discussed above, in the agencies' judgment, there is no single "correct" way to estimate the relationship between CO_2 or fuel consumption and footprint—rather, each statistical result is based on the underlying assumptions about the particular functional form, weightings and error structures embodied in the representational approach. These assumptions are the subject of the following discussion. This process of performing many analyses using combinations of statistical methods generates many possible outcomes, each embodying different potentially reasonable combinations of assumptions and each thus reflective of the data as viewed through a particular lens. The choice of a standard developed by a given combination of these statistical methods is consequently a decision based upon the agencies' determination of how, given the policy objectives for this rulemaking and the agencies' MY 2008-based forecast of the market through MY 2025, to appropriately reflect the current understanding of the evolution of automotive technology and costs, the future prospects for the vehicle market, and thereby establish curves (*i.e.,* standards) for cars and light trucks.

c. What information did the agencies use to estimate a relationship between fuel economy, CO_2 and footprint?

For each fleet, the agencies began with the MY 2008-based market forecast developed to support this proposal (*i.e.,* the baseline fleet), with vehicles' fuel economy levels and technological characteristics at MY 2008 levels.[122] The development, scope, and content of this market forecast is discussed in detail in Chapter 1 of the joint Technical Support Document supporting this rulemaking.

d. What adjustments did the agencies evaluate?

The agencies believe one possible approach is to fit curves to the minimally adjusted data shown above (the approach still includes sales mix adjustments, which influence results of sales-weighted regressions), much as DOT did when it first began evaluating potential attribute-based standards in 2003.[123] However, the agencies have found, as in prior rulemakings, that the data are so widely spread (*i.e.,* when graphed, they fall in a loose "cloud" rather than tightly around an obvious line) that they indicate a relationship between footprint and CO_2 and fuel consumption that is real but not particularly strong. Therefore, as discussed below, the agencies also explored possible adjustments that could help to explain and/or reduce the ambiguity of this relationship, or could help to produce policy outcomes the agencies judged to be more desirable.

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[121] While "significantly" flatter is subjective, the year over year change in curve shapes is discussed in greater detail in Section 0 and Chapter 2 of the joint TSD.

[122] While the agencies jointly conducted this analysis, the coefficients ultimately used in the slope setting analysis are from the CAFE model.

[123] 68 FR 74920–74926.

i. Adjustment to reflect differences in technology

As in prior rulemakings, the agencies consider technology differences between vehicle models to be a significant factor producing uncertainty regarding the relationship between CO_2/fuel consumption and footprint. Noting that attribute-based standards are intended to encourage the application of additional technology to improve fuel efficiency and reduce CO_2 emissions, the agencies, in addition to considering approaches based on the unadjusted engineering characteristics of MY 2008 vehicle models, therefore also considered approaches in which, as for previous rulemakings, technology is added to vehicles for purposes of the curve fitting analysis in order to produce fleets that are less varied in technology content.

The agencies adjusted the baseline fleet for technology by adding all technologies considered, except for the most advanced high-BMEP (brake mean effective pressure) gasoline engines, diesel engines, strong HEVs, PHEVs, EVs, and FCVs. The agencies included 15 percent mass reduction on all vehicles.

ii. Adjustments reflecting differences in performance and ''density''

For the reasons discussed above regarding revisiting the shapes of the curves, the agencies considered adjustments for other differences between vehicle models (*i.e.,* inflating or deflating the fuel economy of each vehicle model based on the extent to which one of the vehicle's attributes, such as power, is higher or lower than average). Previously, NHTSA had rejected such adjustments because they imply that a multi-attribute standard may be necessary, and the agencies judged multi-attribute standard to be more subject to gaming than a footprint-only standard.[124] [125] Having considered this issue again for purposes of this rulemaking, NHTSA and EPA conclude the need to accommodate in the target curves the challenges faced by manufacturers of large pickups currently outweighs these prior concerns. Therefore, the agencies also evaluated curve fitting approaches through which fuel consumption and CO_2 levels were adjusted with respect to weight-to-footprint alone, and in combination with power-to-weight. While the agencies examined these adjustments for purposes of fitting curves, the agencies are not proposing a multi-attribute standard; the proposed fuel economy and CO_2 targets for each vehicle are still functions of footprint alone. No adjustment would be used in the compliance process.

The agencies also examined some differences between the technology-adjusted car and truck fleets in order to better understand the relationship between footprint and CO_2/fuel consumption in the agencies' MY 2008 based forecast. The agencies investigated the relationship between HP/WT and footprint in the agencies' MY2008-based market forecast. On a sales weighted basis, cars tend to become proportionally more powerful as they get larger. In contrast, there is a minimally positive relationship between HP/WT and footprint for light trucks, indicating that light trucks become only slightly more powerful as they get larger.

This analysis, presented in chapter 2.4.1.2 of the agencies' joint TSD, indicated that vehicle performance (power-to-weight ratio) and ''density'' (curb weight divided by footprint) are both correlated to fuel consumption (and CO_2 emission rate), and that these vehicle attributes are also both related to vehicle footprint. Based on these relationships, the agencies explored adjusting the fuel economy and CO_2 emission rates of individual vehicle models based on deviations from ''expected'' performance or weight/footprint at a given footprint; the agencies inflated fuel economy levels of vehicle models with higher performance and/or weight/footprint than the average of the fleet would indicate at that footprint, and deflated fuel economy levels with lower performance and/or weight. Previously, NHTSA had rejected such adjustments because they imply that a multi-attribute standard may be necessary, and the agency judged multi-attribute standard to be more subject to gaming than a footprint-only standard.[126] [127] While the agencies considered this technique for purposes of fitting curves, the agencies are not proposing a multi-attribute standard, as the proposed fuel economy and CO_2 targets for each vehicle are still functions of footprint alone. No adjustment would be used in the compliance process.

The agencies seek comment on the appropriateness of the adjustments as described in Chapter 2 of the joint TSD, particularly regarding whether these adjustments suggest that standards should be defined in terms of other attributes in addition to footprint, and whether they may encourage changes other than encouraging the application of technology to improve fuel economy and reduce CO_2 emissions. The agencies also seek comment regarding whether these adjustments effectively ''lock in'' through MY 2025 relationships that were observed in MY 2008.

e. What statistical methods did the agencies evaluate?

The above approaches resulted in three data sets each for (a) vehicles without added technology and (b) vehicles with technology added to reduce technology differences, any of which may provide a reasonable basis for fitting mathematical functions upon which to base the slope of the standard curves: (1) Vehicles without any further adjustments; (2) vehicles with adjustments reflecting differences in ''density'' (weight/footprint); and (3) vehicles with adjustments reflecting differences in ''density,'' and adjustments reflecting differences in performance (power/weight). Using these data sets, the agencies tested a range of regression methodologies, each judged to be possibly reasonable for application to at least some of these data sets.

i. Regression Approach

In the MYs 2012–2016 final rules, the agencies employed a robust regression approach (minimum absolute deviation, or MAD), rather than an ordinary least squares (OLS) regression.[128] MAD is generally applied to mitigate the effect of outliers in a dataset, and thus was employed in that rulemaking as part of our interest in attempting to best represent the underlying technology. NHTSA had used OLS in early development of attribute-based CAFE

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[124] For example, in comments on NHTSA's 2008 NPRM regarding MY 2011–2015 CAFE standards, Porsche recommended that standards be defined in terms of a ''Summed Weighted Attribute'', wherein the fuel economy target would calculated as follows: *target = f(SWA),* where target is the fuel economy target applicable to a given vehicle model and $SWA = footprint + torque^{1/1.5} + weight^{1/2.5}$. (NHTSA–2008–0089–0174). While the standards the agencies are proposing for MY 2017–2025 are not multi-attributes, that is the target is only a function of footprint, we are proposing curve shapes that were developed considering more than one attribute.

[125] 74 FR 14359.

[126] For example, in comments on NHTSA's 2008 NPRM regarding MY 2011–2015 CAFE standards, Porsche recommended that standards be defined in terms of a ''Summed Weighted Attribute'', wherein the fuel economy target would calculated as follows: *target = f(SWA),* where *target* is the fuel economy target applicable to a given vehicle model and $SWA = footprint + torque^{1/1.5} + weight^{1/2.5}$. (NHTSA–2008–0089–0174). While the standards the agencies are proposing for MY 2017–2025 are not multi-attribute standards, that is the target is only a function of footprint, we are proposing curve shapes that were developed considering more than one attribute.

[127] 74 FR 14359.

[128] See 75 FR at 25359.

standards, but NHTSA (and then NHTSA and EPA) subsequently chose MAD instead of OLS for both the MY 2011 and the MYs 2012–2016 rulemakings. These decisions on regression technique were made both because OLS gives additional emphasis to outliers[129] and because the MAD approach helped achieve the agencies' policy goals with regard to curve slope in those rulemakings.[130] In the interest of taking a fresh look at appropriate regression methodologies as promised in the 2012–2016 light duty rulemaking, in developing this proposal, the agencies gave full consideration to both OLS and MAD. The OLS representation, as described, uses squared errors, while MAD employs absolute errors and thus weights outliers less.

As noted, one of the reasons stated for choosing MAD over least square regression in the MYs 2012–2016 rulemaking was that MAD reduced the weight placed on outliers in the data. However, the agencies have further considered whether it is appropriate to classify these vehicles as outliers. Unlike in traditional datasets, these vehicles' performance is not mischaracterized due to errors in their measurement, a common reason for outlier classification. Being certification data, the chances of large measurement errors should be near zero, particularly towards high CO_2 or fuel consumption. Thus, they can only be outliers in the sense that the vehicle designs are unlike those of other vehicles. These outlier vehicles may include performance vehicles, vehicles with high ground clearance, 4WD, or boxy designs. Given that these are equally legitimate on-road vehicle designs, the agencies concluded that it would appropriate to reconsider the treatment of these vehicles in the regression techniques.

Based on these considerations as well as the adjustments discussed above, the agencies concluded it was not meaningful to run MAD regressions on gpm data that had already been adjusted in the manner described above. Normalizing already reduced the variation in the data, and brought outliers towards average values. This was the intended effect, so the agencies deemed it unnecessary to apply an additional remedy to resolve an issue that had already been addressed, but we seek comment on the use of robust regression techniques under such circumstances.

ii. Sales Weighting

Likewise, the agencies reconsidered employing sales-weighting to represent the data. As explained below, the decision to sales weight or not is ultimately based upon a choice about how to represent the data, and not by an underlying statistical concern. Sales weighting is used if the decision is made to treat each (mass produced) unit sold as a unique physical observation. Doing so thereby changes the extent to which different vehicle model types are emphasized as compared to a non-sales weighted regression. For example, while total General Motors Silverado (332,000) and Ford F–150 (322,000) sales differ by less than 10,000 in MY 2021 market forecast, 62 F–150s models and 38 Silverado models are reported in the agencies baselines. Without sales-weighting, the F–150 models, because there are more of them, are given 63 percent more weight in the regression despite comprising a similar portion of the marketplace and a relatively homogenous set of vehicle technologies.

The agencies did not use sales weighting in the 2012–2016 rulemaking analysis of the curve shapes. A decision to not perform sales weighting reflects judgment that each vehicle model provides an equal amount of information concerning the underlying relationship between footprint and fuel economy. Sales-weighted regression gives the highest sales vehicle model types vastly more emphasis than the lowest-sales vehicle model types thus driving the regression toward the sales-weighted fleet norm. For unweighted regression, vehicle sales do not matter. The agencies note that the light truck market forecast shows MY 2025 sales of 218,000 units for Toyota's 2WD Sienna, and shows 66 model configurations with MY 2025 sales of fewer than 100 units. Similarly, the agencies' market forecast shows MY 2025 sales of 267,000 for the Toyota Prius, and shows 40 model configurations with MY2025 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 in the regressions.[131]

However, the agencies did note in the MYs 2012–2016 final rules that, "sales weighted regression would allow the difference between other vehicle attributes to be reflected in the analysis, and also would reflect consumer demand."[132] In reexamining the sales-weighting for this analysis, the agencies note that there are low-volume model types account for many of the passenger car model types (50 percent of passenger car model types account for 3.3 percent of sales), and it is unclear whether the engineering characteristics of these model types should equally determine the standard for the remainder of the market.

In the interest of taking a fresh look at appropriate methodologies as promised in the last final rule, in developing this proposal, the agencies gave full consideration to both sales-weighted and unweighted regressions.

iii. Analyses Performed

We performed regressions describing the relationship between a vehicle's CO_2/fuel consumption and its footprint, in terms of various combinations of factors: initial (raw) fleets with no technology, versus after technology is applied; sales-weighted versus non-sales weighted; and with and without two sets of normalizing factors applied to the observations. The agencies excluded diesels and dedicated AFVs because the agencies anticipate that advanced gasoline-fueled vehicles are likely to be dominant through MY 2025, based both on our own assessment of potential standards (see Sections III and IV below) as well as our discussions with large number of automotive companies and suppliers.

Thus, the basic OLS regression on the initial data (with no technology applied) and no sales-weighting represents one perspective on the relation between footprint and fuel economy. Adding sales weighting changes the interpretation to include the influence of sales volumes, and thus steps away from representing vehicle technology alone. Likewise, MAD is an attempt to reduce the impact of outliers, but reducing the impact of outliers might perhaps be less representative of technical relationships between the variables, although that relationship may change over time in reality. Each combination of methods and data reflects a perspective, and the regression results simply reflect that perspective in a simple quantifiable manner, expressed as the coefficients determining the line through the average (for OLS) or the median (for MAD) of the data. It is left to policy makers to determine an appropriate perspective and to interpret the consequences of the various alternatives.

We invite comments on the application of the weights as described

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[129] *Id.* at 25362–63.

[130] *Id.* at 25363.

[131] 75 FR at 25362 and n. 64.

[132] 75 FR at 25632/3.

above, and the implications for interpreting the relationship between fuel efficiency (or CO_2) and footprint.

f. What results did the agencies obtain, which methodology did the agencies choose for this proposal, and why is it reasonable?

Both agencies analyzed the same statistical approaches. For regressions against data including technology normalization, NHTSA used the CAFE modeling system, and EPA used EPA's OMEGA model. The agencies obtained similar regression results, and have based today's joint proposal on those obtained by NHTSA. The draft Joint TSD Chapter 2 contains a large set of illustrative of figures which show the range of curves determined by the possible combinations of regression technique, with and without sales weighting, with and without the application of technology, and with various adjustments to the gpm variable prior to running a regression.

The choice among the alternatives presented in the draft Joint TSD Chapter 2 was to use the OLS formulation, on sales-weighted data, using a fleet that has had technology applied, and after adjusting the data for the effect of weight-to-footprint, as described above. The agencies believe that this represents a technically reasonable approach for purposes of developing target curves to define the proposed standards, and that it represents a reasonable trade-off among various considerations balancing statistical, technical, and policy matters, which include the statistical representativeness of the curves considered and the steepness of the curve chosen. The agencies judge the application of technology prior to curve fitting to provide a reasonable means—one consistent with the rule's objective of encouraging manufacturers to add technology in order to increase fuel economy—of reducing variation in the data and thereby helping to estimate a relationship between fuel consumption/CO_2 and footprint.

Similarly, for the agencies' current MY 2008-based market-forecast and the agencies' current estimates of future technology effectiveness, the inclusion of the weight-to-footprint data adjustment prior to running the regression also helps to improve the fit of the curves by reducing the variation in the data, and the agencies believe that the benefits of this adjustment for this proposed rule likely outweigh the potential that resultant curves might somehow encourage reduced load carrying capability or vehicle performance (note that the we are not suggesting that we believe these adjustments will reduce load carrying capability or vehicle performance). In addition to reducing the variability, the truck curve is also steepened, and the car curve flattened compared to curves fitted to sales weighted data that do not include these normalizations. The agencies agree with manufacturers of full-size pick-up trucks that in order to maintain towing and hauling utility, the engines on pick-up trucks must be more powerful, than their low ''density'' nature would statistically suggest based on the agencies' current MY2008-based market forecast and the agencies' current estimates of the effectiveness of different fuel-saving technologies. Therefore, it may be more equitable (*i.e.,* in terms of relative compliance challenges faced by different light truck manufacturers) to adjust the slope of the curve defining fuel economy and CO_2 targets.

As described above, however, other approaches are also technically reasonable, and also represent a way of expressing the underlying relationships. The agencies plan to revisit the analysis for the final rule, after updating the underlying market forecast and estimates of technology effectiveness, and based on relevant public comments received. In addition, the agencies intend to update the technology cost estimates, which could alter the NPRM analysis results and consequently alter the balance of the trade-offs being weighed to determine the final curves.

g. Implications of the proposed slope compared to MY 2012–2016

The proposed slope has several implications relative to the MY 2016 curves, with the majority of changes on the truck curve. With the agencies' current MY2008-based market forecast and the agencies' current estimates of technology effectiveness, the combination of sales weighting and WT/FP normalization produced a car curve slope similar to that finalized in the MY 2012–2016 final rulemaking (4.7 g/mile in MY 2016, vs. 4.5 g/mile proposed in MY 2017). By contrast, the truck curve is steeper in MY 2017 than in MY 2016 (4.0 g/mile in MY 2016 vs. 4.9 g/mile in MY 2017). As discussed previously, a steeper slope relaxes the stringency of targets for larger vehicles relative to those for smaller vehicles, thereby shifting relative compliance burdens among manufacturers based on their respective product mix.

6. Once the agencies determined the appropriate slope for the sloped part, how did the agencies determine the rest of the mathematical function?

The agencies continue to believe that 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 thus leads to a function with an inherent absolute minimum level of performance, while remaining consistent with safety considerations.

Just as for slope, in determining the appropriate footprint and fuel economy values for the ''cutpoints,'' the places along the curve where the sloped portion becomes flat, the agencies took a fresh look for purposes of this proposal, taking into account the updated market forecast and new assumptions about the availability of technologies. The next two sections discuss the agencies' approach to cutpoints for the passenger car and light truck curves separately, as the policy considerations for each vary somewhat.

a. Cutpoints for PC curve

The passenger car fleet upon which the agencies have based the target curves for MYs 2017–2025 is derived from MY 2008 data, as discussed above. In MY 2008, passenger car footprints ranged from 36.7 square feet, the Lotus Exige 5, to 69.3 square feet, the Daimler Maybach 62. In that fleet, 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 are again proposing to cut off the sloped portion of the passenger car function at 41 square feet, consistent with the MYs 2012–2016 rulemaking. The agencies recognize that for manufacturers who make small vehicles in this size range, putting the cutpoint at 41 square feet 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. Putting the cutpoint here 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 to less than 41 square feet in response to this proposal, if present, will be at best minimal. On the other hand, the agencies note that some manufacturers are introducing mini cars not reflected in the agencies MY 2008-based market forecast, such as the Fiat 500, to the U.S. market, and that the footprint at which the curve is limited may affect the incentive for manufacturers to do so.

Above 56 square feet, the only passenger car models 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. As in the MYs 2012–2016 rulemaking, NHTSA and EPA therefore are proposing again to cut off the sloped portion of the passenger car function at 56 square feet.

While meeting with manufacturers prior to issuing the proposal, the agencies received comments from some manufacturers that, combined with slope and overall stringency, using 41 square feet as the footprint at which to cap the target for small cars would result in unduly challenging targets for small cars. The agencies do not agree. No specific vehicle need meet its target (because standards apply to fleet average performance), and maintaining a sloped function toward the smaller end of the passenger car market is important to discourage unsafe downsizing, the agencies are thus proposing to again ''cut off'' the passenger car curve at 41 square feet, notwithstanding these comments.

The agencies seek comment on setting cutpoints for the MYs 2017–2025 passenger car curves at 41 square feet and 56 square feet.

b. Cutpoints for LT curve

The light truck fleet upon which the agencies have based the target curves for MYs 2017–2025, like the passenger car fleet, is derived from MY 2008 data, as discussed in Section 2.4 above. In MY 2008, light truck footprints ranged from 41.0 square feet, the Jeep Wrangler, to 77.5 square feet, the Toyota Tundra. For consistency with the curve for passenger cars, the agencies are proposing to cut off the sloped portion of the light truck function at the same footprint, 41 square feet, although we recognize that no light trucks are currently offered below 41 square feet. With regard to the upper cutpoint, the agencies heard from a number of manufacturers during the discussions leading up to this proposal that the location of the cutpoint in the MYs 2012–2016 rules, 66 square feet, meant that the same standard applied to all light trucks with footprints of 66 square feet or greater, and that in fact the targets for the largest light trucks in the later years of that rulemaking were extremely challenging. Those manufacturers requested that the agencies extend the cutpoint to a larger footprint, to reduce targets for the largest light trucks which represent a significant percentage of those manufacturers light truck sales. At the same time, in re-examining the light truck fleet data, the agencies concluded that aggregating pickup truck models in the MYs 2012–2016 rule had led the agencies to underestimate the impact of the different pickup truck model configurations above 66 square feet on manufacturers' fleet average fuel economy and CO_2 levels (as discussed immediately below). In disaggregating the pickup truck model data, the impact of setting the cutpoint at 66 square feet after model year 2016 became clearer to the agencies.

In the agencies' view, there is legitimate basis for these comments. The agencies' market forecast includes about 24 vehicle configurations above 74 square feet with a total volume of about 50,000 vehicles or less during any MY in the 2017–2025 time frame. While a relatively small portion of the overall truck fleet, for some manufacturers, these vehicles are non-trivial portion of sales. As noted above, the very largest light trucks have significant load-carrying and towing capabilities that make it particularly challenging for manufacturers to add fuel economy-improving/CO_2-reducing technologies in a way that maintains the full functionality of those capabilities.

Considering manufacturer CBI and our estimates of the impact of the 66 square foot cutpoint for future model years, the agencies have initially determined to adopt curves that transition to a different cut point. While noting that no specific vehicle need meet its target (because standards apply to fleet average performance), we believe that the information provided to us by manufacturers and our own analysis supports the gradual extension of the cutpoint for large light trucks in this proposal from 66 square feet in MY 2016 out to a larger footprint square feet before MY 2025.

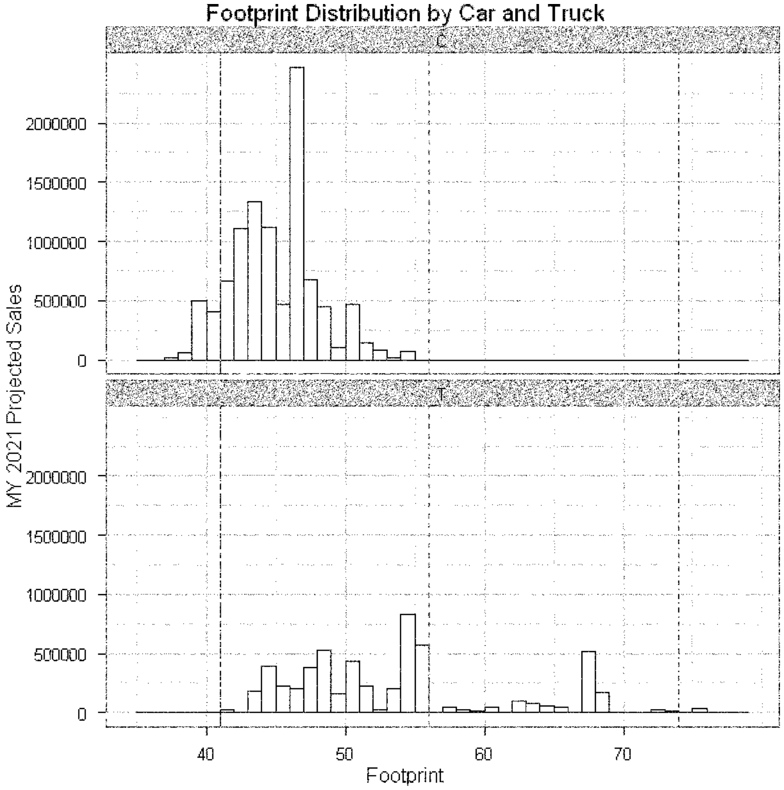

Figure II-1 Footprint Distribution by Car and Truck*

*Proposed truck cutpoints for MY 2025 shown in red, car cutpoints shown in green

The agencies are proposing to phase in the higher cutpoint for the truck curve in order to avoid any backsliding from the MY 2016 standard. A target that is feasible in one model year should never become less feasible in a subsequent model year—manufacturers should have no reason to remove fuel economy-improving/CO_2-reducing technology from a vehicle once it has been applied. Put another way, the agencies are proposing to not allow ''curve crossing'' from one model year to the next. In proposing MYs 2011–2015 CAFE standards and promulgating MY 2011 standards, NHTSA proposed and requested comment on avoiding curve crossing, as an ''anti-backsliding measure.'' [133] The MY 2016 2 cycle test curves are therefore a floor for the MYs 2017–2025 curves. For passenger cars, which have minimal change in slope from the MY 2012–2016 rulemakings and no change in cut points, there are no curve crossing issues in the proposed standards.

The minimum stringency determination was done using the two cycle curves. Stringency adjustments for air conditioning and other credits were calculated after curves that did not cross were determined in two cycle space. The year over year increase in these adjustments cause neither the GHG nor CAFE curves (with A/C) to contact the 2016 curves when charted.

7. Once the agencies determined the complete mathematical function shape, how did the agencies adjust the curves to develop the proposed standards and regulatory alternatives?

The curves discussed above all reflect the addition of technology to individual vehicle models to reduce technology differences between vehicle models before fitting curves. This application of technology was conducted not to directly determine the proposed standards, but rather for purposes of technology adjustments, and set aside considerations regarding potential rates of application (*i.e.,* phase-in caps), and considerations regarding economic implications of applying specific technologies to specific vehicle models. The following sections describe further adjustments to the curves discussed above, that affect both the shape of the curve, and the location of the curve, that helped the agencies determine curves that defined the proposed standards.

a. Adjusting for Year over Year Stringency

As in the MYs 2012–2016 rules, the agencies developed curves defining regulatory alternatives for consideration by ''shifting'' these curves. For the MYs 2012–2016 rules, the agencies did so on an absolute basis, offsetting the fitted curve by the same value (in gpm or g/mi) at all footprints. In developing this proposal, the agencies have reconsidered the use of this approach, and have concluded that after MY 2016, curves should be offset on a relative basis—that is, by adjusting the entire gpm-based curve (and, equivalently, the CO_2 curve) by the same percentage rather than the same absolute value. The agencies' estimates of the effectiveness of these technologies are all expressed in relative terms—that is, each technology (with the exception of A/C) is estimated to reduce fuel consumption (the inverse of fuel economy) and CO_2 emissions by a specific percentage of

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[133] 74 Fed. Reg. at 14370 (Mar. 30, 2009).

fuel consumption without the technology. It is, therefore, more consistent with the agencies' estimates of technology effectiveness to develop the proposed standards and regulatory alternatives by applying a proportional offset to curves expressing fuel consumption or emissions as a function of footprint. In addition, extended indefinitely (and without other compensating adjustments), an absolute offset would eventually (*i.e.,* at very high average stringencies) produce negative (gpm or g/mi) targets. Relative offsets avoid this potential outcome. Relative offsets do cause curves to become, on a fuel consumption and CO_2 basis, flatter at greater average stringencies; however, as discussed above, this outcome remains consistent with the agencies' estimates of technology effectiveness. In other words, given a relative decrease in average required fuel consumption or CO_2 emissions, a curve that is flatter by the same relative amount should be equally challenging in terms of the potential to achieve compliance through the addition of fuel-saving technology.

On this basis, and considering that the ''flattening'' occurs gradually for the regulatory alternatives the agencies have evaluated, the agencies tentatively conclude that this approach to offsetting the curves to develop year-by-year regulatory alternatives neither re-creates a situation in which manufacturers are likely to respond to standards in ways that compromise highway safety, nor undoes the attribute-based standard's more equitable balancing of compliance burdens among disparate manufacturers. The agencies invite comment on these conclusions, and on any other means that might avoid the potential outcomes—in particular, negative fuel consumption and CO_2 targets—discussed above.

b. Adjusting for anticipated improvements to mobile air conditioning systems

The fuel economy values in the agencies' market forecast are based on the 2-cycle (*i.e.,* city and highway) fuel economy test and calculation procedures that do not reflect potential improvements in air conditioning system efficiency, refrigerant leakage, or refrigerant Global Warming Potential (GWP). Recognizing that there are significant and cost effective potential air conditioning system improvements available in the rulemaking timeframe (discussed in detail in Chapter 5 of the draft joint TSD), the agencies are increasing the stringency of the target curves based on the agencies' assessment of the capability of manufacturers to implement these changes. For the proposed CAFE standards and alternatives, an offset is included based on air conditioning system efficiency improvements, as these improvements are the only improvements that effect vehicle fuel economy. For the proposed GHG standards and alternatives, a stringency increase is included based on air conditioning system efficiency, leakage and refrigerant improvements. As discussed above in Chapter 5 of the join TSD, the air conditioning system improvements affect a vehicle's fuel efficiency or CO_2 emissions performance as an additive stringency increase, as compared to other fuel efficiency improving technologies which are multiplicative. Therefore, in adjusting target curves for improvements in the air conditioning system performance, the agencies are adjusting the target curves by additive stringency increases (or vertical shifts) in the curves.

For the GHG target curves, the offset for air conditioning system performance is being handled in the same manner as for the MY 2012–2016 rules. For the CAFE target curves, NHTSA for the first time is proposing to account for potential improvements in air conditioning system performance. Using this methodology, the agencies first use a multiplicative stringency adjustment for the sloped portion of the curves to reflect the effectiveness on technologies other than air conditioning system technologies, creating a series of curve shapes that are ''fanned'' based on two-cycle performance. Then the curves are offset vertically by the air conditioning improvement by an equal amount at every point.

D. Joint Vehicle Technology Assumptions

For the past four to five years, the agencies have been working together closely to follow the development of fuel consumption and GHG reducing technologies. Two major analyses have been published jointly by EPA and NHTSA: The Technical Support Document to support the MYs 2012–2016 final rule and the 2010 Technical Analysis Report (which supported the 2010 Notice of Intent). The latter of these analyses was also done in conjunction with CARB. Both of these analyses have both been published within the past 18 months. As a result, much of the work is still relevant and we continue to rely heavily on these references. However, some technologies—and what we know about them—are changing so rapidly that the analysis supporting this proposal contains a considerable amount of new work on technologies included in this rule, some of which were included in prior rulemakings, and others that were not.

Notably, we have updated our battery costing methodology significantly since the MYs 2012–2016 final rule and even relative to the 2010 TAR. We are now using a peer reviewed model developed by Argonne National Laboratory for the Department of Energy which provides us with more rigorous estimates for battery costs and allows us to estimate future costs specific to hybrids, plug-in hybrids and electric vehicles all of which have different battery design characteristics.

We also have new cost data from more recently completed tear down and other cost studies by FEV which were not available in either the MYs 2012–2016 final rule or the 2010 TAR. These new studies analyzed a 8-speed automatic transmission replacing 6-speed automatic transmission, a 8-speed dual clutch transmission replacing 6-speed dual clutch transmission, a power-split hybrid powertrain with an I4 engine replacing a conventional engine powertrain with V6 engine, a mild hybrid with stop-start technology and an I4 engine replacing a conventional I4 engine, and the Fiat Multi-Air engine technology. We discuss the new tear down studies in Section II.D.2 of this preamble. Based on this, we have updated some of the FEV-developed costs relative to what we used in the 2012–2016 final rule, although these costs are consistent with those used in the 2010 TAR. Furthermore, we have completely re-worked our estimated costs associated with mass reduction relative to both the MYs 2012–2016 final rule and the 2010 TAR.

As would be expected given that some of our cost estimates were developed several years ago, we have also updated all of our base direct manufacturing costs to put them in terms of more recent dollars (2009 dollars for this proposal). We have also updated our methodology for calculating indirect costs associated with new technologies since both the MYs 2012–2016 final rule and the TAR. We continue to use the indirect cost multiplier (ICM) approach used in those analyses, but have made important changes to the calculation methodology—changes done in response to ongoing staff evaluation and public input.

Lastly, we have updated many of the technologies' effectiveness estimates largely based on new vehicle simulation work conducted by Ricardo Engineering. This simulation work provides the effectiveness estimates for a number of the technologies most heavily relied on in the agencies' analysis of potential standards for MYs 2017–2025.

The agencies have also reviewed the findings and recommendations in the updated NAS report ''Assessment of Fuel Economy Technologies for Light-Duty Vehicles'' that was completed after the MYs 2012–2016 final rule was issued,[134] and NHTSA has performed a sensitivity analysis (contained in its PRIA) to examine the impact of using some of the NAS cost and effectiveness estimates on the proposed standards.

Each of these changes is discussed briefly in the remainder of this section and in much greater detail in Chapter 3 of the draft joint TSD. First we provide a brief summary of the technologies we have considered in this proposal before highlighting the above-mentioned items that are new for this proposal. We request comment on all aspects of our analysis as discussed here and detailed in the draft joint TSD.

1. What technologies did the Agencies Consider?

For this proposal, the agencies project that manufacturers can add a variety of technologies to each of their vehicle models and or platforms in order to improve the vehicles' fuel economy and GHG performance. In order to analyze a variety of regulatory alternative scenarios, it is essential to have a thorough understanding of the technologies available to the manufacturers. This analysis includes an assessment of the cost, effectiveness, availability, development time, and manufacturability of various technologies within the normal redesign and refresh periods of a vehicle line (or in the design of a new vehicle). As we describe in the draft Joint TSD, when a technology can be applied can affect the cost as well as the technology penetration rates (or phase-in caps) that are projected in the analysis.

The agencies considered dozens of vehicle technologies that manufacturers could use to improve the fuel economy and reduce CO_2 emissions of their vehicles during the MYs 2017–2025 timeframe. Many of the technologies considered are available today, are well known, and could be incorporated into vehicles once product development decisions are made. These are ''near-term'' technologies and are identical or very similar to those anticipated in the agencies' analyses of compliance strategies for the MYs 2012–2016 final rule. For this rulemaking, given its time frame, other technologies are also considered that are not currently in production, but that are beyond the initial research phase, and are under development and expected to be in production in the next 5–10 years. Examples of these technologies are downsized and turbocharged engines operating at combustion pressures even higher than today's turbocharged engines, and an emerging hybrid architecture combined with an 8 speed dual clutch transmission, a combination that is not available today. These are technologies which the agencies believe can, for the most part, be applied both to cars and trucks, and which are expected to achieve significant improvements in fuel economy and reductions in CO_2 emissions at reasonable costs in the MYs 2017 to 2025 timeframe. The agencies did not consider technologies that are currently in an initial stage of research because of the uncertainty involved in the availability and feasibility of implementing these technologies with significant penetration rates for this analysis. The agencies recognize that due to the relatively long time frame between the date of this proposal and 2025, it is very possible that new and innovative technologies will make their way into the fleet, perhaps even in significant numbers, that we have not considered in this analysis. We expect to reconsider such technologies as part of the mid-term evaluation, as appropriate, and possibly could be used to generate credits under a number of the proposed flexibility and incentive programs provided in the proposed rules.

The technologies considered can be grouped into four broad categories: Engine technologies; transmission technologies; vehicle technologies (such as mass reduction, tires and aerodynamic treatments); and electrification technologies (including hybridization and changing to full electric drive).[135] The specific technologies within each broad group are discussed below. The list of technologies presented below is nearly identical to that presented in both the MYs 2012–2016 final rule and the 2010 TAR, with the following new technologies added to the list since the last final rule: The P2 hybrid, a newly emerging hybridization technology that was also considered in the 2010 TAR; continued improvements in gasoline engines, with greater efficiencies and downsizing; continued significant efficiency improvements in transmissions; and ongoing levels of improvement to some of the seemingly more basic technologies such as lower rolling resistance tires and aerodynamic treatments, which are among the most cost effective technologies available for reducing fuel consumption and GHGs. Not included in the list below are technologies specific to air conditioning system improvements and off-cycle controls, which are presented in Section II.F of this NPRM and in Chapter 5 of the draft Joint TSD.

a. Types of Engine Technologies Considered

Low-friction lubricants including low viscosity and advanced low friction lubricant oils are now available with improved performance. If manufacturers choose to make use of these lubricants, they may need to make engine changes and conduct durability testing to accommodate the lubricants. The costs in our analysis consider these engine changes and testing requirements. This level of low friction lubricants is expected to exceed 85 percent penetration by the 2017 MY.

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 efficient engine operation. This level of engine friction reduction is expected to exceed 85 percent penetration by the 2017 MY.

Advanced Low Friction Lubricant and Second Level of Engine Friction Reduction are new for this analysis. As technologies advance between now and the rulemaking timeframe, there will be further development in low friction lubricants and engine friction reductions. The agencies grouped the development in these two areas into a single technology and applied them for MY 2017 and beyond.

Cylinder deactivation disables 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 valves, exhaust valves, 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

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[134] ''Assessment of Fuel Economy Technologies for Light-Duty Vehicles,'' National Research Council of the National Academies, June 2010.

[135] NHTSA's analysis considers these technologies in five groups rather than four—hybridization is one category, and ''electrification/accessories'' is another.

reduces pumping losses. This is accomplished by controlled switching between two or more cam profile lobe heights.

Continuous variable valve lift is an electromechanical or electrohydraulic 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 as well as combustion quality within the cylinder, which allows for higher compression ratios and increased thermodynamic efficiency.

Turbo charging and downsizing increases the available airflow and specific power level, allowing a reduced engine size while maintaining performance. Engines of this type use gasoline direct injection (GDI) and dual cam phasing. This reduces pumping losses at lighter loads in comparison to a larger engine. We continue to include an 18 bar brake mean effective pressure (BMEP) technology (as in the MYs 2012–2016 final rule) and are also including both 24 bar BMEP and 27 bar BMEP technologies. The 24 bar BMEP technology would use a single-stage, variable geometry turbocharger which would provide a higher intake boost pressure available across a broader range of engine operation than conventional 18 bar BMEP engines. The 27 bar BMEP technology requires additional boost and thus would use a two-stage turbocharger necessitating use of cooled exhaust gas recirculation (EGR) as described below. The 18 bar BMEP technology is applied with 33 percent engine downsizing, 24 bar BMEP is applied with 50 percent engine downsizing, and 27 bar BMEP is applied with 56 percent engine downsizing.

Cooled exhaust-gas recirculation (EGR) reduces the incidence of knocking combustion with additional charge dilution and obviates the need for fuel enrichment at high engine power. This allows for higher boost pressure and/or compression ratio and further reduction in engine displacement and both pumping and friction losses while maintaining performance. Engines of this type use GDI and both dual cam phasing and discrete variable valve lift. The EGR systems considered in this assessment would use a dual-loop system with both high and low pressure EGR loops and dual EGR coolers. For this proposal, cooled EGR is considered to be a technology that can be added to a 24 bar BMEP engine and is an enabling technology for 27 bar BMEP engines.

Diesel engines have several characteristics that give superior fuel efficiency, including reduced pumping losses due to lack of (or greatly reduced) throttling, high pressure direct injection of fuel, a combustion cycle that operates at a higher compression ratio, and a very lean air/fuel mixture relative to an equivalent-performance gasoline engine. This technology requires additional enablers, such as a NO_x adsorption catalyst system or a urea/ammonia selective catalytic reduction system for control of NO_x emissions during lean (excess air) operation.

b. Types of Transmission Technologies Considered

Improved automatic transmission controls optimize the shift schedule to maximize fuel efficiency under wide ranging conditions and minimizes losses associated with torque converter slip through lock-up or modulation. The first level of controls is expected to exceed 85 percent penetration by the 2017 MY.

Shift optimization is a strategy whereby the engine and/or transmission controller(s) emulates a CVT by continuously evaluating all possible gear options that would provide the necessary tractive power and select the best gear ratio that lets the engine run in the most efficient operating zone.

Six-, seven-, and eight-speed automatic transmissions are optimized by changing the gear ratio span to enable the engine to operate in a more efficient operating range over a broader range of vehicle operating conditions. While a six speed transmission application was most prevalent for the MYs 2012–2016 final rule, eight speed transmissions are expected to be readily available and applied in the MYs 2017 through 2025 timeframe.

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 (DCT) 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. The 2012–2016 final rule limited DCT applications to a maximum of 6-speeds. For this proposal we have considered both 6-speed and 8-speed DCT transmissions.

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. The CVT is maintained for existing baseline vehicles and not considered for future vehicles in this proposal due to the availability of more cost effective transmission technologies.

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

High Efficiency Gearbox (automatic, DCT or manual)—continuous improvement in seals, bearings and clutches, super finishing of gearbox parts, and development in the area of lubrication, all aimed at reducing frictional and other parasitic load in the system for an automatic or DCT type transmission.

c. Types of Vehicle Technologies Considered

Lower-rolling-resistance tires have characteristics that reduce frictional losses associated with the energy dissipated mainly in the deformation of the tires under load, thereby improving fuel economy and reducing CO_2 emissions. New for this proposal (and also marking an advance over low rolling resistance tires considered during the heavy duty greenhouse gas rulemaking, see 76 FR at 57207, 57229) is a second level of lower rolling resistance tires that reduce frictional losses even further. The first level of low rolling resistance tires will have 10 percent rolling resistance reduction while the 2nd level would have 20 percent rolling resistance reduction compared to 2008 baseline vehicle. The first level of lower rolling resistance tires is expected to exceed 85 percent penetration by the 2017 MY.

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 can be achieved via two approaches, either reducing the drag coefficients or reducing vehicle frontal area. To reduce the drag coefficient, skirts, air dams, underbody covers, and more aerodynamic side view mirrors can be applied. In addition to the standard aerodynamic treatments, the agencies have included a second level of aerodynamic technologies which could include active grill shutters, rear visors, and larger under body panels. The first level of aero dynamic drag improvement is estimated to reduce aerodynamic drag by 10 percent relative to the baseline 2008 vehicle while the second level would reduce aero dynamic drag by 20 percent relative to 2008 baseline vehicles. The second level of aerodynamic technologies was not considered in the MYs 2012–2016 final rule.

Mass Reduction can be achieved in many ways, such as material substitution, design optimization, part consolidation, improving manufacturing process, etc. The agencies applied mass reduction of up to 20 percent relative to MY 2008 levels in this NPRM compared to only 10 percent in 2012–2016 final rule. The agencies also determined effectiveness values for hybrid, plug-in and electric vehicles based on net mass reduction, or the delta between the applied mass reduction (capped at 20 percent) and the added mass of electrification components. In assessing compliance strategies and in structuring the standards, the agencies only considered amounts of vehicle mass reduction that would result in what we estimated to be no adverse effect on overall fleet safety. The agencies have an extensive discussion of mass reduction technologies as well as the cost of mass reduction in chapter 3 of the draft joint TSD.

d. Types of Electrification/Accessory and Hybrid Technologies Considered

Electric power steering (EPS)/Electro-hydraulic power steering (EHPS) 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. Manufacturers have informed the agencies that full EPS systems are being developed for all light-duty vehicles, including large trucks. However, the agencies have applied the EHPS technology to large trucks and the EPS technology to all other light-duty vehicles.

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. New for this proposal is a second level of IACC (IACC2) which consists of the IACC technologies and the addition of a mild regeneration strategy and a higher efficiency alternator. The first level of IACC improvements is expected to be at more than 85 percent penetration by the 2017MY.

12-volt Stop-Start, sometimes referred to as idle-stop or 12-volt micro hybrid is the most basic hybrid system that facilitates idle-stop capability. These systems typically incorporate an enhanced performance battery and other features such as electric transmission and cooling pumps to maintain vehicle systems during idle-stop.

Higher Voltage Stop-Start/Belt Integrated Starter Generator (BISG) sometimes referred to as a mild hybrid, 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). This mild hybrid technology is not included by either agency as an enabling technology in the analysis supporting this proposal, although some automakers have expressed interest in possibly using the technology during the rulemaking time frame. EPA and NHTSA are providing incentives to encourage this and similar hybrid technologies on pick-up trucks in particular, as described in Section II.F, and the agencies are in the process of including this technology for the final rule analysis as we expand our understanding of the associated costs and limitations.

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). The IMA technology is not included by either agency as an enabling technology in the analysis supporting this proposal, although it is included as a baseline technology because it exists in our 2008 baseline fleet.

P2 Hybrid is a newly emerging hybrid technology that uses a transmission integrated electric motor placed between the engine and a gearbox or CVT, much like the IMA system described above except with a wet or dry separation clutch which is used to decouple the motor/transmission from the engine. In addition, a P2 hybrid would typically be equipped with a larger electric machine. Disengaging the clutch allows all-electric operation and more efficient brake-energy recovery. Engaging the clutch allows efficient coupling of the engine and electric motor and, when combined with a DCT transmission, reduces gear-train losses relative to power-split or 2-mode hybrid systems.

2–Mode Hybrid 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. The 2-mode hybrid technology is not included by either agency as an enabling technology in the analysis supporting this proposal, although it is included as a baseline technology because it exists in our 2008 baseline fleet.

Power-split Hybrid is 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. The power-split hybrid technology is not included by either agency as an enabling technology in the analysis supporting this proposal, (the agencies evaluate the P2 hybrid technology discussed above where power-split hybrids might otherwise have been appropriate) although it is included as a baseline technology because it exists in our 2008 baseline fleet.

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 hybrid electric vehicles. They also use a control system that allows the battery pack to be substantially depleted under electric-only or blended mechanical/electric operation and batteries that can be cycled in charge sustaining operation at a lower state of charge than is typical of other hybrid electric vehicles. These vehicles are sometimes referred to as Range Extended Electric Vehicles (REEV). In this MYs 2017–2025 analysis, PHEVs with several all-electric ranges—both a 20 mile and a 40 mile all-electric range—have been included as potential technologies.

Electric vehicles (EV) are equipped with all-electric drive and with systems powered by energy-optimized batteries charged primarily from grid electricity. EVs with several ranges—75 mile, 100 mile and 150 mile range—have been included as potential technologies.

e. Technologies Considered but Deemed ''Not Ready'' in the MYs 2017–2025 Timeframe

Fuel cell electric vehicles (FCEVs) utilize a full electric drive platform but consume electricity generated by an on-board fuel cell and hydrogen fuel. Fuel cells are electro-chemical devices that directly convert reactants (hydrogen and oxygen via air) into electricity, with the potential of achieving more than twice the efficiency of conventional internal combustion engines. High pressure gaseous hydrogen storage tanks are used by most automakers for FCEVs that are currently under development. The high pressure tanks are similar to those used for compressed gas storage in more than 10 million CNG vehicles worldwide, except that they are designed to operate at a higher pressure (350 bar or 700 bar vs. 250 bar for CNG). While we expect there will be some limited introduction of FCEVs into the market place in the time frame of this rule, we expect this introduction to be relatively small, and thus FCEVs are not considered in the modeling analysis conducted for this proposal.

There are a number of other technologies that the agencies have not considered in their analysis, but may be considered for the final rule. These include HCCI, ''multi-air'', and camless valve actuation, and other advanced engines currently under development.

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

As noted in the introduction to this section, most of the direct cost estimates for technologies carried over from the MYs 2012–2016 final rule and subsequently used in this proposal are fundamentally unchanged since the MYs 2012–2016 final rule analysis and/or the 2010 TAR. We say ''fundamentally'' unchanged since the basis of the direct manufacturing cost estimates have not changed; however, the costs have been updated to more recent dollars, the learning effects have resulted in further cost reductions for some technologies, the indirect costs are calculated using a modified methodology and the impact of long-term ICMs is now present during the rulemaking timeframe. Besides these changes, there are also some other notable changes to the costs used in previous analyses. We highlight these changes in Section II.D.2.a, below. We highlight the changes to the indirect cost methodology and adjustments to more recent dollars in Sections II.D.2.b and c. Lastly, we present some updated terminology used for our approach to estimating learning effects in an effort to eliminate confusion with our past terminology. This is discussed in Section II.D.2.d, below.

The agencies note that the technology costs included in this proposal take into account only those associated with the initial build of the vehicle. Although comments were received to the MYs 2012–2016 rulemaking 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 believe that it is equally possible that maintenance costs could decrease for some vehicles, especially when considering full electric vehicles (which lack routine engine maintenance) or the replacement of automatic transmissions with simpler dual-clutch transmissions. The agencies request comment on the possible maintenance cost impacts associated with this proposal, reminding potential commenters that increased warranty costs are already considered as part of the ICMs.

a. Direct Manufacturing Costs (DMC)

For direct manufacturing costs (DMC) related to turbocharging, downsizing, gasoline direct injection, transmissions, as well as non-battery-related costs on hybrid, plug-in hybrid and electric vehicles, the agencies have relied on costs derived from teardown studies. For battery related DMC for HEVs, PHEVs and EVs, the agencies have relied on the BatPaC model developed by Argonne National Laboratory for the Department of Energy. For mass reduction DMC, the agencies have relied on several studies as described in detail in the draft Joint TSD. We discuss each of these briefly here and in more detail in the draft joint TSD. For the majority of the other technologies considered in this proposal and described above, the agencies have relied on the 2012–2016 final rule and sources described there for estimates of DMC.

i. Costs from Tear-down Studies

As a general matter, the agencies believe that the best method to derive technology cost estimates is to conduct studies involving tear-down and analysis of actual vehicle components. A ''tear-down'' involves breaking down a technology into its fundamental parts and manufacturing processes by completely disassembling actual vehicles and vehicle subsystems and precisely determining what is required for its production. The result of the tear-down is a ''bill of materials'' for each and every part of the relevant vehicle systems. This tear-down method of costing technologies is often used by manufacturers to benchmark their products against competitive products. Historically, vehicle and vehicle component tear-down has not been done on a large scale by researchers and regulators due to the expense required for such studies. While tear-down studies are highly accurate at costing technologies for the year in which the study is intended, their accuracy, like that of all cost projections, may diminish over time as costs are extrapolated further into the future because of uncertainties in predicting commodities (and raw material) prices, labor rates, and manufacturing practices. The projected costs may be higher or lower than predicted.

Over the past several years, EPA has contracted with FEV, Inc. and its subcontractor Munro & Associates, to conduct tear-down cost studies for a number of key technologies evaluated by the agencies in assessing the feasibility of future GHG and CAFE standards. The analysis methodology included procedures to scale the tear-down results to smaller and larger vehicles, and also to different technology configurations. FEV's methodology was documented in a report published as part of the MY 2012–2016 rulemaking, detailing the costing of the first tear-down conducted in this work (#1 in the below list).[136] This report was peer reviewed by experts in the industry and revised by FEV in response to the peer review

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[136] U.S. EPA, ''Light-Duty Technology Cost Analysis Pilot Study,'' Contract No. EP–C–07–069, Work Assignment 1–3, December 2009, EPA–420–R–09–020, Docket EPA–HQ–OAR–2009–0472–11282.

comments.[137] Subsequent tear-down studies (#2–5 in the below list) were documented in follow-up FEV reports made available in the public docket for the MY 2012–2016 rulemaking.[138]

Since then, FEV's work under this contract work assignment has continued. Additional cost studies have been completed and are available for public review.[139] The most extensive study, performed after the MY 2012–2016 Final Rule, involved whole-vehicle tear-downs of a 2010 Ford Fusion powersplit hybrid and a conventional 2010 Ford Fusion. (The latter served as a baseline vehicle for comparison.) In addition to providing powersplit HEV costs, the results for individual components in these vehicles were subsequently used by FEV/Munro to cost another hybrid technology, the P2 hybrid, which employs similar hardware. This approach to costing P2 hybrids was undertaken because P2 HEVs were not yet in volume production at the time of hardware procurement for tear-down. Finally, an automotive lithium-polymer battery was torn down and costed to provide supplemental battery costing information to that associated with the NiMH battery in the Fusion. This HEV cost work, including the extension of results to P2 HEVs, has been extensively documented in a new report prepared by FEV.[140] Because of the complexity and comprehensive scope of this HEV analysis, EPA commissioned a separate peer review focused exclusively on it. Reviewer comments generally supported FEV's methodology and results, while including a number of suggestions for improvement many of which were subsequently incorporated into FEV's analysis and final report. The peer review comments and responses are available in the rulemaking docket.[141] [142]

Over the course of this work assignment, teardown-based studies have been performed thus far on the technologies listed below. These completed studies provide a thorough evaluation of the new technologies' costs relative to their baseline (or replaced) technologies.

1. Stoichiometric gasoline direct injection (SGDI) and turbocharging with engine downsizing (T–DS) on a DOHC (dual overhead cam) I4 engine, replacing a conventional DOHC I4 engine.
2. SGDI and T–DS on a SOHC (single overhead cam) on a V6 engine, replacing a conventional 3-valve/cylinder SOHC V8 engine.
3. SGDI and T–DS on a DOHC I4 engine, replacing a DOHC V6 engine.
4. 6-speed automatic transmission (AT), replacing a 5-speed AT.
5. 6-speed wet dual clutch transmission (DCT) replacing a 6-speed AT.
6. 8-speed AT replacing a 6-speed AT.
7. 8-speed DCT replacing a 6-speed DCT.
8. Power-split hybrid (Ford Fusion with I4 engine) compared to a conventional vehicle (Ford Fusion with V6). The results from this tear-down were extended to address P2 hybrids. In addition, costs from individual components in this tear-down study were used by the agencies in developing cost estimates for PHEVs and EVs.
9. Mild hybrid with stop-start technology (Saturn Vue with I4 engine), replacing a conventional I4 engine. (Although results from this cost study are included in the rulemaking docket, they were not used by the agencies in this rulemaking's technical analyses.)
10. Fiat Multi-Air engine technology. (Although results from this cost study are included in the rulemaking docket, they were not used by the agencies in this rulemaking's technical analyses.)

Items 6 through 10 in the list above are new since the 2012–2016 final rule.

In addition, FEV and EPA extrapolated the engine downsizing costs for the following scenarios that were based on the above study cases:

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 have relied on the findings of FEV for estimating the cost of the technologies covered by the tear-down studies.

ii. Costs of HEV, EV & PHEV

The agencies have also reevaluated the costs for HEVs, PHEVs, and EVs since both the 2012–2016 final rule and the 2010 TAR. First, electrified vehicle technologies are developing rapidly and the agencies sought to capture results from the most recent analysis. Second, the 2012–2016 rule employed a single $/kWhr estimate and did not consider the specific vehicle and technology application for the battery when we estimated the cost of the battery. Specifically, batteries used in HEVs (high power density applications) versus EVs (high energy density applications) need to be considered appropriately to reflect the design differences, the chemical material usage differences and differences in $/kWhr as the power to energy ratio of the battery changes for different applications.

To address these issues for this proposal, the agencies have done two things. First, EPA has developed a spreadsheet tool that was used to size the motor and battery based on the different road load of various vehicle classes. Second, the agencies have used a battery cost model developed by Argonne National Laboratory (ANL) for the Vehicle Technologies Program of the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy.[143] The model developed by ANL allows users to estimate unique battery pack costs using user customized input sets for different hybridization applications, such as strong hybrid, PHEV and EV. The DOE has established long term industry goals and targets for advanced battery systems as it does for many energy efficient technologies. ANL was funded by DOE to provide an independent assessment of Li-ion battery costs because of ANL's expertise in the field as one of the primary DOE National Laboratories responsible for basic and applied battery energy storage technologies for future HEV, PHEV and EV applications. Since publication of the 2010 TAR, ANL's battery cost model has been peer-reviewed and ANL has updated the model and documentation to incorporate suggestions from peer-reviewers, such as including a battery management system, a battery disconnect unit, a thermal management system, etc.[144] In this proposal, NHTSA and EPA have used the recently revised version of this updated model.

The agencies are using the ANL model as the basis for estimating large-

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[137] FEV pilot study response to peer review document November 6, 2009, is at EPA–HQ–OAR–2009–0472–11285.

[138] U.S. EPA, ''Light-duty Technology Cost Analysis—Report on Additional Case Studies,'' EPA–HQ–OAR–2009–0472–11604.

[139] FEV, Inc., ''Light-Duty Technology Cost Analysis, Report on Additional Transmission, Mild Hybrid, and Valvetrain Technology Case Studies'', November 2011.

[140] FEV, Inc., ''Light-Duty Technology Cost Analysis, Power-Split and P2 HEV Case Studies'', EPA–420–R–11–015, November 2011.

[141] ICF, ''Peer Review of FEV Inc. Report Light Duty Technology Cost Analysis, Power-Split and P2 Hybrid Electric Vehicle Case Studies'', EPA–420–R–11–016, November 2011.

[142] FEV and EPA, ''FEV Inc. Report 'Light Duty Technology Cost Analysis, Power-Split and P2 Hybrid Electric Vehicle Case Studies', Peer Review Report—Response to Comments Document'', EPA–420–R–11–017, November 2011.

[143] ANL BatPac model Docket number EPA–HQ–OAR–2010–0799.

[144] Nelson, P.A., Santinit, D.J., Barnes, J. ''Factors Determining the Manufacturing Costs of Lithium-Ion Batteries for PHEVs,'' 24th World Battery, Hybrid and Fuel Cell Electric Vehicle Symposium and Exposition EVS–24, Stavenger, Norway, May 13–16, 2009 (*www.evs24.org*).

format lithium-ion batteries for this assessment for the following reasons. The model was developed by scientists at ANL who have significant experience in this area. The model uses a bill of materials methodology for developing cost estimates. The ANL model appropriately considers the vehicle application's power and energy requirements, which are two of the fundamental parameters when designing a lithium-ion battery for an HEV, PHEV, or EV. The ANL model can estimate production costs based on user defined inputs for a range of production volumes. The ANL model's cost estimates, while generally lower than the estimates we received from the OEMs, are consistent with some of the supplier cost estimates that EPA received from large-format lithium-ion battery pack manufacturers. This includes data which was received from on-site visits done by the EPA in the 2008–2011 time frame. Finally, the ANL model has been described and presented in the public domain and does not rely upon confidential business information (which could not be reviewed by the public).

The potential for future reductions in battery cost and improvements in battery performance relative to current batteries will play a major role in determining the overall cost and performance of future PHEVs and EVs. The U.S. Department of Energy manages major battery-related R&D programs and partnerships, and has done so for many years, including the ANL model utilized in this report. DOE has reviewed the battery cost projections underlying this proposal and supports the use of the ANL model for the purposes of this rulemaking.

We have also estimated cost associated with in-home chargers and installation of in-home chargers expected to be necessary for PHEVs and EVs. Charger costs are covered in more detail in chapter 3 of the draft Joint TSD.

iii. Mass Reduction Costs

The agencies have revised the costs for mass reduction from the MYs 2012–2016 rule and the 2010 Technical Assessment Report. For this proposal, the agencies are relying on a wide assortment of sources from the literature as well as data provided from a number of OEMs. Based on this review, the agencies have estimated a new cost curve such that the costs increase as the levels of mass reduction increase. For the final rule the agencies will consider any new studies that become available, including two studies that the agencies are sponsoring and expect will be completed in time to inform the final rule. These studies are discussed in TSD chapter 3.

b. Indirect Costs (IC)

i. Markup Factors to Estimate Indirect Costs

For this analysis, indirect costs are estimated by applying indirect cost multipliers (ICM) to direct cost estimates. ICMs were derived by EPA as a basis for estimating the impact on indirect costs of individual vehicle technology changes that would result from regulatory actions. Separate ICMs were derived for low, medium, and high complexity technologies, thus enabling estimates of indirect costs that reflect the variation in research, overhead, and other indirect costs that can occur among different technologies. ICMs were also applied in the MYs 2012–2016 rulemaking.

Prior to developing the ICM methodology,[145] EPA and NHTSA both applied a retail price equivalent (RPE) factor to estimate indirect costs. RPEs are estimated by dividing the total revenue of a manufacturer by the direct manufacturing costs. As such, it includes all forms of indirect costs for a manufacturer and assumes that the ratio applies equally for all technologies. ICMs are based on RPE estimates that are then modified to reflect only those elements of indirect costs that would be expected to change in response to a regulatory-induced technology change. For example, warranty costs would be reflected in both RPE and ICM estimates, while marketing costs might only be reflected in an RPE estimate but not an ICM estimate for a particular technology, if the new regulatory-induced technology change is not one expected to be marketed to consumers. Because ICMs calculated by EPA are for individual technologies, many of which are small in scale, they often reflect a subset of RPE costs; as a result, for low complexity technologies, the RPE is typically higher than the ICM. This is not always the case, as ICM estimates for particularly complex technologies, specifically hybrid technologies (for near term ICMs), and plug-in hybrid battery and full electric vehicle technologies (for near term and long term ICMs), reflect higher than average indirect costs, with the resulting ICMs for those technologies equaling or exceeding the averaged RPE for the industry.

There is some level of uncertainty surrounding both the ICM and RPE markup factors. The ICM estimates used in this proposed action group all technologies into four broad categories and treat them as if individual technologies within each of the categories (''low'', ''medium'', ''high1'' and ''high2'' complexity) will have the same ratio of indirect costs to direct costs. This simplification means it is likely that the direct cost for some technologies within a category will be higher and some lower than the estimate for the category in general. More importantly, the ICM estimates have not been validated through a direct accounting of actual indirect costs for individual technologies. Rather, the ICM estimates were developed using adjustment factors developed in two separate occasions: the first, a consensus process, was reported in the RTI report; the second, a modified Delphi method, was conducted separately and reported in an EPA memo.[146] Both these panels were composed of EPA staff members with previous background in the automobile industry; the memberships of the two panels overlapped but were not identical.[147] The panels evaluated each element of the industry's RPE estimates and estimated the degree to which those elements would be expected to change in proportion to changes in direct manufacturing costs. The method and estimates in the RTI report were peer reviewed by three industry experts and subsequently by reviewers for the International Journal of Production Economics. RPEs themselves are inherently difficult to estimate because the accounting statements of manufacturers do not neatly categorize all cost elements as either direct or indirect costs. Hence, each researcher developing an RPE estimate must apply a certain amount of judgment to the allocation of the costs. Since empirical estimates of ICMs are ultimately derived from the same data used to measure RPEs, this affects both measures. However, the value of RPE has not been measured for specific technologies, or for groups of specific technologies. Thus applying a single

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[145] The ICM methodology was developed by RTI International, under contract to EPA. The results of the RTI report were published in Alex Rogozhin, Michael Gallaher, Gloria Helfand, and Walter McManus, ''Using Indirect Cost Multipliers to Estimate the Total Cost of Adding New Technology in the Automobile Industry.'' International Journal of Production Economics 124 (2010): 360–368.

[146] Helfand, Gloria, and Sherwood, Todd. ''Documentation of the Development of Indirect Cost Multipliers for Three Automotive Technologies.'' Memorandum, Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, August 2009.

[147] NHTSA staff participated in the development of the process for the second, modified Delphi panel, and reviewed the results as they were developed, but did not serve on the panel.

average RPE to any given technology by definition overstates costs for very simple technologies, or understates them for advanced technologies.

In every recent GHG and fuel economy rulemaking proposal, we have requested comment on our ICM factors and whether it is most appropriate to use ICMs or RPEs. We have generally received little to no comment on the issue specifically, other than basic comments that the ICM values are too low. In addition, in the June 2010 NAS report, NAS noted that the under the initial ICMs, no technology would be assumed to have indirect costs as high as the average RPE. NRC found that ''RPE factors certainly do vary depending on the complexity of the task of integrating a component into a vehicle system, the extent of the required changes to other components, the novelty of the technology, and other factors. However, until empirical data derived by means of rigorous estimation methods are available, the committee prefers to use average markup factors.'' [148] The committee also stated that ''The EPA (Rogozhin et al., 2009), however, has taken the first steps in attempting to analyze this problem in a way that could lead to a practical method of estimating technology-specific markup factors'' where ''this problem'' spoke to the issue of estimating technology-specific markup factors and indirect cost multipliers.[149]

The agencies note that, since the committee completed their work, EPA has published its work in the Journal of Production Economics [150] and has also published a memorandum furthering the development of ICMs,[151] neither of which the committee had at their disposal. Further, having published two final rulemakings—the 2012–2016 light-duty rule (see 75 FR 25324) and the more recent heavy-duty GHG rule (see 76 FR 57106)—as well as the 2010 TAR where ICMs served as the basis for all or most of the indirect costs, EPA believes that ICMs are indeed fully developed for regulatory purposes. As thinking has matured, we have adjusted our ICM factors such that they are slightly higher and, importantly, we have changed the way in which the factors are applied.

The first change—increased ICM factors—has been done as a result of further thought among EPA and NHTSA that the ICM factors presented in the original RTI report for low and medium complexity technologies should no longer be used and that we should rely solely on the modified-Delphi values for these complexity levels. For that reason, we have eliminated the averaging of original RTI values with modified-Delphi values and instead are relying solely on the modified-Delphi values for low and medium complexity technologies. The second change—the way the factors are applied—results in the warranty portion of the indirect costs being applied as a multiplicative factor (thereby decreasing going forward as direct manufacturing costs decrease due to learning), and the remainder of the indirect costs being applied as an additive factor (thereby remaining constant year-over-year and not being reduced due to learning). This second change has a comparatively large impact on the resultant technology costs and, we believe, more appropriately estimates costs over time. In addition to these changes, a secondary-level change was also made as part of this ICM recalculation to ICMs. That change was to revise upward the RPE level reported in the original RTI report from an original value of 1.46 to 1.5, to reflect the long term average RPE. The original RTI study was based on 2008 data. However, an analysis of historical RPE data indicates that, although there is year to year variation, the average RPE has remained roughly constant at 1.5. ICMs will be applied to future years' data and, therefore, NHTSA and EPA staffs believe that it would be appropriate to base ICMs on the historical average rather than a single year's result. Therefore, ICMs have been adjusted to reflect this average level. These changes to the ICMs and the methodology are described in greater detail in Chapter 3 of the draft Joint TSD.

ii. Stranded Capital

Because the production of automotive components is capital-intensive, it is possible for substantial capital investments in manufacturing equipment and facilities to become ''stranded'' (where their value is lost, or diminished). This would occur when the capital is rendered useless (or less useful) by some factor that forces a major change in vehicle design, plant operations, or manufacturer's product mix, such as a shift in consumer demand for certain vehicle types. It can also be caused by new standards that phase-in at a rate too rapid to accommodate planned replacement or redisposition of existing capital to other activities. The lost value of capital equipment is then amortized in some way over production of the new technology components.

It is difficult to quantify accurately any capital stranding associated with new technology phase-ins under the proposed standards because of the iterative dynamic involved—that is, the new technology phase-in rate strongly affects the potential for additional cost due to stranded capital, but that additional cost in turn affects the degree and rate of phase-in for other individual competing technologies. In addition, such an analysis is very company-, factory-, and manufacturing process-specific, particularly in regard to finding alternative uses for equipment and facilities. Nevertheless, in order to account for the possibility of stranded capital costs, the agencies asked FEV to perform a separate bounding analysis of potential stranded capital costs associated with rapid phase-in of technologies due to new standards, using data from FEV's primary teardown-based cost analyses.[152]

The assumptions made in FEV's stranded capital analysis with potential for major impacts on results are:

- All manufacturing equipment was bought brand new when the old technology started production (no carryover of equipment used to make the previous components that the old technology itself replaced).
- 10-year normal production runs: Manufacturing equipment used to make old technology components is straight-line depreciated over a 10-year life.
- Factory managers do not optimize capital equipment phase-outs (that is, they are assumed to routinely repair and replace equipment without regard to whether or not it will soon be scrapped due to adoption of new vehicle technology).
- Estimated stranded capital is amortized over 5 years of annual production at 450,000 units (of the new technology components). This annual production is identical to that assumed in FEV's primary teardown-based cost analyses. The 5-year recovery period is chosen to help ensure a conservative analysis; the actual recovery would of course vary greatly with market conditions.

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[148] NRC, Finding 3–2 at page 3–23.

[149] NRC at page 3–19.

[150] Alex Rogozhin, Michael Gallaher, Gloria Helfand, and Walter McManus, ''Using Indirect Cost Multipliers to Estimate the Total Cost of Adding New Technology in the Automobile Industry.'' International Journal of Production Economics 124 (2010): 360–368.

[151] Helfand, Gloria, and Sherwood, Todd. ''Documentation of the Development of Indirect Cost Multipliers for Three Automotive Technologies.'' Memorandum, Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, August 2009.

[152] FEV, Inc., ''Potential Stranded Capital Analysis on EPA Light-Duty Technology Cost Analysis'', Contract No. EP–C–07–069 Work Assignment 3–3. November 2011.

The stranded capital analysis was performed for three transmission technology scenarios, two engine technology scenarios, and one hybrid technology scenario. The methodology used by EPA in applying the results to the technology costs is described in Chapter 3.8.7 and Chapter 5.1 of EPA's draft RIA. The methodology used by NHTSA in applying the results to the technology costs is described in NHTSA's preliminary RIA section V.

c. Cost Adjustment to 2009 Dollars

This simple change is to update any costs presented in earlier analyses to 2009 dollars using the GDP price deflator as reported by the Bureau of Economic Analysis on January 27, 2011. The factors used to update costs from 2007 and 2008 dollars to 2009 dollars are shown below. For the final rule, we are considering moving to 2010 dollars but, for this analysis, given the timing of conducting modeling runs and developing inputs to those runs, the factors for converting to 2010 dollars were not yet available.

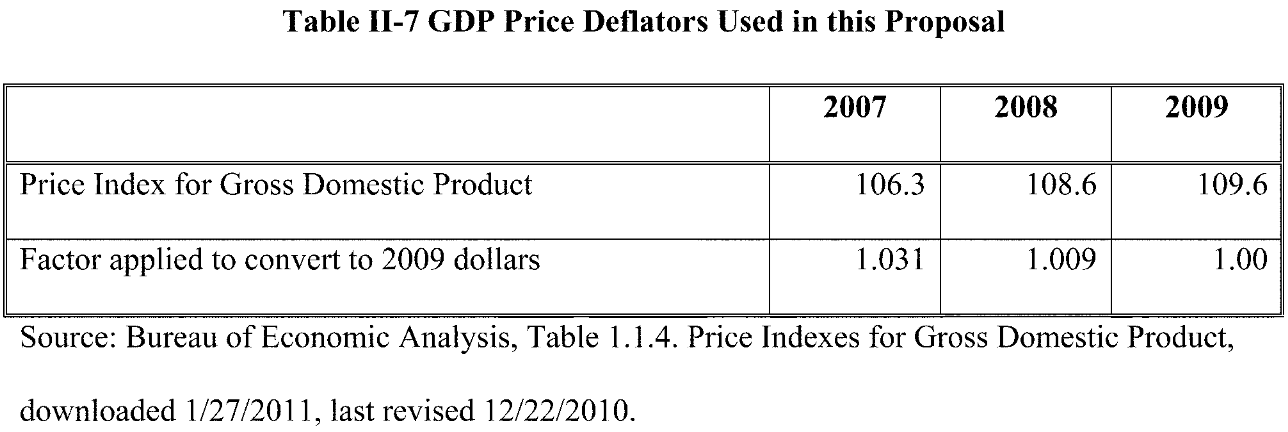

Table II-7 GDP Price Deflators Used in this Proposal

	2007	2008	2009
Price Index for Gross Domestic Product	106.3	108.6	109.6
Factor applied to convert to 2009 dollars	1.031	1.009	1.00

Source: Bureau of Economic Analysis, Table 1.1.4. Price Indexes for Gross Domestic Product, downloaded 1/27/2011, last revised 12/22/2010.

d. Cost Effects Due to Learning

For many of the technologies considered in this rulemaking, the agencies expect that the industry should be able to realize reductions in their costs over time as a result of ''learning effects,'' that is, the fact that as manufacturers gain experience in production, they are able to reduce the cost of production in a variety of ways. The agencies continue to apply learning effects in the same way as we did in both the MYs 2012–2016 final rule and in the 2010 TAR. However, we have employed some new terminology in an effort to eliminate some confusion that existed with our old terminology. This new terminology was described in the recent heavy-duty GHG final rule (see 76 FR 57320). Our old terminology suggested we were accounting for two completely different learning effects—one based on volume production and the other based on time. This was not the case since, in fact, we were actually relying on just one learning phenomenon, that being the learning-by-doing phenomenon that results from cumulative production volumes.

As a result, the agencies have also considered the impacts of manufacturer learning on the technology cost estimates by reflecting the phenomenon of volume-based learning curve cost reductions in our modeling using two algorithms depending on where in the learning cycle (*i.e.,* on what portion of the learning curve) we consider a technology to be—''steep'' portion of the curve for newer technologies and ''flat'' portion of the curve for more mature technologies. The observed phenomenon in the economic literature which supports manufacturer learning cost reductions are based on reductions in costs as production volumes increase with the highest absolute cost reduction occurring with the first doubling of production. The agencies use the terminology ''steep'' and ''flat'' portion of the curve to distinguish among newer technologies and more mature technologies, respectively, and how learning cost reductions are applied in cost analyses.

Learning impacts have been considered on most but not all of the technologies expected to be used because some of the expected technologies are already used rather widely in the industry and, presumably, quantifiable learning impacts have already occurred. The agencies have applied the steep learning algorithm for only a handful of technologies considered to be new or emerging technologies such as PHEV and EV batteries which are experiencing heavy development and, presumably, rapid cost declines in coming years. For most technologies, the agencies have considered them to be more established and, hence, the agencies have applied the lower flat learning algorithm. For more discussion of the learning approach and the technologies to which each type of learning has been applied the reader is directed to Chapter 3 of the draft Joint TSD. Note that, since the agencies had to project how learning will occur with new technologies over a long period of time, we request comments on the assumptions of learning costs and methodology. In particular, we are interested in input on the assumptions for advanced 27-bar BMEP cooled exhaust gas recirculation (EGR) engines, which are currently still in the experimental stage and not expected to be available in volume production until 2017. For our analysis, we have based estimates of the costs of this engine on current (or soon to be current) production technologies (*e.g.,* gasoline direct injection fuel systems, engine downsizing, cooled EGR, 18-bar BMEP capable turbochargers), and assumed that, since learning (and the associated cost reductions) begins in 2012 for them that it also does for the similar technologies used in 27-bar BMEP engines. We seek comment on the appropriateness of this assumption.[153]

3. How did the agencies determine the effectiveness of each of these technologies?

In 2007 EPA conducted a detailed vehicle simulation project to quantify the effectiveness of a multitude of technologies for the MYs 2012–2016

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[153] EPA notes that our modeling projections for the proposed CO_2 standards show a technology penetration rate of 2% in the 2021MY and 5% in the 2025MY for 27-bar BMEP engines and, thus, our cost estimates are not heavily reliant on this technology.

rule (as well as the 2010 NOI). This technical work was conducted by the global engineering consulting firm, Ricardo, Inc. and was peer reviewed and then published in 2008. For this current rule, EPA has conducted another peer reviewed study with Ricardo to broaden the scope of the original project in order to expand the range of vehicle classes and technologies considered, consistent with a longer-term outlook through model years MYs 2017–2025. The extent of the project was vast, including hundreds of thousands of vehicle simulation runs. The results were, in turn, employed to calibrate and update EPA's lumped parameter model, which is used to quantify the synergies and dis-synergies associated with combining technologies together for the purposes of generating inputs for the agencies respective OMEGA and CAFE modeling.

Additionally, there were a number of technologies that Ricardo did not model explicitly. For these, the agencies relied on a variety of sources in the literature. A few of the values are identical to those presented in the MYs 2012–2016 final rule, while others were updated based on the newer version of the lumped parameter model. More details on the Ricardo simulation, lumped parameter model, as well as the effectiveness for supplemental technologies are described in Chapter 3 of the draft Joint TSD.

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 virtually unlimited spectrum of possible values that could result from adding the technology to different vehicles. For example, while the agencies have estimated an effectiveness of 0.6 to 0.8 percent, depending on the vehicle subclass 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 proposal, 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.

E. Joint Economic and Other Assumptions

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

In reviewing these variables and the agencies' estimates of their values for purposes of this NPRM, NHTSA and EPA reconsidered comments that the agencies previously received on both the Interim Joint TAR and during the MYs 2012–2016 light duty vehicle rulemaking and also reviewed newly available literature. As a consequence, for today's proposal, the agencies are proposing to update some economic assumptions and parameter estimates, while retaining a majority of values consistent with the Interim Joint TAR and the MYs 2012–2016 final rule. To review the parameters and assumptions the agencies used in the 2012–2016 final rule, please refer to 75 FR 25378 and Chapter 4 of the Joint Technical Support Document that accompanied the final rule.[154] The proposed values summarized below are discussed in greater detail in Chapter 4 of the joint TSD that accompanies this proposal and elsewhere in the preamble and respective RIAs. The agencies seek comment on all of the assumptions discussed below.

- *Costs of fuel economy-improving technologies*—These inputs are discussed in summary form above and in more detail in the agencies' respective sections of this preamble, in Chapter 3 of the draft joint TSD, and in the agencies' respective RIAs. The technology direct manufacturing cost estimates used in this analysis are intended to represent manufacturers' direct costs for high-volume production of vehicles with these technologies in the year for which we state the cost is considered ''valid.'' Technology direct manufacturing cost estimates are fundamentally unchanged from those employed by the agencies in the 2012–2016 final rule, the heavy-duty truck rule (to the extent relevant), and TAR for most technologies, although revised costs are used for batteries, mass reduction, transmissions, and a few other technologies. Indirect costs are accounted for by applying near-term indirect cost multipliers ranging from 1.24 to 1.77 to the estimates of vehicle manufacturers' direct costs for producing or acquiring each technology, depending on the complexity of the technology and the time frame over which costs are estimated. These values are reduced to 1.19 to 1.50 over the long run as some aspects of indirect costs decline. Indirect cost markup factors have been revised from previous rulemakings and the Interim Joint TAR to reflect the agencies current thinking regarding a number of issues. These changes are discussed in detail in Section II.D.2 of this preamble and in Chapter 3 of the draft joint TSD. Details of the agencies' technology cost assumptions and how they were derived can be found in Chapter 3 of the draft joint TSD.
- *Potential opportunity costs of improved fuel economy*—This issue 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 project that these vehicle attributes will not change as a result of this rule. Section II.C above and Chapter 2 of the draft joint TSD describes how the agency carefully selected an attribute-based standard to minimize manufacturers' incentive to reduce vehicle capabilities. While manufacturers may choose to do this for other reasons, the agencies continue to believe that the rule itself will not result in such changes. Additionally, EPA and NHTSA have sought to include the cost of maintaining these attributes as part of the cost estimates for technologies that are included in the cost analysis for the proposal. For example, downsized engines are assumed to be turbocharged, so that they provide the same performance and utility even though they are smaller.[155] Nonetheless, it is

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[154] See *http://www.epa.gov/otaq/climate/regulations/420r10901.pdf.*

[155] The agencies do not believe that adding fuel-saving technology should preclude future improvements in performance, safety, or other attributes, though it is possible that the costs of

possible that in some cases, the technology cost estimates may not include adequate allowance for the necessary efforts by manufacturers to maintain vehicle acceleration performance, payload, or utility while improving fuel economy and reducing GHG emissions. As described in Section III.D.3 and Section IV.G, there are two possible exceptions in cases where some vehicle types are converted to hybrid or full electric vehicles (EVs), but, in such cases, we believe that sufficient options would exist for consumers concerned about the possible loss of utility (*e.g.,* they would purchase the non-hybridized version of the vehicle or not buy an EV) that welfare loss should not necessarily be assumed. Although consumer vehicle demand models can measure these effects, past analyses using such models have not produced consistent estimates of buyers' willingness-to-pay for higher fuel economy, and it is difficult to decide whether one data source, model specification, or estimation procedure is clearly preferred over another. Thus, the agencies seek comment on how to estimate explicitly the changes in vehicle buyers' choices and welfare from the combination of higher prices for new vehicle models, increases in their fuel economy, and any accompanying changes in vehicle attributes such as performance, passenger- and cargo-carrying capacity, or other dimensions of utility.

- *The on-road fuel economy "gap"*—Actual fuel economy levels achieved by light-duty vehicles in on-road driving fall somewhat short of their levels measured under the laboratory test conditions used by EPA to establish compliance with the proposed CAFE and GHG standards. The modeling approach in this proposal follows the 2012–2016 final rule and the Interim Joint TAR. In calculating benefits of the program, the agencies estimate that actual on-road fuel economy attained by light-duty vehicles that operate on liquid fuels will be 20 percent lower than published fuel economy ratings for vehicles that operate on liquid fuels. 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).[156] Based on manufacturer confidential business information, as well as data derived from the 2006 EPA fuel economy label rule, the agencies use a 30 percent gap for consumption of wall electricity for electric vehicles and plug-in hybrid electric vehicles.[157]
- *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, and fuel savings account for the majority of the proposed rule's estimated benefits. For this proposed rule, the agencies are using the most recent fuel price projections from the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2011 reference case forecast. The forecasts of fuel prices reported in EIA's AEO 2011 extend through 2035. Fuel prices beyond the time frame of AEO's forecast were estimated using an average growth rate for the years 2017–2035 to each year after 2035. This is the same methodology used by the agencies in the 2012–2016 rulemaking, in the heavy duty truck and engine rule (76 FR 57106), and in the Interim Joint TAR. For example, these forecasts of gasoline fuel prices in 2009$ include $3.25 per gallon in 2017, $3.39 in 2021 and $3.71 in 2035. Extrapolating as described above, retail gasoline prices reach $4.16 per gallon in 2050 (measured in constant 2009 dollars). As discussed in Chapter 4 of the draft Joint TSD, while the agencies believe that EIA's AEO reference case generally represents a reasonable forecast of future fuel prices for purposes of use in our analysis of the benefits of this rule, we recognize that there is a great deal of uncertainty in any such forecast that could affect our estimates. The agencies request comment on how best to account for uncertainty in future fuel prices.
- *Consumer valuation of fuel economy and payback period*—In estimating the value of fuel economy improvements to potential vehicle buyers that would result from alternative CAFE and GHG standards, the agencies assume that buyers value the resulting fuel savings over only part of the expected lifetimes 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. The five-year figure represents the current average term of consumer loans to finance the purchase of new vehicles.
- *Vehicle sales assumptions*—The first step in estimating lifetime fuel consumption by vehicles produced during a model year is to calculate the number that are expected to be produced and sold. The agencies relied on the AEO 2011 Reference Case for forecasts of total vehicle sales, while the baseline market forecast developed by the agencies (discussed in Section II.B and in Chapter 1 of the TSD) divided total projected sales into sales of cars and light trucks.
- *Vehicle lifetimes and survival rates*—As in the 2012–2016 final rule and Interim Joint TAR, we apply updated values of age-specific survival rates for cars and light trucks to adjusted forecasts of passenger car and light truck sales to determine the number of these vehicles expected to remain in use during each year of their lifetimes. These values remain unchanged from prior analyses.
- *Vehicle miles traveled*—We 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 Travel Survey (NHTS),[158] adjusted to account for the effects on vehicle use of subsequent increases in fuel prices. In order to insure that the resulting mileage schedules imply reasonable estimates of future growth in *total* car and light truck use, we calculated the rate of future growth in annual mileage at each age that would be necessary for total car and light truck travel to increase at the rates forecast in the AEO 2011 Reference Case. The growth rate in average annual car and light truck use produced by this calculation is approximately 1 percent per year through 2030 and 0.5 percent thereafter. We applied these growth rates applied to the mileage figures derived from the 2001 NHTS to estimate annual mileage by vehicle age during each year of the expected lifetimes of MY 2017–2025 vehicles. A similar approach to estimating future vehicle use was used in the 2012–2016 final rule and Interim Joint TAR, but the

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these additions may be affected by the presence of fuel-saving technology.

[156] 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.

[157] See 71 FR at 77887, and 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 for general background on the analysis. See also EPA's Response to Comments (EPA–420–R–11–005) to the 2011 labeling rule, page 189, first paragraph, specifically the discussion of the derived five cycle equation and the non-linear adjustment with increasing MPG.

[158] For a description of the Survey, see *http://www.bts.gov/programs/national_household_travel_survey/* (last accessed Sept. 9, 2011).

future growth rates in average vehicle use have been revised for this proposal.

- *Accounting for the rebound effect of higher fuel economy*—The rebound effect refers to the increase in vehicle use that results if an increase in fuel efficiency lowers the cost of driving. For purposes of this NPRM, the agencies elected to continue to use a 10 percent rebound effect in their analyses of fuel savings and other benefits from higher standards, consistent with the 2012–2016 light-duty vehicle rulemaking and the Interim Joint TAR. That is, we assume a 10 percent decrease in fuel cost per mile resulting from our proposed standards would result in a 1 percent increase in the annual number of miles driven at each age over a vehicle's lifetime. In Chapter 4 of the joint TSD, we provide a detailed explanation of the basis for our rebound estimate, including a summary of new literature published since the 2012–2016 rulemaking that lends further support to the 10 percent rebound estimate. We also refer the reader to Chapters X and XII of NHTSA's PRIA and Chapter 4 of the EPA DRIA that accompanies this preamble for sensitivity and uncertainty analyses of alternative rebound assumptions.
- *Benefits from increased vehicle use*—The increase in vehicle use from the rebound effect provides additional benefits to drivers, 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. The analysis estimates the economic benefits from increased rebound-effect driving as the sum of the fuel costs they incur in that additional travel plus the consumer surplus drivers receive from the improved accessibility their travel provides. As in the 2012–2016 final rule we estimate the economic value of this consumer surplus 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.
- *Added costs from congestion, accidents, and noise*—Although it provides benefits to drivers as described above, increased vehicle use associated with the rebound effect also contributes to increased traffic congestion, motor vehicle accidents, and highway noise. Depending on how the additional travel is distributed over the day and where it takes place, additional vehicle use can contribute to traffic congestion and delays by increasing traffic volumes on facilities that are already heavily traveled. These added delays impose higher costs on drivers and other vehicle occupants in the form of increased travel time and operating expenses. At the same time, this travel also increases 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 these increased external costs caused by added driving.[159] This method is consistent with the 2012–2016 final rule.
- *Petroleum consumption and import externalities*—U.S. consumption of imported 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 increased U.S. demand for imported oil on the world oil price (''monopsony costs''); (2) the expected costs associated with 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 the U.S. economy against the effects of oil supply disruptions.[160] Although the reduction in the global price of petroleum and refined products due to decreased demand for fuel in the U.S. resulting from this rule represents a benefit to the U.S. economy, it simultaneously represents an economic loss to other countries that produce and sell oil or petroleum products to the U.S. Recognizing the redistributive nature of this ''monopsony effect'' when viewed from a global perspective (which is consistent with the agencies' use of a global estimate for the social cost of carbon to value reductions in CO_2 emissions, the energy security benefits estimated to result from this program exclude the value of this monopsony effect. In contrast, the macroeconomic disruption and adjustment costs that arise from sudden reductions in the supply of imported oil to the U.S. do not have offsetting impacts outside of the U.S., so the estimated reduction in their expected value stemming from reduced U.S. petroleum imports is included in the energy security benefits estimated for this program. U.S. military costs are excluded from the analysis because their attribution to particular missions or activities is difficult. Also, historical variation in U.S. military costs have not been associated with changes in U.S. petroleum imports, although we recognize that more broadly, there may be significant (if unquantifiable) benefits in improving national security by reducing oil imports. Similarly, since the size or other factors affecting the cost of maintaining the SPR historically have not varied in response to changes in U.S. oil import levels, changes in the costs of the SPR are excluded from the estimates of the energy security benefits of the program. To summarize, the agencies have included only the macroeconomic disruption and adjustment costs portion of the energy security benefits to estimate the monetary value of the total energy security benefits of this program. Based on a recent update of an earlier peer-reviewed Oak Ridge National Laboratory study that was used in support of the both the 2012–2016 light duty vehicle and the 2014–2018 medium- and heavy-duty vehicle rulemaking, we estimate that each gallon of fuel saved will reduce the expected macroeconomic disruption and adjustment costs of sudden reductions in the supply of imported oil to the U.S. economy by $0.185 (2009$) in 2025. 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.[161] The energy security analysis conducted for this proposal also estimates that the world price of oil will fall modestly in response to lower U.S. demand for refined fuel.[162] [163] The energy security

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[159] 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 Sept. 9, 2011).

[160] 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.

[161] 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 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.

[162] Leiby, Paul. Oak Ridge National Laboratory. ''Approach to Estimating the Oil Import Security

methodology used in this proposal is the same as that used by the agencies in both the 2012–2016 light duty vehicle and 2014–2018 medium- and heavy-duty vehicle rulemakings. In those rulemakings, the agencies addressed comments about the magnitude of their energy security estimates and methodological issues such as whether to include the monopsony benefits in energy security calculations.

- *Air pollutant emissions*—
  - *Impacts on criteria air pollutant emissions*—Criteria air pollutants emitted by vehicles and during fuel production and distribution 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). Although 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, and additional electricity production will increase emissions. 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. The agencies' analysis assumes that the per-mile emission rates for cars and light trucks produced during the model years affected by the proposed rule will remain constant at the levels resulting from EPA's Tier 2 light duty vehicle emissions standards. The agencies' approach to estimating criteria air pollutant emissions is consistent with the method used in the 2012–2016 final rule (where the agencies received no significant adverse comments), although the agencies employ a more recent version of the EPA's MOVES (Motor Vehicle Emissions Simulator) model.
  - *Economic value of reductions in criteria pollutant emissions*—For the purpose of the joint technical analysis, EPA and NHTSA estimate the economic value of the human health benefits associated with reducing population 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 other pollutants that contribute to atmospheric levels of $PM_{2.5}$ (such as NO_X, SO_X, and VOCs), from a specified source. These unit values remain unchanged from the 2012–2016 final rule, and the agencies received no significant adverse comment on the analysis. Note that the agencies' analysis includes no estimates of the direct health or other benefits associated with reductions in emissions of criteria pollutants other than $PM_{2.5}$.
  - *Impacts on greenhouse gas (GHG) emissions*—NHTSA estimates reductions in emissions of carbon dioxide (CO_2) from passenger car and light truck use by multiplying the estimated reduction in consumption of fuel (gasoline and diesel) by the quantity or mass of CO_2 emissions released per gallon of fuel consumed. EPA directly calculates reductions in total CO_2 emissions from the projected reductions in CO_2 emissions by each vehicle subject to the proposed rule.[164] Both agencies also calculate the impact on CO_2 emissions that occur during fuel production and distribution resulting from lower fuel consumption, as well as the emission impacts due to changes in electricity production. Although CO_2 emissions account for nearly 95 percent of total GHG emissions that result from fuel combustion during vehicle use, emissions of other GHGs are potentially significant as well because of their higher ''potency'' as GHGs than that of CO_2 itself. EPA and NHTSA therefore also estimate the change in upstream and downstream emissions of non-CO_2 GHGs that occur during the aforementioned processes due to their respective standards.[165] The agencies approach to estimating GHG emissions is consistent with the method used in the 2012–2016 final rule and the Interim Joint TAR.
  - *Economic value of reductions in CO_2 emissions*—EPA and NHTSA assigned a dollar value to reductions in CO_2 emissions using recent estimates of the ''social cost of carbon'' (SCC) developed by a federal interagency group that included the two agencies. As that group's report observed, ''The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change.''[166] 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.[167] The SCC estimates used in this analysis were developed through an interagency process that included EPA, DOT/NHTSA, and other executive branch entities, and concluded in February 2010. We first used these SCC estimates in the benefits analysis for the 2012–2016 light-duty vehicle rulemaking. We have continued to use these estimates in other rulemaking analyses, including the Greenhouse Gas Emission Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (76 FR 57106, p. 57332) . The SCC Technical Support Document (SCC TSD) provides a complete discussion of the methods used to develop these SCC estimates.
- *The value of changes in 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 provides additional benefits to their owners. The primary benefits from the reduction in the number of required refueling cycles are the value of time saved to drivers and other adult vehicle occupants, as well as the savings to owners in terms of the cost of the fuel that would have otherwise been consumed in transit during those (now no longer required) refueling trips. Using recent data on vehicle owners' refueling patterns gathered from a survey conducted by the National Automotive Sampling System (NASS), NHTSA was able to better estimate parameters associated with refueling trips. NASS data provided NHTSA with

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Premium for the MY 2017–2025 Light Duty Vehicle Proposal'' 2011.

[163] Note that this change in world oil price is not reflected in the AEO projections described earlier in this section.

[164] The weighted average CO_2 content of certification gasoline is estimated to be 8,887 grams per gallon, while that of diesel fuel is estimated to be approximately 10,200 grams per gallon.

[165] There is, however, an exception. NHTSA does not and cannot claim benefit from reductions in downstream emissions of HFCs because they do not relate to fuel economy, while EPA does because all GHGs are relevant for purposes of EPA's Clean Air Act standards.

[166] SCC TSD, see page 2. Docket ID EPA–HQ–OAR–2009–0472–114577, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, Interagency Working Group on Social Cost of Carbon,* with participation by Council of Economic Advisers, Council on Environmental Quality, Department of Agriculture, Department of Commerce, Department of Energy, Department of Transportation, Environmental Protection Agency, National Economic Council, Office of Energy and Climate Change, Office of Management and Budget, Office of Science and Technology Policy, and Department of Treasury (February 2010). Also available at *http://epa.gov/otaq/climate/regulations.htm*

[167] SCC TSD, see pages 6–7.

the ability to estimate the average time required for a refueling trip, the average time and distance drivers typically travel out of their way to reach fueling stations, the average number of adult vehicle occupants, the average quantity of fuel purchased, and the distribution of reasons given by drivers for refueling. From these estimates, NHTSA constructed an updated set of economic assumptions to update those used in the 2012–2016 FRM in calculating refueling-related benefits. The 2012–2016 FRM discusses NHTSA's intent to utilize the NASS data on refueling trip characteristics in future rulemakings. While the NASS data improve the precision of the inputs used in the analysis of the benefits resulting from fewer refueling cycles, the framework of the analysis remains essentially the same as in the 2012–2016 final rule. Note that this topic and associated benefits were not covered in the Interim Joint TAR. Detailed discussion and examples of the agencies' approach are provided in Chapter VIII of NHTSA's PRIA and Chapter 8 of EPA's DRIA.

- *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.[168] The discount rate expresses the percent decline in the value of these future fuel-savings and other 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, consistent with the 2012–2016 final rule and OMB Circular A–4 guidance.

For the reader's reference, Table II–8 and Table II–9 below summarize the values used to calculate the impacts of each proposed standard. The values presented in this table are summaries of the inputs used for the models; specific values used in the agencies' respective analyses may be aggregated, expanded, or have other relevant adjustments. See Joint TSD 4 and each agency's respective RIA for details. The agencies seek comment on the economic assumptions presented in the table.

In addition, the agencies analyzed the sensitivity of their estimates of the benefits and costs associated with this proposed rule to variation in the values of many of these economic assumptions and other inputs. The values used in these sensitivity analyses and their results are presented their agencies' respective RIAs. A wide range of estimates is available for many of the primary inputs that are used in the agencies' CAFE and GHG emissions models. The agencies recognize that each of these values has some degree of uncertainty, which the agencies further discuss in the draft Joint TSD. The agencies have tested the sensitivity of their estimates of costs and benefits to a range of assumptions about each of these inputs, and present these sensitivity analyses in their respective RIAs. For example, NHTSA conducted separate sensitivity analyses for, among other things, discount rates, fuel prices, the social cost of carbon, the rebound effect, consumers' valuation of fuel economy benefits, battery costs, mass reduction costs, the value of a statistical life, and the indirect cost markup factor. This list is similar in scope to the list that was examined in the MY 2012–2016 final rule, but includes battery costs and mass reduction costs, while dropping military security and monopsony costs. NHTSA's sensitivity analyses are contained in Chapter X of NHTSA's PRIA. EPA conducted sensitivity analyses on the rebound effect, battery costs, mass reduction costs, the indirect cost markup factor and on the cost learning curves used in this analysis. These analyses are found in Chapters 3 and 4 of the EPA DRIA. In addition, NHTSA performs a probabilistic uncertainty analysis examining simultaneous variation in the major model inputs including technology costs, technology benefits, fuel prices, the rebound effect, and military security costs. This information is provided in Chapter XII of NHTSA's PRIA. These uncertainty parameters are consistent with those used in the MY 2012–2016 final rule. The agencies will consider conducting additional sensitivity and uncertainty analyses for the final rule as appropriate.

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[168] Because all costs associated with improving vehicles' fuel economy and reducing CO_2 emissions are assumed to be incurred at the time they are produced, these costs are already expressed in their present values as of each model year affected by the proposed rule, and require discounting only for the purpose of expressing them as present values as of a common year.

Table II-8 Economic Values for Benefits Computations (2009$)

Fuel Economy Rebound Effect	10%
"Gap" between test and on-road MPG for liquid-fueled vehicles	20%
"Gap" between test and on-road wall electricity consumption for electric and plug-in hybrid electric vehicles	30%
Value of refueling time per ($ per vehicle-hour)	$21.27 Cars $21.62 Trucks
Average tank volume refilled during refueling stop	65%
Annual growth in average vehicle use	1.1% through 2030, 0.5% thereafter
Fuel Prices (2017-50 average, $/gallon)	
Retail gasoline price	$3.71
Pre-tax gasoline price	$3.35
Economic Benefits from Reducing Oil Imports ($/gallon)	
"Monopsony" Component	$ 0.00
Price Shock Component	$ 0.185 in 2025
Military Security Component	$ 0.00
Total Economic Costs ($/gallon)	$ 0.185 in 2025

Emission Damage Costs (2020, \$/short ton)	
Carbon monoxide	\$ 0
Volatile organic compounds (VOC)	\$ 1,300
Nitrogen oxides (NO_X) – vehicle use	\$ 5,500
Nitrogen oxides (NO_X) – fuel production and distribution	\$ 5,300
Particulate matter ($PM_{2.5}$) – vehicle use	\$ 300,000
Particulate matter ($PM_{2.5}$) – fuel production and distribution	\$ 250,000
Sulfur dioxide (SO_2)	\$ 32,000
Annual CO_2 Damage Cost (per metric ton)	Variable, depending on discount rate and year (see Table II-9 for 2017 estimate)
External Costs from Additional Automobile Use (\$/vehicle-mile)	
Congestion	\$ 0.056
Accidents	\$ 0.024
Noise	\$ 0.001
Total External Costs	\$ 0.080
External Costs from Additional Light Truck Use (\$/vehicle-mile)	

Congestion	$0.049
Accidents	$0.027
Noise	$0.001
Total External Costs	$0.077
Discount Rates Applied to Future Benefits	3%, 7%

Table II-9 Social Cost of CO_2 ($/metric ton), 2017 (2009$)

Discount Rate	**5%**	**3%**	**2.5%**	**3%**
Source of Estimate	Mean of Estimated Values			95th percentile estimate
2017 Estimate	$6	$26	$41	$78

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F. Air Conditioning Efficiency CO_2 Credits and Fuel Consumption Improvement Values, Off-cycle Reductions, and Full-size Pickup Trucks

For MYs 2012–2016, EPA provided an option for manufacturers to generate credits for complying with GHG standards by incorporating efficiency improving vehicle technologies that would reduce CO_2 and fuel consumption from air conditioning (A/C) operation or from other vehicle operation that is not captured by the Federal Test Procedure (FTP) and Highway Fuel Economy Test (HFET), also collectively known as the ‘‘two-cycle’’ test procedure. EPA referred to these credits as ‘‘off-cycle credits.’’

For this proposal, EPA, in coordination with NHTSA, is proposing under their EPCA authorities to allow manufacturers to generate fuel consumption improvement values for purposes of CAFE compliance based on the use of A/C efficiency and off-cycle technologies. This proposed expansion is a change from the 2012–16 final rule where EPA only provided the A/C efficiency and off-cycle credits for the GHG program. EPA is not proposing to allow these increases for compliance with the CAFE program for MYs 2012–2016, nor to allow any compliance with the CAFE program as a result of reductions in direct A/C emissions resulting from leakage of HFCs from air conditioning systems, which remains a flexibility unique to the GHG program.

The agencies believe that because of the significant amount of credits and fuel consumption improvement values offered under the A/C program (up to 5.0 g/mi for cars and 7.2 g/mi for trucks which is equivalent to a fuel consumption improvement value of 0.000563 gal/mi for cars and 0.000586 gal/mi for trucks) that manufacturers will maximize the benefits these credits and fuel consumption improvement values afford. Consistent with the 2012–2016 final rule, EPA will continue to adjust the stringency of the two-cycle tailpipe CO_2 standards in order to account for this projected widespread penetration of A/C credits (as described more fully in Section III.C), and NHTSA has also accounted for expected A/C efficiency improvements in determining the maximum feasible CAFE standards. The agencies discuss these proposed CO_2 credits/fuel consumption improvement values below and in more detail in the Joint TSD (Chapter 5). EPA discusses additional proposed GHG A/C leakage credits that are unrelated to CO_2 and fuel consumption (though they are part of EPA's CO_2 equivalent calculation) in Section III.C below.

EPA, in coordination with NHTSA, is also proposing to add for MYs 2017–2025 a new incentive for Advanced Technology for Full Sized Pickup Trucks. Under its EPCA authority for CAFE and under its CAA authority for GHGs, EPA is proposing GHG credits and fuel economy improvement values for manufacturers that hybridize a significant quantity of their full size pickup trucks, or that use other technologies that significantly reduce CO_2 emissions and fuel consumption. Further discussions of the A/C, off-cycle, and the advanced technology for pick-up truck incentive programs are provided below.

1. Proposed Air Conditioning CO_2 Credits and Fuel Consumption Improvement Values

The credits/fuel consumption improvement values for higher-efficiency air conditioning technologies are very similar to those EPA included in the 2012–2016 GHG final rule. The proposed credits/fuel consumption improvement values represent an improved understanding of the relationships between A/C technologies and CO_2 emissions and fuel consumption. Much of this understanding results from a new vehicle simulation tool that EPA has developed and the agencies are using for this proposal. EPA designed this model to simulate in an integrated way the dynamic behavior of the several key systems that affect vehicle efficiency: The engine, electrical, transmission, and vehicle systems. The simulation model is supported by data from a wide range of sources; Chapter 2 of the Draft Regulatory Impact Analysis discusses its development in more detail.

The agencies have identified several technologies that are key to the amount of fuel a vehicle consumes and thus the amount of CO_2 it emits. Most of these technologies already exist on current vehicles, but manufacturers can improve the energy efficiency of the technology designs and operation. For example, most of the additional air conditioning related load on an engine is due to the compressor which pumps the refrigerant around the system loop. The less the compressor operates, the less load the compressor places on the engine resulting in less fuel consumption and CO_2 emissions. Thus, optimizing compressor operation with cabin demand using more sophisticated sensors, controls and control strategies, is one path to improving the overall efficiency of the A/C system. Additional components or control strategies are available to manufacturers to reduce the air conditioning load on the engine which are discussed in more detail in Chapter 5 of the joint TSD. Overall, the agencies have concluded that these improved technologies could together reduce A/C-related CO_2 and fuel consumption of today's typical air conditioning systems by 42%. The agencies propose to use this level of improvement to represent the maximum efficiency credit available to a manufacturer.

Demonstrating the degree of efficiency improvement that a manufacturer's air conditioning systems achieve—thus quantifying the appropriate amount of GHG credit and CAFE fuel consumption improvement value the manufacturer is eligible for—would ideally involve a performance test. That is, a test that would directly measure CO_2 (and thus allow calculation of fuel consumption) before and after the incorporation of the improved technologies. Progress toward such a test continues. As mentioned in the introduction to this section, the primary vehicle emissions and fuel consumption test, the Federal Test Procedure (FTP) or ''two-cycle'' testing, does not require or simulate air conditioning usage through the test cycle. The SC03 test is designed to identify any effect the air conditioning system has on other emissions when it is operating under extreme conditions, but is not designed to measure the small differences in CO_2 due to different A/C technologies.

At the time of the final rule for the 2012–2016 GHG program, EPA concluded that a practical, performance-based test procedure capable of quantifying efficiency credits was not yet available. However, EPA introduced a specialized new procedure that it believed would be appropriate for the more limited purpose of demonstrating that the design improvements for which a manufacturer was earning credits produced actual efficiency improvements. EPA's test is a fairly simple test, performed while the vehicle is at idle. Beginning with the 2014 model year, the A/C Idle Test was to be used to qualify a manufacturer to be able to use the technology lookup table (''menu'') approach to quantify credits. That is, a manufacturer would need to achieve a certain CO_2 level on the Idle Test in order to access the ''menu'' and generate GHG efficiency credits.

Since that final rule was published, several manufacturers have provided data that raises questions about the ability of the Idle Test to fulfill its intended purpose. Especially for small, lower-powered vehicles, the data also shows that it is difficult to achieve reasonable test-to-test repeatability. The manufacturers have also informed EPA (in meetings subsequent to the 2012–2016 final rule) that the Idle Test does not accurately capture the improvements from many of the technologies listed in the menu. EPA has been aware of all of these issues, and proposing to modify the Idle Test such that the threshold would be a function of engine displacement, in contrast to the flat threshold from the previous rule. EPA continues to consider this Idle Test to be a reasonable measure of some A/C CO_2 emissions as there is significant real-world driving activity at idle, and the Idle Test significantly exercises a number of the A/C technologies from the menu. Sec III.C.1.b.i below and Chapter 5 (5.1.3.5) of the Joint TSD describe further the adjustments EPA is proposing to the Idle Test for manufacturers to qualify for MYs 2014–2016 A/C efficiency credits. EPA proposes that manufacturers continue to use the menu for MYs 2014–2016 to determine credits for the GHG program. This was also the approach that EPA used for efficiency credits in the MY2012–2016 GHG rule. However for MYs 2017–2025, EPA is proposing a new test procedure to demonstrate the effectiveness of A/C efficiency technologies and credits as described below. For MYs 2014–2016, EPA requests comment on substituting the Idle Test requirement with a reporting requirement from this new test procedure as described in Section III.C.1.b.i below.

In order to correct the shortcomings of the available tests, EPA has developed a four-part performance test, called the AC17. The test includes the SC03 driving cycle, the fuel economy highway cycle, in addition to a pre-conditioning cycle, and a solar soak period. EPA is proposing that manufacturers use this test to demonstrate that new or improved A/C technologies actually result in efficiency improvements. Since the appropriateness of the test is still being evaluated, EPA proposes that manufacturers continue to use the menu to determine credits and fuel consumption improvement values for the GHG and CAFE programs. This design-based approach would assign CO_2 credit to each efficiency-improving air conditioning technology that the manufacturer incorporates in a vehicle model. The sum of these values for all technologies would be the amount of CO_2 credit generated by that vehicle, up to a maximum of 5.0 g/mi for car and 7.2 g/mi for trucks. As stated above, this is equivalent to a fuel consumption value of 0.000563 gallons/mi for cars and 0.000586 gallons/mi for trucks. EPA will consult with NHTSA on the amount of fuel consumption improvement value manufacturers may factor into their CAFE calculations if there are adjustments that may be required in the future. Table II–10 presents the proposed CO_2 credit and CAFE fuel consumption improvement values for each of the efficiency-reducing air conditioning technologies considered in this rule. More detail is provided on the calculation of indirect A/C CAFE fuel consumption improvement values in chapter 5 of the TSD. EPA is proposing very specific definitions of each of the technologies in the table below which are discussed in Chapter 5 of the draft joint TSD to ensure that the air conditioner technology used by manufacturers seeking these credits corresponds with the technology used to derive the credit/fuel consumption improvement values.

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Table II-10 A/C Efficiency Credits and Fuel Consumption Improvement Values

Technology Description	**Estimated reduction in A/C CO_2 Emissions and Fuel Consumption**	**Car A/C Efficiency Credit (g/mi CO_2)**	**Truck A/C Efficiency Credit (g/mi CO_2)**	**Car A/C Efficiency Fuel Consumption Improvement (gallon / mi)**	**Truck A/C Efficiency Fuel Consumption Improvement (gallon / mi)**
Reduced reheat, with externally-controlled, variable-displacement compressor	30%	1.5	2.2	0.000169	0.000248
Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable displacement compressor	20%	1.0	1.4	0.000113	0.000158
Default to recirculated air with closed-loop control of the air supply (sensor feedback to control interior air quality) whenever the outside ambient temperature is 75 °F or higher (although deviations from this temperature are allowed based on additional analysis)	30%	1.5	2.2	0.000169	0.000248
Default to recirculated air with open-loop control of the air supply (no sensor feedback) whenever the outside ambient temperature is 75 °F or higher (although deviations from this temperature are allowed if accompanied by an engineering analysis)	20%	1.0	1.4	0.000113	0.000158

Blower motor control which limit wasted electrical energy (e.g. pulsewidth modulated power controller)	15%	0.8	1.1	0.000090	0.000124
Internal heat exchanger (or suction line heat exchanger)	20%	1.0	1.4	0.000113	0.000158
Improved evaporators and condensers (with engineering analysis on each component indicating a COP improvement greater than 10%, when compared to previous design)	20%	1.0	1.4	0.000113	0.000158
Oil Separator (internal or external to compressor)	10%	0.8	0.7	0.000090	0.000079

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As mentioned above, EPA, working with manufacturers and CARB, has made significant progress in developing a more robust test that may eventually be capable of measuring differences in A/C efficiency. While EPA believes that more testing and development will be necessary before the new test could be used directly to quantify efficiency credits and fuel consumption improvement values, EPA is proposing that the test be used to demonstrate that new or improved A/C technologies result in reductions in GHG emissions and fuel consumption. EPA is proposing the AC17 test as a reporting-only alternative to the Idle Test for MYs 2014–2016, and as a prerequisite for generating Efficiency Credits and fuel consumption improvement values for MY 2017 and later. To demonstrate that a vehicle's A/C system is delivering the efficiency benefits of the new technologies, manufacturers would run the AC17 test procedure on a vehicle that incorporates the new technologies, with the A/C system off and then on, and then compare that result to the result from a previous model year or baseline vehicle with similar vehicle characteristics, except that the comparison vehicle would not have the new technologies. If the test result with the new technology demonstrated an emission reduction that is greater than or equal to the menu-based credit potential of those technologies, the manufacturer would generate the appropriate credit based on the menu. However, if the test result did not demonstrate the full menu-based potential of the technology, partial credit could still be earned, in proportion to how far away the result was from the expected menu-based credit amount.

EPA discusses the new test in more detail in Section III.C.1.b below and in Chapter 5 (5.1.3.5) of the joint TSD. Due to the length of time to conduct the test procedure, EPA is also proposing that required testing on the new AC17 test procedure be limited to a subset of vehicles. The agencies request comment on this approach to establishing A/C efficiency credits and fuel consumption improvement values and the use of the new A/C test.

For the CAFE program, EPA is proposing to determine a fleet average fuel consumption improvement value in a manner consistent with the way a fleet average CO_2 credits will be determined. EPA would convert the metric tons of CO_2 credits for air conditioning, off-cycle, and full size pick-up to fleet-wide fuel consumption improvement values, consistent with the way EPA would convert the improvements in CO_2 performance to metric tons of credits. See discussion in section III. C. There would be separate improvement values for each type of credit, calculated separately for cars and for trucks. These improvement values would be subtracted from the manufacturer's two-cycle-based fleet fuel consumption value to yield a final new fleet fuel consumption value, which would be inverted to determine a final fleet fuel CAFE value. EPA considered, but is not proposing, an approach where the fuel consumption improvement values would be accounted for at the individual vehicle level. In this case a credit-adjusted MPG value would have to be calculated for each vehicle that accrues air conditioning, off-cycle, or pick-up truck credits, and a credit-adjusted CAFE would be calculated by sales-weighting each vehicle. EPA found that a significant issue with this approach is that the credit programs do not align with the way fuel economy and GHG emissions are currently reported to EPA or to NHTSA, *i.e.*, at the model type level. Model types are similar in basic engine and transmission characteristics, but credits are expected to vary within a model type, possibly considerably. For example, within a model type the credits could vary by body style, trim level, footprint, and the type of air conditioning systems and other GHG reduction technologies installed. Manufacturers would have to report sales volumes for each unique combination of all of these factors in order to enable EPA to perform the CAFE averaging calculations. This would require a dramatic and expensive overhaul of EPA's data systems, and the manufacturers would likely face similar impacts. The vehicle-specific approach would also likely introduce more opportunities for errors resulting from data entry and rounding, since each vehicle's base fuel economy would be modified by multiple consumption values reported to at least six decimal places. The proposed approach would instead focus on calculating the GHG credits correctly and summing them for each of the car and truck fleets, and the step of transforming to a fuel consumption improvement value is relatively straightforward. However, given that the vehicle-specific and fleet-based approaches yield the same end result, EPA requests comment on whether one approach or the other is preferable, and if so, why a specific approach is preferable.

2. Off-Cycle CO_2 Credits

For MYs 2012–2016, EPA provided an option for manufacturers to generate adjustments (credits) for employing new and innovative technologies that achieve CO_2 reductions which are not reflected on current 2-cycle test procedures. For this proposal, EPA, in coordination with NHTSA, is proposing to apply the off-cycle credits and equivalent fuel consumption improvement values to both the CAFE and GHG programs. This proposed expansion is a change from the 2012–16 final rule where only EPA provided the off-cycle credits for the GHG program. For MY 2017 and later, EPA is proposing that manufacturers may continue to use off-cycle credits for GHG compliance and begin to use fuel consumption improvement values for CAFE compliance. In addition, EPA is proposing a set of defined (*e.g.* default) values for identified off-cycle technologies that would apply unless the manufacturer demonstrates to EPA that a different value for its technology is appropriate.

Starting with MY2008, EPA started employing a ''five-cycle'' test methodology to measure fuel economy for the fuel economy label. However, for GHG and CAFE compliance, EPA continues to use the established ''two-cycle'' (city and highway test cycles, also known as the FTP and HFET) test methodology. As learned through development of the ''five-cycle'' methodology and researching this proposal, EPA and NHTSA recognize that there are technologies that provide real-world GHG emissions and fuel consumption improvements, but those improvements are not fully reflected on the ''two-cycle'' test.

During meetings with vehicle manufacturers, EPA received comments that the approval process for generating off-cycle credits was complicated and did not provide sufficient certainty on the amount of credits that might be approved. Commenters also maintained that it is impractical to measure small incremental improvements on top of a large tailpipe measurement, similar to comments received related to quantifying air conditioner improvements. These same manufacturers believed that such a process could stifle innovation and fuel efficient technologies from penetrating into the vehicle fleet.

In response to these concerns, EPA is proposing a menu with a number of technologies that the agency believes will show real-world CO_2 and fuel consumption benefits which can be reasonably quantified by the agencies at this time. This list of pre-approved technologies includes a quantified default value that would apply unless the manufacturer demonstrates to EPA that a different value for a technology is appropriate. This list is similar to the menu driven approach described in the previous section on A/C efficiency credits. The estimates of these credits were largely determined from research, analysis and simulations, rather from full vehicle testing, which would have been cost and time prohibitive. These predefined estimates are somewhat conservative to avoid the potential for windfall. If manufactures believe their specific off-cycle technology achieves larger improvement, they may apply for greater credits and fuel consumption improvement values with supporting data. For technologies not listed, EPA is proposing a case-by-case approach for approval of off-cycle credits and fuel consumption improvement values, similar to the approach in the 2012–2016 rule but with important modifications to streamline the approval process. EPA will also consult with NHTSA during the review process. See section III.C below; technologies for which EPA is proposing default off-cycle credit values and fuel consumption improvement values are shown in Table II—11 below. Fuel consumption improvement values under the CAFE program based on off-cycle technology would be equivalent to the off-cycle credit allowed by EPA under the GHG program, and these amounts would be determined using the same procedures and test methods as are proposed for use in EPA's GHG program.

EPA and NHTSA are not proposing to adjust the stringency of the standards based on the availability of off-cycle credits and fuel consumption improvement values. There are a number of reasons for this. First, the agencies have limited technical information on the cost, development time necessary, and manufacturability of many of these technologies. The analysis presented below (and in greater detail in Chapter 5 of the joint TSD) is limited to quantifying the effectiveness of the technology (for the purposes of quantifying credits and fuel consumption improvement values). It is based on a combination of data and engineering analysis for each technology. Second, for most of these technologies the agencies have no data on what the rates of penetration of these technologies would be during the rule timeframe. Thus, with the exception of active aerodynamic improvements and stop start technology, the agencies do not have adequate information available to consider the technologies on the list when determining the appropriate GHG emissions or CAFE standards. The agencies expect to continue to improve their understanding of these technologies over time. If further information is obtained during the comment period that supports consideration of these technologies in setting the standards, EPA and NHTSA will reevaluate their positions. However, given the current lack of detailed information about these technologies, the agencies do not expect that it will be able to do more for the final rule than estimate some general amount of reasonable projected cost savings from generation of off-cycle credits and fuel consumption improvement values. Therefore, effectively the off-cycle credits and fuel consumption improvement values allow manufacturers additional flexibility in selecting technologies that may be used to comply with GHG emission and CAFE standards.

Two technologies on the list—active aerodynamic improvements and stop start—are in a different position than the other technologies on the list. Both of these technologies are included in the agencies' modeling analysis of technologies projected to be available for use in achieving the reductions needed for the standards. We have information on their effectiveness, cost, and availability for purposes of considering them along with the various other technologies we consider in determining the appropriate CO_2 emissions standard. These technologies are among those listed in Chapter 3 of the joint TSD and have measureable benefit on the 2-cycle test. However, in the context of off-cycle credits and fuel consumption improvement values, stop start is any technology which enables a vehicle to automatically turn off the engine when the vehicle comes to a rest and restart the engine when the driver applies pressure to the accelerator or releases the brake. This includes HEVs and PHEVs (but not EVs). In addition, active grill shutters is just one of various technologies that can be used as part of aerodynamic design improvements (as part of the ''aero2'' technology). The modeling and other analysis developed for determining the appropriate emissions standard includes these technologies, using the effectiveness values on the 2-cycle test. This is consistent with our consideration of all of the other technologies included in these analyses. Including them on the list for off-cycle credit and fuel consumption improvement value generation, for purposes of compliance with the standards, would recognize that these technologies have a higher degree of effectiveness than reflected in their 2-cycle effectiveness. As discussed in Sections III.C and Chapter 5 of the joint TSD, the agencies have taken into account the generation of off-cycle credits and fuel consumption improvement values by these two technologies in determining the appropriateness of the proposed standards, considering the amount of credit and fuel consumption improvement value, the projected degree of penetration of these technologies, and other factors. The proposed standards are appropriate recognizing that these technologies would also generate off-cycle credits and fuel consumption improvement values. Section III.D has a more detailed discussion on the feasibility of the standards within the context of the flexibilities (such as off-cycle credits and fuel consumption improvement values) proposed in this rule.

For these technologies that provide a benefit on five-cycle testing, but show less benefit on two cycle testing, in order to quantify the emissions impacts of these technologies, EPA will simply subtract the two-cycle benefit from the five-cycle benefit for the purposes of assigning credit and fuel consumption improvement values for this pre-approved list. Other technologies, such as more efficient lighting show no benefit over any test cycle. In these cases, EPA will estimate the average amount of usage using MOVES [169] data if possible and use this to calculate a duty-cycle-weighted benefit (or credit and fuel consumption improvement value). In the 2012–2016 rule, EPA stated a technology must have ''real world GHG reductions not significantly captured on the current 2-cycle tests* * *'' For this proposal, EPA is proposing to modify this requirement to allow technologies as long as the incremental benefit in the real-world is significantly better than on the 2-cycle test. There are environmental benefits to encouraging these kinds of technologies that might not otherwise be employed, beyond the level that the 2-cycle standards already do, thus we are now allowing credits and fuel consumption improvement values to be generated where the technology achieves an incremental benefit that is significantly better than on the 2-cycle test, as is the case for the technologies on the list.

EPA and NHTSA evaluated many more technologies for off-cycle credits and fuel consumption improvement values and decided that the following technologies should be eligible for off-cycle credits and fuel consumption improvement values. These eleven technologies eligible for credits and fuel consumption improvement values are shown in Table II–11 below. EPA is proposing that a CAFE improvement value for off-cycle improvements be determined at the fleet level by converting the CO_2 credits determined under the EPA program (in metric tons of CO_2) for each fleet (car and truck) to a fleet fuel consumption improvement value. This improvement value would then be used to adjust the fleet's CAFE level upward. See the proposed regulations at 40 CFR 600.510–12. Note that while the table below presents fuel consumption values equivalent to a given CO_2 credit value, these consumption values are presented for informational purposes and are not meant to imply that these values will be used to determine the fuel economy for individual vehicles.

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[169] MOVES is EPA's MOtor Vehicle Emissions Simulator. This model contains (in its database) a wide variety of fleet and activity data as well as national ambient temperature conditions.

Table II-11 Off-cycle Technologies and Proposed Credits and Equivalent Fuel Consumption Improvement Values for Cars and Light Trucks

Technology	Cars		Light Trucks	
	g/mi	gallons/mi	g/mi	gallons/mi
High Efficiency Exterior Lighting	1.1	0.000124	1.1	0.000124
Engine Heat Recovery	0.7	0.000778	0.7	0.000778
Solar Roof Panels	3.0	0.000338	3.0	0.000338
Active Aerodynamic Improvements	0.6	0.0000675	1.0	0.000113
Engine Start-Stop	2.9	0.000326	4.5	0.000506
Electric Heater Circulation Pump	1.0	0.000123	1.5	0.000169
Active Transmission Warm-Up	1.8	0.000203	1.8	0.000203
Active Engine Warm-Up	1.8	0.000203	1.8	0.000203
Solar Control	Up to 3.0	Up to 0.000338	Up to 4.3	Up to 0.000484

Table II–11 shows the proposed list of off-cycle technologies and credits and equivalent fuel consumption improvement values for cars and trucks. The credits and fuel consumption improvement values for engine heat recovery and solar roof panels are scalable, depending on the amount of energy these systems can generate for the vehicle. The Solar/Thermal control technologies are varied and are limited to 3 and 4.3 g/mi (car and truck respectively) total.

To ensure that the off cycle technology used by manufacturers seeking these credits and fuel consumption improvement values corresponds with the technology used to derive the credit and fuel consumption improvement values, EPA is proposing very specific definitions of each of the technologies in the table of the list of technologies in Chapter 5 of the draft joint TSD. The agencies are requesting comment on all aspects of the off-cycle credit and fuel consumption improvement value program, and would welcome any data to support an adjustment to this table, whether it is to adjust the values or to add or remove technologies.

Vehicle Simulation Tool

Chapter 2 of the RIA provides a detailed description of the vehicle simulation tool that EPA has been developing. This tool is capable of simulating a wide range of conventional and advanced engines, transmissions, and vehicle technologies over various driving cycles. It evaluates technology package effectiveness while taking into account synergy (and dis-synergy) effects among vehicle components and estimates GHG emissions for various combinations of technologies. For the 2017 to 2025 GHG proposal, this simulation tool was used to assist estimating the amount of GHG credits for improved A/C systems and off-cycle technologies. EPA seeks public comments on this approach of using the tool for directly generating and fine-tuning some of the credits in order to capture the amount of GHG reductions provided by primarily off-cycle technologies.

There are a number of technologies that could bring additional GHG reductions over the 5-cycle drive test (or in the real world) compared to the combined FTP/Highway (or two) cycle test. These are called off-cycle technologies and are described in chapter 5 of the Joint TSD in detail. Among them are technologies related to reducing vehicle's electrical loads, such as High Efficiency Exterior Lights, Engine Heat Recovery, and Solar Roof Panels. In an effort to streamline the process for approving off-cycle credits, we have set a relatively conservative estimate of the credit based on our efficacy analysis. EPA seeks comment on utilizing the model in order to quantify the credits more accurately, if actual data of electrical load reduction and/or on-board electricity generation by one or more of these technologies is available through data submission from manufacturers. Similarly, there are technologies that would provide additional GHG reduction benefits in the 5-cycle test by actively reducing the vehicle's aerodynamic drag forces. These are referred to as active aerodynamic technologies, which include but are not limited to active grill shutters and active suspension lowering. Like the electrical load reduction technologies, the vehicle simulation tool can be used to more accurately estimate the additional GHG reductions (therefore the credits) provided by these active aerodynamic technologies over the 5-cycle drive test. EPA seeks comment on using the simulation tool in order to quantify these credits. In order to do this properly, manufacturers would be expected to submit two sets of coast-down coefficients (with and without the active aerodynamic technologies). Or, they could submit two sets of aerodynamic drag coefficient (with and without the active aerodynamic technologies) as a function of vehicle speed.

There are other technologies that would result in additional GHG reduction benefits that cannot be fully captured on the combined FTP/Highway cycle test. These technologies typically reduce engine loads by utilizing advanced engine controls, and they range from enabling the vehicle to turn off the engine at idle, to reducing cabin temperature and thus A/C compressor loading when the vehicle is restarted. Examples include Engine Start-Stop, Electric Heater Circulation Pump, Active Engine/Transmission Warm-Up, and Solar Control. For these types of technologies, the overall GHG reduction largely depends on the control and calibration strategies of individual manufacturers and vehicle types. Also, the current vehicle simulation tool does not have the capability to properly simulate the vehicle behaviors that depend on thermal conditions of the vehicle and its surroundings, such as Active Engine/Transmission Warm-Up and Solar Control. Therefore, the vehicle simulation may not provide full benefits of the technologies on the GHG reductions. For this reason, the agency is not proposing to use the simulation tool to generate the GHG credits for these technologies at this time, though future versions of the model may be more capable of quantifying the efficacy of these off-cycle technologies as well.

3. Advanced Technology Incentives for Full Sized Pickup Trucks

The agencies recognize that the standards under consideration for MY 2017–2025 will be most challenging to large trucks, including full size pickup trucks that are often used for commercial purposes and have generally higher payload and towing capabilities, and cargo volumes than other light-duty vehicles. In Section II.C and Chapter 2 of the joint TSD, EPA and NHTSA describe the proposal to adjust the slope of the truck curve compared to the 2012–2016 rule. In Sections III.B and IV.F, EPA and NHTSA describe the progression of the truck standards. In this section, the agencies describe a credit and fuel consumption improvement value for full size pickup trucks to incentivize advanced technologies on this class of vehicles.

The agencies' goal is to incentivize the penetration into the marketplace of "game changing" technologies for these pickups, including their hybridization. For that reason, EPA, in coordination with NHTSA, is proposing credits and corresponding equivalent fuel consumption improvement values for manufacturers that hybridize a significant quantity of their full size pickup trucks, or use other technologies that significantly reduce CO_2 emissions and fuel consumption. This proposed credit and corresponding equivalent fuel consumption improvement value would be available on a per-vehicle basis for mild and strong HEVs, as well as other technologies that significantly improve the efficiency of the full sized pickup class.[170] The credits and fuel consumption improvement values would apply for purposes of compliance with both the GHG emissions standards and the CAFE standards. This provides the incentive to begin transforming this most challenging category of vehicles toward use of the most advanced technologies.

Access to this credit and fuel consumption improvement value is conditioned on a minimum penetration of the technologies in a manufacturer's full size pickup truck fleet. To ensure its use for only full sized pickup trucks, EPA is proposing a very specific definition for a full sized pickup truck based on minimum bed size and minimum towing capability. The specifics of this proposed definition can be found in Chapter 5 of the draft joint TSD (see Section 5.3.1). This proposed definition is meant to ensure that smaller pickup trucks, which do not offer the same level of utility (*e.g.,* bed size, towing capability and/or payload capability) and thus may not face the same technical challenges to improving fuel economy and reducing CO_2 emissions as compared to full sized pickup trucks, do not qualify.[171] For this proposal, a full sized pickup truck would be defined as meeting requirements 1 and 2, below, as well as either requirement 3 or 4, below:

1. The vehicle must have an open cargo box with a minimum width between the wheelhouses of 48 inches measured as the minimum lateral distance between the limiting interferences (pass-through) of the wheelhouses. The measurement would exclude the transitional arc, local protrusions, and depressions or pockets, if present.[172] An open cargo box means a vehicle where the cargo bed does not have a permanent roof or cover. Vehicles sold with detachable covers are considered "open" for the purposes of these criteria.

2. Minimum open cargo box length of 60 inches defined by the lesser of the pickup bed length at the top of the body (defined as the longitudinal distance from the inside front of the pickup bed to the inside of the closed endgate; this would be measured at the height of the top of the open pickup bed along vehicle centerline and the pickup bed length at the floor) and the pickup bed length at the floor (defined as the longitudinal distance from the inside front of the pickup bed to the inside of the closed endgate; this would be measured at the cargo floor surface along vehicle centerline).[173]

3. Minimum Towing Capability—the vehicle must have a GCWR (gross combined weight rating) minus GVWR (gross vehicle weight rating) value of at least 5,000 pounds.[174]

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[170] Note that EPA's proposed calculation methodology in 40 CFR 600.510–12 does not use vehicle-specific fuel consumption adjustments to determine the CAFE increase due to the various incentives allowed under the proposed program. Instead, EPA would convert the total CO_2 credits due to each incentive program from metric tons of CO_2 to a fleetwide CAFE improvement value. The fuel consumption values are presented to give the reader some context and explain the relationship between CO_2 and fuel consumption improvements.

[171] As discussed in TSD Section 5.3.1, EPA is seeking comment on expanding the scope of this credit to somewhat smaller pickups, provided they have the towing and/or hauling capabilities of the larger full-size trucks.

[172] This dimension is also known as dimension W202 as defined in Society of Automotive Engineers Procedure J1100.

[173] The pickup body length at the top of the body is also known as dimension L506 in Society of Automotive Engineers Procedure J1100. The pickup body length at the floor is also known as dimension L505 in Society of Automotive Engineers Procedure J1100.

[174] Gross combined weight rating means the value specified by the vehicle manufacturer as the maximum weight of a loaded vehicle and trailer, consistent with good engineering judgment. Gross vehicle weight rating means the value specified by the vehicle manufacturer as the maximum design loaded weight of a single vehicle, consistent with good engineering judgment. Curb weight is defined in 40 CFR 86.1803, consistent with the provisions of 40 CFR 1037.140.

4. Minimum Payload Capability—the vehicle must have a GVWR (gross vehicle weight rating) minus curb weight value of at least 1,700 pounds.

The technical basis for these proposed definitions is found in Section III.C below and Chapter 5 of the joint TSD. EPA is proposing that mild HEV pickup trucks would be eligible for a per-truck 10 g/mi CO_2 credit (equal to a 0.001125 gal/mi fuel consumption improvement value) during MYs 2017–2021 if the mild HEV technology is used on a minimum percentage of a company's full sized pickups. That minimum percentage would be 30 percent of a company's full sized pickup production in MY 2017 with a ramp up to at least 80 percent of production in MY 2021.

EPA is also proposing that strong HEV pickup trucks would be eligible for a per-truck 20 g/mi CO_2 credit (equal to a 0.002250 gal/mi fuel consumption improvement value) during MYs 2017–2025 if the strong HEV technology is used on a minimum percentage of a company's full sized pickups. That minimum percentage would be 10 percent of a company's full sized pickup production in each year over the model years 2017–2025.

To ensure that the hybridization technology used by manufacturers seeking one of these credits and fuel consumption improvement values meets the intent behind the incentives, EPA is proposing very specific definitions of what qualifies as a mild and a strong HEV. These definitions are described in detail in Chapter 5 of the draft joint TSD (see section 5.3.3).

For similar reasons, EPA is also proposing a performance-based incentive credit and equivalent fuel consumption improvement value for full size pickup trucks that achieve an emission level significantly below the applicable target.[175] EPA, in coordination with NHTSA, proposes this credit to be either 10 g/mi CO_2 (equivalent to 0.001125 gal/mi for the CAFE program) or 20 g/mi CO_2 (equivalent to 0.002250 gal/mi for the CAFE program) for pickups achieving 15 percent or 20 percent, respectively, better CO_2 than their footprint based target in a given model year. Because the footprint target curve has been adjusted to account for A/C related credits, the CO_2 level to be compared with the target would also include any A/C related credits generated by the vehicle. Further details on this performance-based incentive are in Section III.C below and in Chapter 5 of the draft joint TSD (see Section 5.3.4). The 10 g/mi (equivalent to 0.001125 gal/mi) performance-based credit and fuel consumption improvement value would be available for MYs 2017 to 2021 and a vehicle meeting the requirements would receive the credit and fuel consumption improvement value until MY 2021 unless its CO_2 level increases or fuel economy decreases. The 20 g/mi CO_2 (equivalent to 0.0023 gal/mi fuel consumption improvement value) performance-based credit would be available for a maximum of 5 years within the model years of 2017 to 2025, provided its CO_2 level and fuel consumption does not increase. The rationale for these limits is because of the year over year progression of the stringency of the truck target curves. The credits and fuel consumption improvement values would begin in the model year of introduction, and could not extend past MY 2021 for the 10 g/mi credit (equivalent to 0.001125 gal/mi) and MY 2025 for the 20 g/mi credit (equivalent to 0.002250 gal/mi).

As with the HEV-based credit and fuel consumption improvement value, the performance-based credit and fuel consumption improvement value requires that the technology be used on a minimum percentage of a manufacturer's full-size pickup trucks. That minimum percentage for the 10 g/mi GHG credit (equivalent to 0.001125 gal/mi fuel consumption improvement value) would be 15 percent of a company's full sized pickup production in MY 2017 with a ramp up to at least 40 percent of production in MY 2021. The minimum percentage for the 20 g/mi credit (equivalent to 0.002250 gal/mi fuel consumption improvement value) would be 10 percent of a company's full sized pickup production in each year over the model years 2017–2025.

Importantly, the same vehicle could not receive credit and fuel consumption improvement under both the HEV and the performance-based approaches. EPA and NHTSA request comment on all aspects of this proposed pickup truck incentive credit and fuel consumption improvement value, including the proposed definitions for full sized pickup truck and mild and strong HEV.

G. Safety Considerations in Establishing CAFE/GHG Standards

1. Why do the agencies consider safety?

The primary goals of the proposed CAFE and GHG standards are to reduce fuel consumption and GHG emissions from the on-road light-duty vehicle fleet, but in addition to these intended effects, the agencies also consider the potential of the standards to affect vehicle safety.[176] As a safety agency, NHTSA has long considered the potential for adverse safety consequences when establishing CAFE standards,[177] and under the CAA, EPA considers factors related to public health and human welfare, and safety, in regulating emissions of air pollutants from mobile sources.[178] Safety trade-offs associated with fuel economy increases have occurred in the past (particularly before NHTSA CAFE standards were attribute-based), and the agencies must be mindful of the possibility of future ones. These past safety trade-offs may have 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 cars generally have been heavy and large, while the cars with the highest fatal-crash rates have been light and small. The question, then, is whether past is necessarily prologue when it comes to potential changes in vehicle size (both footprint and ''overhang'') and mass in response to these proposed future CAFE and GHG standards. Manufacturers have stated that they will reduce vehicle mass as one of the cost-effective means of increasing fuel economy and reducing CO_2 emissions in order to meet the proposed standards, and the

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[175] The 15 and 20 percent thresholds would be based on CO_2 performance compared to the applicable CO_2 vehicle target for both CO_2 credits and corresponding CAFE fuel consumption improvement values. As with A/C and off-cycle credits, EPA would convert the total CO_2 credits due to the pick-up incentive program from metric tons of CO_2 to a fleetwide equivalent CAFE improvement value.

[176] In this rulemaking document, ''vehicle safety'' is defined as societal fatality rates per vehicle miles traveled (VMT), which include fatalities to occupants of all the vehicles involved in the collisions, plus any pedestrians.

[177] This practice is recognized approvingly in case law. As the United States Court of Appeals for the DC Circuit stated 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).

[178] See *NRDC* v. *EPA, 655 F. 2d 318, 332 n. 31 (DC Cir. 1981). (EPA may consider safety in developing standards under section 202 (a) and did so appropriately in the given instance).*

agencies have incorporated this expectation into our modeling analysis supporting the proposed standards. Because the agencies discern a historical relationship between vehicle mass, size, and safety, it is reasonable to assume that these relationships will continue in the future. The question of whether vehicle design can mitigate the adverse effects of mass reduction is discussed below.

Manufacturers are less likely than they were in the past to reduce vehicle footprint in order to reduce mass for increased fuel economy. 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. See section II. C.1, above. This is because, as footprint decreases, the corresponding fuel economy/GHG emission target becomes more stringent. We also believe that the shape of the footprint curves themselves is approximately ''footprint-neutral,'' that is, that it should neither encourage manufacturers to increase the footprint of their fleets, nor to decrease it. Upsizing footprint is also discouraged through the curve ''cut-off'' at larger footprints.[179] However, the 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 of other areas of the vehicle outside the wheels. The crush space provided by those portions of a vehicle can make important contributions to managing crash energy. Additionally, simply because footprint-based standards create no incentive to downsize vehicles does not mean that manufacturers will not downsize if doing so makes it easier to meet the overall CAFE/GHG standard, as for example if the smaller vehicles are so much lighter that they exceed their targets by much greater amounts. On balance, however, we believe the target curves and the incentives they provide generally will not encourage down-sizing (or up-sizing) in terms of footprint reductions (or increases).[180] Consequently, all of our analyses are based on the assumption that this rulemaking, in and of itself, will not result in any differences in the sales weighted distribution of vehicle sizes.

Given that we expect manufacturers to reduce vehicle mass in response to the proposed standards, and do not expect manufacturers to reduce vehicle footprint in response to the proposed standards, the agencies must attempt to predict the safety effects, if any, of the proposed standards based on the best information currently available. This section explained why the agencies consider safety; the following section discusses how the agencies consider safety.

2. How do the agencies consider safety?

Assessing the effects of vehicle mass reduction and size on societal safety is a complex issue. One part of estimating potential safety effects involves trying to understand better the relationship between mass and vehicle design. The extent of mass reduction that manufacturers may be considering to meet more stringent fuel economy and GHG standards may raise different safety concerns from what the industry has previously faced. The principal difference between the heavier vehicles, especially truck-based LTVs, and the lighter vehicles, especially passenger cars, is that mass reduction has a different effect in collisions with another car or LTV. When two vehicles of unequal mass collide, the change in velocity (delta V) is higher in the lighter vehicle, similar to the mass ratio proportion. As a result of the higher change in velocity, the fatality risk may also increase. Removing more mass from the heavier vehicle than in the lighter vehicle by amounts that bring the mass ratio closer to 1.0 reduces the delta V in the lighter vehicle, possibly resulting in a net societal benefit.

Another complexity is that if a vehicle is made lighter, adjustments must be made to the vehicle's structure such that it will be able to manage the energy in a crash while limiting intrusion into the occupant compartment after adopting materials that may be stiffer. To maintain an acceptable occupant compartment deceleration, the effective front end stiffness has to be managed such that the crash pulse does not increase as stiffer yet lighter materials are utilized. If the energy is not well managed, the occupants may have to ''ride down'' a more severe crash pulse, putting more burdens on the restraint systems to protect the occupants. There may be technological and physical limitations to how much the restraint system may mitigate these effects.

The agencies must attempt to estimate now, based on the best information currently available to us, how the assumed levels of mass reduction without additional changes (*i.e.* footprint, performance, functionality) might affect the safety of vehicles, and how lighter vehicles might affect the safety of drivers and passengers in the entire on-road fleet, as we are analyzing potential future CAFE and GHG standards. The agencies seek to ensure that the standards are designed to encourage manufacturers to pursue a path toward compliance that is both cost-effective and safe.

To estimate the possible safety effects of the MY 2017–2025 standards, then, the agencies have undertaken research that approaches this question from several angles. First, we are using a statistical approach to study the effect of vehicle mass reduction on safety historically, as discussed in greater detail in section C below. Statistical analysis is performed using the most recent historical crash data available, and is considered as the agencies' best estimate of potential mass-safety effects. The agencies recognize that negative safety effects estimated based on the historical relationships could potentially be tempered with safety technology advances in the future, and may not represent the current or future fleet. Second, we are using an engineering approach to investigate what amount of mass reduction is affordable and feasible while maintaining vehicle safety and other major functionalities such as NVH and acceleration performance. Third, we are also studying the new challenges these lighter vehicles might bring to vehicle safety and potential countermeasures available to manage those challenges effectively.

The sections below discuss more specifically the state of the research on the mass-safety relationship, and how the agencies integrate that research into our assessment of the potential safety effects of the MY 2017–2025 CAFE and GHG standards.

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[179] The agencies recognize that at the other end of the curve, manufacturers who make small cars and trucks below 41 square feet (the small footprint cut-off point) have some incentive to downsize their vehicles to make it easier to meet the constant target. That cut-off may also create some incentive for manufacturers who do not currently offer models that size to do so in the future. However, at the same time, the agencies believe that there is a limit to the market for cars and trucks smaller than 41 square feet: most consumers likely have some minimum expectation about interior volume, for example, among other things. Additionally, vehicles in this segment are the lowest price point for the light-duty automotive market, with several models in the $10,000-$15,000 range. Manufacturers who find themselves incentivized by the cut-off will also find themselves adding technology to the lowest price segment vehicles, which could make it challenging to retain the price advantage. Because of these two reasons, the agencies believe that the incentive to increase the sales of vehicles smaller than 41 square feet due to this rulemaking, if any, is small. *See* Section II.C.1 above and Chapter 1 of the draft Joint TSD for more information on the agencies' choice of ''cut-off'' points for the footprint-based target curves.

[180] This statement makes no prediction of how consumer choices of vehicle size will change in the future, independent of this proposal.

3. What is the current state of the research on statistical analysis of historical crash data?

a. Background

Researchers have been using statistical analysis to examine the relationship of vehicle mass and safety in historical crash data for many years, and continue to refine their techniques over time. In the MY 2012–2016 final rule, the agencies stated that we would conduct further study and research into the interaction of mass, size and safety to assist future rulemakings, and start to work collaboratively by developing an interagency working group between NHTSA, EPA, DOE, and CARB to evaluate all aspects of mass, size and safety. The team would seek to coordinate government supported studies and independent research, to the greatest extent possible, to help ensure the work is complementary to previous and ongoing research and to guide further research in this area.

The agencies also identified three specific areas to direct research in preparation for future CAFE/GHG rulemaking in regards to statistical analysis of historical data.

First, NHTSA would contract 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. The 2010 NHTSA report was also peer reviewed by two other experts in the safety field—Charles Farmer (Insurance Institute for Highway Safety) and Anders Lie (Swedish Transport Administration).[181]

Second, NHTSA and EPA, in consultation with DOE, would update the MYs 1991–1999 database on which the safety analyses in the NPRM and final rule are based with newer vehicle data, and create a common database that could be made publicly available to help address concerns that differences in data were leading to different results in statistical analyses by different researchers.

And 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, the agencies sought to identify vehicles that are using material substitution and smart design, and to try to assess if there is sufficient crash data involving those vehicles for statistical analysis. If sufficient data exists, 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.

Significant progress has been made on these tasks since the MY 2012–2016 final rule, as follows: The independent review of recent and updated statistical analyses of the relationship between vehicle mass, size, and crash fatality rates has been completed. NHTSA contracted with the University of Michigan Transportation Research Institute (UMTRI) to conduct this review, and the UMTRI team led by Paul Green evaluated over 20 papers, including studies done by NHTSA's Charles Kahane, Tom Wenzel of the US Department of Energy's Lawrence Berkeley National Laboratory, Dynamic Research, Inc., and others. UMTRI's basic findings will be discussed below. Some commenters in recent CAFE rulemakings, including some vehicle manufacturers, suggested that the designs and materials of more recent model year vehicles may have weakened the historical statistical relationships between mass, size, and safety. The agencies agree that the statistical analysis would be improved by using an updated database that reflects more recent safety technologies, vehicle designs and materials, and reflects changes in the overall vehicle fleet. The agencies also believe, as UMTRI also found, that different statistical analyses may have had different results because they each used slightly different datasets for their analyses. In order to try to mitigate this problem and to support the current rulemaking, NHTSA has created a common, updated database for statistical analysis that consists of crash data of model years 2000–2007 vehicles in calendar years 2002–2008, as compared to the database used in prior NHTSA analyses which was based on model years 1991–1999 vehicles in calendar years 1995–2000. The new database is the most up-to-date possible, given the processing lead time for crash data and the need for enough crash cases to permit statistically meaningful analyses. NHTSA has made the new databases available to the public,[182] enabling other researchers to analyze the same data and hopefully minimizing discrepancies in the results that would have been due to inconsistencies across databases.[183] The agencies recognize, however, that the updated database may not represent the future fleet, because vehicles have continued and will continue to change.

The agencies are aware that several studies have been initiated using NHTSA's 2011 newly established safety database. In addition to a new Kahane study, which is discussed in section II.G.4, other on-going studies include two by Wenzel at Lawrence Berkeley National Laboratory (LBNL) under contract with the U.S. DOE, and one by Dynamic Research, Inc. (DRI) contracted by the International Council on Clean Transportation (ICCT). These studies may take somewhat different approaches to examine the statistical relationship between fatality risk, vehicle mass and size. In addition to a detailed assessment of the NHTSA 2011 report, Wenzel is expected to consider the effect of mass and footprint reduction on casualty risk per crash, using data from thirteen states. Casualty risk includes both fatalities and serious or incapacitating injuries. DRI is expected to use a two-stage approach to separate the effect of mass reduction on two components of fatality risk, crash avoidance and crashworthiness. The LBNL assessment of the NHTSA 2011 report is available in the docket for this NPRM.[184] The casualty risk effect study was not available in time to inform this NPRM. The completed final peer reviewed-report on both assessments will be available prior to the final rule. DRI has also indicated that it expects its study to be publicly available prior to the final rule. The agencies will consider these studies and any others that become available, and the results may influence the safety analysis for the final rule.

Other researchers are free to download the database from NHTSA's Web site, and we expect to see additional papers in the coming months and as comments to the rulemaking that may also inform our consideration of these issues for the final rule. Kahane's updated study for 2011 is currently undergoing peer-review, and is available

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[181] All three of the peer reviews are in docket, NHTSA–2010–0152. You can access the docket at *http://www.regulations.gov/#!home* by typing 'NHTSA–2010–0152' where it says ''enter keyword or ID'' and then clicking on ''Search.''

[182] The new databases are available at *http://www.nhtsa.gov/fuel-economy* (look for ''Download Crash Databases for Statistical Analysis of Relationships Between Vehicles' Fatality Risk, Mass, and Footprint.''

[183] 75 Fed. Reg. 25324 (May 7, 2010); the discussion of planned statistical analyses is on pp. 25395–25396.

[184] Wenzel, T.P. (2011b). *Assessment of NHTSA's Report ''Relationships between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs'',* available at…

in the docket for this rulemaking for review by commenters.

Finally, EPA and NHTSA with DOT's Volpe Center, part of the Research and Innovative Technology Administration (RITA), attempted to investigate the implications of ''Smart Design,'' by identifying and describing the types of ''Smart Design'' and methods for using ''Smart Design'' to result in vehicle mass reduction, selecting analytical pairs of vehicles, and using the appropriate crash database to analyze vehicle crash data. The analysis identified several one-vehicle and two-vehicle crash datasets with the potential to shed light on the issue, but the available data for specific crash scenarios was insufficient to produce consistent results that could be used to support conclusions regarding historical performance of ''smart designs.''

Undertaking these tasks has helped the agencies come closer to resolving some of the ongoing debates in statistical analysis research of historical crash data. We intend to apply these conclusions going forward, and we believe that the public discussion of the issues will be facilitated by the research conducted. The following sections discuss the findings from these studies and others in greater detail, to present a more nuanced picture of the current state of the statistical research.

b. NHTSA Workshop on Vehicle Mass, Size and Safety

On February 25, 2011, NHTSA hosted a workshop on mass reduction, vehicle size, and fleet safety at the Headquarters of the U.S. Department of Transportation in Washington, DC.[185] The purpose of the workshop was to provide the agencies with a broad understanding of current research in the field and provide stakeholders and the public with an opportunity to weigh in on this issue. NHTSA also created a public docket to receive comments from interested parties that were unable to attend.

The speakers included Charles Kahane of NHTSA, Tom Wenzel of Lawrence Berkeley National Laboratory, R. Michael Van Auken of Dynamic Research Inc. (DRI), Jeya Padmanaban of JP Research, Inc., Adrian Lund of the Insurance Institute for Highway Safety, Paul Green of the University of Michigan Transportation Research Institute (UMTRI), Stephen Summers of NHTSA, Gregg Peterson of Lotus Engineering, Koichi Kamiji of Honda, John German of the International Council on Clean Transportation (ICCT), Scott Schmidt of the Alliance of Automobile Manufacturers, Guy Nusholtz of Chrysler, and Frank Field of the Massachusetts Institute of Technology.

The wide participation in the workshop allowed the agencies to hear from a broad range of experts and stakeholders. The contributions were particularly relevant to the agencies' analysis of the effects of weight reduction for this proposed rule. The presentations were divided into two sessions that addressed the two expansive sets of issues—statistical evidence of the roles of mass and size on safety, and engineering realities—structural crashworthiness, occupant injury and advanced vehicle design.

The first session focused on previous and ongoing statistical studies of crash data that attempt to identify the relative effects of vehicle mass and size on fleet safety. There was consensus that there is a complicated relationship with many confounding influences in the data. Wenzel summarized a recent study he conducted comparing four types of risk (fatality or casualty risk, per vehicle registration-years or per crash) using police-reported crash data from five states.[186] He showed that the trends in risk for various classes of vehicles (*e.g.,* non-sports car passenger cars, vans, SUVs, crossover SUVs, pickups) were similar regardless of what risk was being measured (fatality or casualty) or what exposure metric was used (*e.g.,* registration years, police-reported crashes, etc.). In general, most trends showed a lower risk for drivers of larger, heavier vehicles.

Although Wenzel's analysis was focused on differences in the four types of risk on the relative risk by vehicle type, he cautioned that, when analyzing casualty risk per crash, analysts should control for driver age and gender, crash location (urban vs. rural), and the state in which the crash occurred (to account for crash reporting biases).

Several participants pointed out that analyses must also control for individual technologies with significant safety effects (*e.g.,* Electronic Stability Control, airbags).It was not always conclusive whether a specialty vehicle group (*e.g.,* sports cars, two-door cars, early crossover SUVs) were outliers that confound the trend or unique datasets that isolate specific vehicle characteristics. Unfortunately, specialty vehicle groups are usually adopted by specific driver groups, often with outlying vehicle usage or driver behavior patterns. Green, who conducted an independent review of the previous statistical analyses, suggested that evaluating residuals will give an indication of whether or not a data subset can be legitimately removed without inappropriately affecting the analytical results.

It was recognized that the physics of a two-vehicle crash require that the lighter vehicle experience a greater change in velocity, which often leads to disproportionately more injury risk. Lund noted persistent historical trends that, in any time period, occupants of the smallest and lightest vehicles had, on average, fatality rates approximately twice those of occupants of the largest and heaviest vehicles but predicted ''the sky will not fall'' as the fleet downsizes, we will not see an increase in absolute injury risk because smaller cars will become increasingly protective of their occupants. Padmanaban also noted in her research of the historical trends that mass ratio and vehicle stiffness are significant predictors with mass ratio consistently the dominant parameter when correlating harm. Reducing the mass of any vehicle may have competing societal effects as it increases the injury risk in the lightened vehicle and decreases them in the partner vehicle

The separation of key parameters was also discussed as a challenge to the analyses, as vehicle size has historically been highly correlated with vehicle mass. Presenters had varying approaches for dealing with the potential multicollinearity between these two variables. Van Auken of DRI stated that there was latitude in the value of Variance Inflation Factor (VIF, a measure of multicollinearity) that would call results into question, and suggested that the large value of VIF for curb weight might imply ''perhaps the effect of weight is too small in comparison to other factors.'' Green, of UMTRI, stated that highly correlated variables may not be appropriate for use in a predictive model and that ''match[ing] on footprint'' (*i.e.,* conducting multiple analyses for data subsets with similar footprint values) may be the most effective way to resolve the issue.

There was no consensus on the overall effect of the maneuverability of smaller, lighter vehicles. German noted that lighter vehicles should have improved handling and braking characteristics and ''may be more likely to avoid collisions''. Lund presented

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[185] A video recording, transcript, and the presentations from the NHTSA workshop on mass reduction, vehicle size and fleet safety is available at *http://www.nhtsa.gov/fuel-economy* (look for ''NHTSA Workshop on Vehicle Mass-Size-Safety on Feb. 25'')

[186] Wenzel, T.P. (2011a). *Analysis of Casualty Risk per Police-Reported Crash for Model Year 2000 to 2004 Vehicles, using Crash Data from Five States,* March 2011, LBNL–4897E, available at: *http://eetd.lbl.gov/EA/teepa/pub.html#Vehicle*

crash involvement data that implied that, among vehicles of similar function and use rates, crash risk does not go down for more ''nimble'' vehicles. Several presenters noted the difficulties of projecting past data into the future as new technologies will be used that were not available when the data were collected. The advances in technology through the decades have dramatically improved safety for all weight and size classes. A video of IIHS's 50th anniversary crash test of a 1959 Chevrolet Bel Air and 2009 Chevrolet Malibu graphically demonstrated that stark differences in design and technology that can possibly mask the discrete mass effects, while videos of compatibility crash tests between smaller, lighter vehicles and contemporary larger, heavier vehicles graphically showed the significance of vehicle mass and size.

Kahane presented results from his 2010 report[187] that found that a scenario which took some mass out of heavier vehicles but little or no mass out of the lightest vehicles did not impact safety in absolute terms. Kahane noted that if the analyses were able to consider the mass of both vehicles in a two-vehicle crash, the results may be more indicative of future crashes. There is apparent consistency with other presentations (*e.g.,* Padmanaban, Nusholtz) that reducing the overall ranges of masses and mass ratios seems to reduce overall societal harm. That is, the effect of mass reduction exclusively does not appear to be a ''zero sum game'' in which any increase in harm to occupants of the lightened vehicle is precisely offset by a decrease in harm to the occupants of the partner vehicle. If the mass of the heavier vehicle is reduced by a larger percentage, the changes in velocity from the collision are more nearly equal and the injuries suffered in the lighter vehicle are likely to be reduced more than the injuries in the heavier vehicle are increased. Alternatively, a fixed mass reduction (say, 100 lbs) in all vehicles could increase societal harm whereas a fixed percentage mass reduction is more likely to be neutral.

Padmanaban described a series of studies conducted in recent years. She included numerous vehicle parameters including bumper height and several measures of vehicle size and stiffness and also commented on previous analyses that using weight and wheelbase together in a logistic model distorts the estimates, resulting in inflated variance with wrong signs and magnitudes in the results. Her results consistently showed that vehicle mass ratio was a more important parameter than those describing vehicle geometry or stiffness. Her ultimate conclusion was that removing mass (*e.g.,* 100 lbs.) from all passenger cars would cause an overall increase in fatalities in truck-to-car crashes while removing the same amount from light trucks would cause an overall decrease in fatalities.

c. Report by Green et al., UMTRI—''Independent Review: Statistical Analyses of Relationship Between Vehicle Curb Weight, Track Width, Wheelbase and Fatality Rates,'' April 2011.

As explained above, NHTSA contracted with the University of Michigan Transportation Research Institute (UMTRI) to conduct an independent review ;[188] of a set of statistical analyses of relationships between vehicle curb weight, the footprint variables (track width, wheelbase) and fatality rates from vehicle crashes. The purpose of this review was to examine analysis methods, data sources, and assumptions of the statistical studies, with the objective of identifying the reasons for any differences in results. Another objective was to examine the suitability of the various methods for estimating the fatality risks of future vehicles.

UMTRI reviewed a set of papers, reports, and manuscripts provided by NHTSA (listed in Appendix A of UMTRI's report, which is available in the docket to this rulemaking) that examined the statistical relationships between fatality or casualty rates and vehicle properties such as curb weight, track width, wheelbase and other variables.

It is difficult to summarize a study of that length and complexity for purposes of this discussion, but fundamentally, the UMTRI team concluded the following:

- Differences in data may have complicated comparisons of earlier analyses, but if the methodology is robust, and the methods were applied in a similar way, small changes in data should not lead to different conclusions. The main conclusions and findings should be reproducible. The data base created by Kahane appears to be an impressive collection of files from appropriate sources and the best ones available for answering the research questions considered in this study.
- In statistical analysis simpler models generally lead to improved inference, assuming the data and model assumptions are appropriate. In that regard, the disaggregate logistic regression model used by NHTSA in the 2003 report [189] seems to be the most appropriate model, and valid for the analysis in the context that it was used: finding general associations between fatality risk and mass—and the general directions of the reported associations are correct.
- The two-stage logistic regression model in combination with the two-step aggregate regression used by DRI seems to be more complicated than is necessary based on the data being analyzed, and summing regression coefficients from two separate models to arrive at conclusions about the effects of reductions in weight or size on fatality risk seems to add unneeded complexity to the problem.
- One of the biggest issues regarding this work is the historical correlation between curb weight, wheelbase, and track width. Including three variables that are highly correlated in the same model can have adverse effects on the fit of the model, especially with respect to the parameter estimates, as discussed by Kahane. UMTRI makes no conclusions about multicollinearity, other than to say that inferences made in the presence of multicollinearity should be judged with great caution. At the NHTSA workshop on size, safety and mass, Paul Green suggested that a matched analysis, in which regressions are run on the relationship between mass reduction and risk separately for vehicles of similar footprint, could be undertaken to investigate the effect of multicollinearity between vehicle mass and size. Kahane has combined wheelbase and track width into one variable (footprint) to compare with curb weight. NHTSA believes that the 2011 Kahane analysis has done all it can to lessen concerns about multicollinearity, but a concern still exists. In considering other studies provided by NHTSA for evaluation by the UMTRI team:
    - ○ Papers by Wenzel, and Wenzel and Ross, addressing associations between fatality risk per vehicle registration-year, weight, and size by vehicle model contribute to understanding some of the relationships between risk, weight, and size. However, least squares linear regression models, without

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[187] Kahane, C. J. (2010). ''Relationships Between Fatality Risk, Mass, and Footprint in Model Year 1991–1999 and Other Passenger Cars and LTVs,'' *Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2012–MY 2016 Passenger Cars and Light Trucks.* Washington, DC: National Highway Traffic Safety Administration, pp. 464–542, available at *http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2012–2016_FRIA_04012010.pdf.*

[188] The review is independent in the sense that it was conducted by an outside third party without any interest in the reported outcome.

[189]

modification, are not exposure-based risk models and inference drawn from these models tends to be weak since they do not account for additional differences in vehicles, drivers, or crash conditions that could explain the variance in risk by vehicle model.

○ A 2009 J.P. Research paper focused on the difficulties associated with separating out the contributions of weight and size variables when analyzing fatality risk properly recognized the problem arising from multicollinearity and included a clear explanation of why fatality risk is expected to increase with increasing mass ratio. UMTRI concluded that the increases in fatality risk associated with a 100-pound reduction in weight allowing footprint to vary with weight as estimated by Kahane and JP Research, are broadly more convincing than the 6.7 percent reduction in fatality risk associated with mass reduction while holding footprint constant, as reported by DRI.

○ A paper by Nusholtz et al. focused on the question of whether vehicle size can reasonably be the dominant vehicle factor for fatality risk, and finding that changing the mean mass of the vehicle population (leaving variability unchanged) has a stronger influence on fatality risk than corresponding (feasible) changes in mean vehicle dimensions, concluded unequivocally that reducing vehicle mass while maintaining constant vehicle dimensions will increase fatality risk. UMTRI concluded that if one accepts the methodology, this conclusion is robust against realistic changes that may be made in the force vs. deflection characteristics of the impacting vehicles.

○ Two papers by Robertson, one a commentary paper and the other a peer-reviewed journal article, were reviewed. The commentary paper did not fit separate models according to crash type, and included passenger cars, vans, and SUVs in the same model. UMTRI concluded that some of the claims in the commentary paper appear to be overstated, and intermediate results and more documentation would help the reader determine if these claims are valid. The second paper focused largely on the effects of electronic stability control (ESC), but generally followed on from the first paper except that curb weight is not fit and fuel economy is used as a surrogate.

The UMTRI study provided a number of useful suggestions that Kahane considered in updating his 2011 analysis, and that have been incorporated into the safety effects estimates for the current rulemaking.

d. Report by Dr. Charles Kahane, NHTSA—“Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs,” 2011

The relationship between a vehicle's mass, size, and fatality risk is complex, and it varies in different types of crashes. NHTSA, along with others, has been examining this relationship for over a decade. The safety chapter of NHTSA's April 2010 final regulatory impact analysis (FRIA) of CAFE standards for MY 2012–2016 passenger cars and light trucks included a statistical analysis of relationships between fatality risk, mass, and footprint in MY 1991–1999 passenger cars and LTVs (light trucks and vans), based on calendar year (CY) 1995–2000 crash and vehicle-registration data.[190] The 2010 analysis used the same data as the 2003 analysis, but included vehicle mass and footprint in the same regression model.

The principal findings of NHTSA's 2010 analysis were that mass reduction in lighter cars, even while holding footprint constant, would significantly increase societal fatality risk, whereas mass reduction in the heavier LTVs would significantly reduce net societal fatality risk, because it would reduce the fatality risk of occupants in lighter vehicles which collide with the heavier LTVs. NHTSA concluded that, as a result, any reasonable combination of mass reductions while holding footprint constant in MY 2012–2016 vehicles—concentrated, at least to some extent, in the heavier LTVs and limited in the lighter cars—would likely be approximately safety-neutral; it would not significantly increase fatalities and might well decrease them.

NHTSA's 2010 report partially agreed and partially disagreed with analyses published during 2003–2005 by Dynamic Research, Inc. (DRI). NHTSA and DRI both found a significant protective effect for footprint, and that reducing mass *and* footprint together (downsizing) on smaller vehicles was harmful. DRI's analyses estimated a significant overall reduction in fatalities from mass reduction in all light-duty vehicles if wheelbase and track width were maintained, whereas NHTSA's report showed overall fatality reductions only in the heavier LTVs, and benefits only in some types of crashes for other vehicle types. Much of NHTSA's 2010 report, as well as recent work by DRI, involved sensitivity tests on the databases and models, which generated a range of estimates somewhere between the initial DRI and NHTSA results.[191]

Immediately after issuing the final rule for MYs 2012–2016 CAFE and GHG standards in May 2010, NHTSA and EPA began work on the next joint rulemaking to develop CAFE and GHG standards for MY 2017 to 2025 and beyond. The preamble to the 2012–2016 final rule stated that NHTSA, working closely with EPA and the Department of Energy (DOE), would perform a new statistical analysis of the relationships between fatality rates, mass and footprint, updating the crash and exposure databases to the latest available model years, refining the methodology in response to peer reviews of the 2010 report and taking into account changes in vehicle technologies. The previous databases of MY 1991–1999 vehicles in CY 1995–2000 crashes has become outdated as new safety technologies, vehicle designs and materials were introduced. The new databases comprising MY 2000–2007 vehicles in CY 2002–2008 crashes with the most up-to-date possible, given the processing lead time for crash data and the need for enough crash cases to permit statistically meaningful analyses. NHTSA has made the new databases available to the public,[192] enabling other researchers to analyze the same data and hopefully minimizing discrepancies in the results due to inconsistencies across the data used.[193]

One way to estimate these effects is via statistical analyses of societal fatality

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[190] Kahane, C. J. (2010). “Relationships Between Fatality Risk, Mass, and Footprint in Model Year 1991–1999 and Other Passenger Cars and LTVs,” *Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2012–MY 2016 Passenger Cars and Light Trucks.* Washington, DC: National Highway Traffic Safety Administration, pp. 464–542, available at *http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2012-2016_FRIA_04012010.pdf.*

[191] Van Auken, R. M., and Zellner, J. W. (2003). *A Further Assessment of the Effects of Vehicle Weight and Size Parameters on Fatality Risk in Model Year 1985–98 Passenger Cars and 1986–97 Light Trucks.* Report No. DRI–TR–03–01. Torrance, CA: Dynamic Research, Inc.; Van Auken, R. M., and Zellner, J. W. (2005a). *An Assessment of the Effects of Vehicle Weight and Size on Fatality Risk in 1985 to 1998 Model Year Passenger Cars and 1985 to 1997 Model Year Light Trucks and Vans.* Paper No. 2005–01–1354. Warrendale, PA: Society of Automotive Engineers; Van Auken, R. M., and Zellner, J. W. (2005b). *Supplemental Results on the Independent Effects of Curb Weight, Wheelbase, and Track on Fatality Risk in 1985–1998 Model Year Passenger Cars and 1986–97 Model Year LTVs.* Report No. DRI–TR–05–01. Torrance, CA: Dynamic Research, Inc.; Van Auken, R.M., and Zellner, J. W. (2011). “Updated Analysis of the Effects of Passenger Vehicle Size and Weight on Safety,” *NHTSA Workshop on Vehicle Mass-Size-Safety,* Washington, February 25, 2011, *http://www.nhtsa.gov/staticfiles/rulemaking/pdf/MSS/MSSworkshop_VanAuken.pdf*

[192] *http://www.nhtsa.gov/fuel-economy.*

[193] 75 FR 25324 (May 7, 2010); the discussion of planned statistical analyses is on pp. 25395–25396.

rates per vehicle miles traveled (VMT), by vehicles' mass and footprint, for the current on-road vehicle fleet. The basic analytical method used for the 2011 NHTSA report is the same as in NHTSA's 2010 report: Cross-sectional analyses of the effect of mass and footprint reductions on the *societal* fatality rate per billion vehicle miles of travel (VMT), while controlling for driver age and gender, vehicle type, vehicle safety features, crash times and locations, and other factors. Separate logistic regression models are run for three types of vehicles and nine types of crashes. Societal fatality rates include occupants of all vehicles in the crash, as well as non-occupants, such as pedestrians and cyclists. NHTSA's 2011 Report[194] analyzes MY 2000–2007 cars and LTVs in CY 2002–2008 crashes. Fatality rates were derived from FARS data, 13 State crash files, and registration and mileage data from R.L. Polk.

The most noticeable change in MY 2000–2007 vehicles from MY 1991–1999 has been the increase in crossover utility vehicles (CUV), which are SUVs of unibody construction, often but not always built upon a platform shared with passenger cars. CUVs have blurred the distinction between cars and trucks. The new analysis treats CUVs and minivans as a separate vehicle class, because they differ in some respects from pickup-truck-based LTVs and in other respects from passenger cars. In the 2010 report, the many different types of LTVs were combined into a single analysis and NHTSA believes that this may have made the analyses too complex and might have contributed to some of the uncertainty in the results.

The new database has accurate VMT estimates, derived from a file of odometer readings by make, model, and model year recently developed by R.L. Polk and purchased by NHTSA.[195] For the 2011 report, the relative distribution of crash types has been changed to reflect the projected distribution of crashes during the period from 2017 to 2025, based on the estimated effectiveness of electronic stability control (ESC) in reduction the number of fatalities in rollover crashes and crashes with a stationary object. The annual target population of fatalities or the annual fatality distribution baseline[196] was not decreased in the period between 2017 and 2025 for the safety statistics analysis, but is taken into account later in the Volpe model analysis, since all vehicles in the future will be equipped with ESC.[197]

For the 2011 report, vehicles are now grouped into five classes rather than four: passenger cars (including both 2-door and 4-door cars) are split in half by median weight; CUVs and minivans; and truck-based LTVs, which are also split in half by median weight of the model year 2000–2007 vehicles. Table II–12 presents the estimated percent increase in U.S. societal fatality risk per ten billion VMT for each 100-pound reduction in vehicle mass, while holding footprint constant, for each of the five classes of vehicles.

Table II-12 Results of 2011 NHTSA report Fatality Increase (%) per 100-Pound Mass Reduction While Holding Footprint Constant

MY 2000-2007 CY 2002-2008	Fatality Increase (%) Per 100-Pound Mass Reduction While Holding Footprint Constant	
	Point Estimate	95% Confidence Bounds
Cars < 3,106 pounds	1.44	+ .29 to +2.59
Cars ≥ 3,106 pounds	.47	- .58 to +1.52
CUVs and minivans	- .46	-1.75 to + .83
Truck-based LTVs < 4,594 pounds	.52	- .43 to +1.46
Truck-based LTVs ≥ 4,594 pounds	- .39	-1.06 to + .27

Only the 1.44 percent risk increase in the lighter cars is statistically significant. There are non-significant increases in the heavier cars and the lighter truck-based LTVs, and non-significant societal benefits for mass

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[194] Kahane, C. J. (2011). "Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs," July 2011. The report is available in the NHTSA docket, NHTSA–2010–0152. You can access the docket at *http://www.regulations.gov/#!home* by typing 'NHTSA–2010–0152' where it says "enter keyword or ID" and then clicking on "Search."

[195] In the 1991–1999 data base, VMT was estimated only by vehicle class, based on NASS CDS data.

[196] MY 2004–2007 vehicles with fatal crashes occurred in CY 2004–2008 are selected as the annual fatality distribution baseline in the Kahane analysis.

[197] In the Volpe model, NHTSA assumed that the safety trend would result in 12.6 percent reduction between 2007 and 2020 due to the combination of ESC, new safety standard, and behavior changes anticipated.

reduction in CUVs, minivans, and the heavier truck-based LTVs. Based on these results, potential combinations of mass reductions that maintain footprint and are proportionately somewhat higher for the heavier vehicles may be safety-neutral or better as point estimates and, in any case, unlikely to significantly increase fatalities. The primarily non-significant results are not due to a paucity of data, but because the societal effect of mass reduction while maintaining footprint, if any, is small.

MY 2000–2007 vehicles of all types are heavier and larger than their MY 1991–1999 counterparts. The average mass of passenger cars increased by 5 percent from 2000 to 2007 and the average mass of pickup trucks increased by 19 percent. Other types of vehicles became heavier, on the average, by intermediate amounts. There are several reasons for these increases: during this time frame, some of the lighter make-models were discontinued; many models were redesigned to be heavier and larger; and consumers more often selected stretched versions such as crew cabs in their new-vehicle purchases.

It is interesting to compare the new results to NHTSA's 2010 analysis of MY 1991–1999 vehicles in CY 1995–2000, especially the new point estimate to the ''actual regression result scenario'' in the 2010 report:

Table II-13 2010 Report: MY 1991-1999, CY 1995-2000 Fatality Increase (%) per 100-Pound Mass Reduction While Holding Footprint Constant

	Actual Regression Result Scenario	Upper-Estimate Scenario	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

Table II-14 Fatality Increase (%) per 100-Pound Mass Reduction While Holding Footprint Constant

	NHTSA (2010)	NHTSA (2011)
Lighter cars	2.21%	1.43%
Heavier cars	0.89%	0.48%
Lighter LTVs	0.17%*	0.52%
Heavier LTVs	-1.90%*	-0.40%
CUV/ minivan		-0.47%

*Includes CUV/minivan

The new results are directionally the same as in 2010: fatality increase in the lighter cars, safety benefit in the heavier LTVs, but the effects may have become weaker at both ends. (The agencies do not consider this conclusion to be definitive because of the relatively wide confidence bounds of the estimates.) The fatality increase in the lighter cars tapered off from 2.21 percent to 1.44 percent while the societal benefit of mass reduction in the heaviest LTVs diminished from 1.90 percent to 0.39 percent and is no longer statistically significant.

The agencies believe that the changes may be due to a combination of both changes in the characteristics of newer vehicles and revisions to the analysis. NHTSA believes, above all, that several light, small car models with poor safety performance were discontinued by 2000 or during 2000–2007. Also, the tendency of light, small vehicles to be driven poorly is not as strong as it used to be—perhaps in part because safety improvements in lighter and smaller vehicles have made some good drivers more willing to buy them. Both agencies believe that at the other end of the weight/size spectrum, blocker beams and other voluntary compatibility improvements in LTVs, as well as compatibility-related self-protection improvements to cars, have made the heavier LTVs less aggressive in collisions with lighter vehicles (although the effect of mass disparity remains). This report's analysis of CUVs and minivans as a separate class of vehicles may have relieved some inaccuracies in the 2010 regression results for LTVs. Interestingly, the new actual-regression results are quite close to the previous report's ''lower-estimate scenario,'' which was an attempt to adjust for supposed inaccuracies in some regressions and for a seemingly excessive trend toward higher crash rates in smaller and lighter cars.

The principal difference between the heavier vehicles, especially truck-based LTVs, and the lighter vehicles, especially passenger cars, is that mass reduction has a different effect in collisions with another car or LTV. When two vehicles of unequal mass collide, the delta V is higher in the lighter vehicle, in the same proportion as the mass ratio. As a result, the fatality risk is also higher. Removing some mass from the heavy vehicle reduces delta V in the lighter vehicle, where fatality risk is high, resulting in a large benefit, offset by a small penalty because delta V increases in the heavy vehicle, where fatality risk is low—adding up to a net societal benefit. Removing some mass from the lighter vehicle results in a large penalty offset by a small benefit—adding up to net harm. These considerations drive the overall result: fatality increase in the lighter cars, reduction in the heavier LTVs, and little effect in the intermediate groups. However, in some types of crashes, especially first event rollovers and impacts with fixed objects, mass reduction is usually not harmful and often beneficial, because the lighter vehicles respond more quickly to braking and steering and are often more stable because their center of gravity is lower. Offsetting that benefit is the continuing historical tendency of lighter and smaller vehicles to be driven less well—although it continues to be unknown why that is so, and to what extent, if any, the lightness or smallness of the vehicle contributes to people driving it less safely.

The estimates of the model are formulated for each 100-pound reduction in mass; in other words, if risk increases by 1 percent for 100 pounds reduction in mass, it would increase by 2 percent for a 200-pound reduction, and 3 percent for a 300-pound reduction (more exactly, 2.01 percent and 3.03 percent, because the effects work like compound interest). Confidence bounds around the point estimates will grow wider by the same proportions.

The regression results are best suited to predict the effect of a small change in mass, leaving all other factors, including footprint, the same. With each additional change from the current environment, the model may become somewhat less accurate and it is difficult to assess the sensitivity to additional mass reduction greater than 100 pounds. The agencies recognize that the light-duty vehicle fleet in the 2017–2025 timeframe will be different than the 2000–2007 fleet analyzed for this study. Nevertheless, one consideration provides some basis for confidence. This is NHTSA's fourth evaluation of the effects of mass reduction and/or downsizing, comprising databases ranging from MY 1985 to 2007. The results of the four studies are not identical, but they have been consistent up to a point. During this time period, many makes and models have increased substantially in mass, sometimes as much as 30–40 percent.[198] If the statistical analysis has, over the past years, been able to accommodate mass increases of this magnitude, perhaps it will also succeed in modeling the effects of mass reductions on the order of 10–20 percent, if they occur in the future.

e. Report by Tom Wenzel, LBNL, ''An Assessment of NHTSA's Report 'Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs'', 2011

DOE contracted with Tom Wenzel of Lawrence Berkeley National Laboratory to conduct an assessment of NHTSA's updated 2011 study of the effect of mass and footprint reductions on U.S. fatality risk per vehicle miles traveled, and to provide an analysis of the effect of mass and footprint reduction on casualty risk per police-reported crash, using independent data from thirteen states. The assessment has been completed and reviewed by NHTSA and EPA staff, and a draft final version is included in the docket of today's rulemaking; the separate analysis of crash data from thirteen states will be completed and included in the docket shortly. Both reports will be peer reviewed by outside experts.

The LBNL report replicates Kahane's analysis for NHTSA, using the same data and methods, and in many cases using the same SAS programs. The Wenzel report finds that although mass reduction in lighter (less than 3,106 lbs) cars leads to a statistically significant 1.44% increase in fatality risk per vehicle miles travelled (VMT), the increase is small. He tests this result for sensitivity to changes in specifications of the regression models and what data are used. In addition Wenzel shows that there is a wide range in fatality rates by vehicle model for models that have the same mass, even after accounting for differences in drivers' age and gender, safety features installed, and crash times and locations. This section summarizes the results of the Wenzel assessment of the most recent NHTSA analysis.

The LBNL report highlights the effect of the other driver, vehicle, and crash control variables, in addition to the effect of mass and footprint reduction, on risk. Some of the other variables NHTSA included in its regression models have much larger effects on fatality risk than mass or footprint reduction. For example, the models indicate that a 100-lb increase in the mass of a lighter car results in a 1.44% reduction in fatality risk; this is the largest estimated effect of changes in vehicle mass, and the only one that is statistically significant. For comparison this reduction in fatality risk could also be achieved by a 13% increase in 4-door sedans equipped with ESC.

The 1.44% increase in risk from reducing mass in the lighter cars was

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[198] For example, one of the most popular models of small 4-door sedans increased in curb weight from 1,939 pounds in MY 1985 to 2,766 pounds in MY 2007, a 43 percent increase. A high-sales mid-size sedan grew from 2,385 to 3,354 pounds (41%); a best-selling pickup truck from 3,390 to 4,742 pounds (40%) in the basic model with 2-door cab and rear-wheel drive; and a popular minivan from 2,940 to 3,862 pounds (31%).

tested for sensitivity changes in the specification of, or the data used in, the regression models. For example, using the current distribution of crashes, rather than adjusting the distribution to that expected after full adoption of ESC, reduces the effect to 1.18%; excluding the calendar year variables from the model, which may be weakening the modeled benefits of vehicle safety technologies, reduces the effect to 1.39%; and including vehicle make in the model increases the effect to 1.81%. The results also are sensitive to the selection of data to include in the analysis: Excluding bad drivers increases the effect to 2.03%, while excluding crashes involving alcohol or drugs increases the effect to 1.66%, and including sports, police, and all-wheel drive cars increases the effect to 1.64%. Finally, changing the definition of risk also affects the result for lighter cars: Using the number of fatalities per induced exposure crash reduces the effect to −0.24% (that is, a 0.24% reduction in risk), while using the number of fatal crashes (rather than total fatalities) per VMT increases the effect to 1.84%. These sensitivity tests, except one, changed the estimated coefficient by less than 1 percentage point, which is within its statistical confidence bounds of 0.29 to 2.59 percent and may be considered compatible with the baseline result. Using two or more variables that are strongly correlated in the same regression model (referred to as multicollinearity) can lead to inaccurate results. However, the correlation between vehicle mass and footprint may not be strong enough to cause serious concern. Experts suggest that a correlation of greater than 0.60 (or a variance inflation factor of 2.5) raises concern about multicollinearity.[199] The correlation between vehicle mass and footprint ranges from over 0.80 for four-door sedans, pickups, and SUVs, to about 0.65 for two-door cars and CUVs, to 0.26 for minivans; when pickups and SUVs are considered together, the correlation between mass and footprint is 0.65. Wenzel notes that the 2011 NHTSA report recognizes that the ''near'' multicollinearity between mass and footprint may not be strong enough to invalidate the results from a regression model that includes both variables. In addition, NHTSA included several analyses to address possible effects of the near-multicollinearity between mass and footprint.

First, NHTSA ran a sensitivity model specification, where footprint is not held constant, but rather allowed to vary as mass varies (*i.e.* NHTSA ran a regression model which includes mass but not footprint). If the multicollinearity was so great that including both variables in the same model gave misleading results, removing footprint from the model could give mass coefficients five or more percentage points different than keeping it in the model. NHTSA's sensitivity test indicates that when footprint is allowed to vary with mass, the effect of mass reduction on risk increases from 1.44% to 2.64% for lighter cars, and from a non-significant 0.47% to a statistically-significant 1.94% for heavier cars (changes of less than two percentage points); however, the effect of mass reduction on light trucks is unchanged, and is still not statistically significant for CUVs/minivans.

Second, NHTSA conducted a stratification analysis of the effect of mass reduction on risk by dividing vehicles into deciles based on their footprint, and running a separate regression model for each vehicle and crash type, for each footprint decile (3 vehicle types times 9 crash types times 10 deciles equals 270 regressions). This analysis estimates the effect of mass reduction on risk separately for vehicles with similar footprint. The analysis indicates that mass reduction does not consistently increase risk across all footprint deciles for any combination of vehicle type and crash type. Mass reduction increases risk in a majority of footprint deciles for 13 of the 27 crash and vehicle combinations, but few of these increases are statistically significant. On the other hand, mass reduction *decreases* risk in a majority of footprint deciles for 9 of the 27 crash and vehicle combinations; in some cases these risk reductions are large and statistically significant.[200] If reducing vehicle mass while maintaining footprint inherently leads to an increase in risk, the coefficients on mass reduction should be more consistently positive, and with a larger R^2, across the 27 vehicle/crash combinations, than shown in the analysis. These findings are consistent with the conclusion of the basic regression analyses, namely, that the effect of mass reduction while holding footprint constant, if any, is small.

One limitation of using logistic regression to estimate the effect of mass reduction on risk is that a standard statistic to measure the extent to which the variables in the model explain the range in risk, equivalent to the R^2≤ statistic in a linear regression model, does not exist. (SAS does generate a pseudo-R^2 value for logistic regression models; in almost all of the NHTSA regression models this value is less than 0.10). For this reason LBNL conducted an analysis of risk versus mass by vehicle model. LBNL used the results of the NHTSA logistic regression model to predict the number of fatalities expected after accounting for all vehicle, driver, and crash variables included in the NHTSA regression model except for vehicle weight and footprint. LBNL then plotted expected fatality risk per VMT by vehicle model against the mass of each model, and analyzed the change in risk as mass increases, as well as how much of the change in risk was explained by all of the variables included in the model.

The analysis indicates that, after accounting for all the variables, risk does decrease as mass increases; however, risk and mass are not strongly correlated, with the R^2 ranging from 0.33 for CUVs to less than 0.15 for all other vehicle types (as shown in Figure x). This means that, on average, risk decreases as mass increases, but the variation in risk among individual vehicle models is stronger than the trend in risk from light to heavy vehicles. For fullsize (*i.e.* 3/4- and 1-ton) pickups, risk increases as mass increases, with an R^2 of 0.43, consistent with NHTSA's basic regression results for the heavier LTVs (societal risk increases as mass increases). LBNL also examined the relationship between residual risk, that is the remaining unexplained risk after accounting for all vehicle, driver and crash variables, and mass, and found similarly poor correlations. This implies that the remaining factors not included in the regression model that account for the observed range in risk by vehicle model also are not correlated with mass. (LBNL found similar results when the analysis compared risk to vehicle footprint.)

Figure II–2 indicates that some vehicles on the road today have the same, or lower, fatality rates than models that weigh substantially more, and are substantially larger in terms of footprint. After accounting for differences in driver age and gender, safety features installed, and crash times and locations, there are numerous examples of different models with similar weight and footprint yet widely varying fatality rates. The variation of fatality rates among individual models may reflect differences in vehicle

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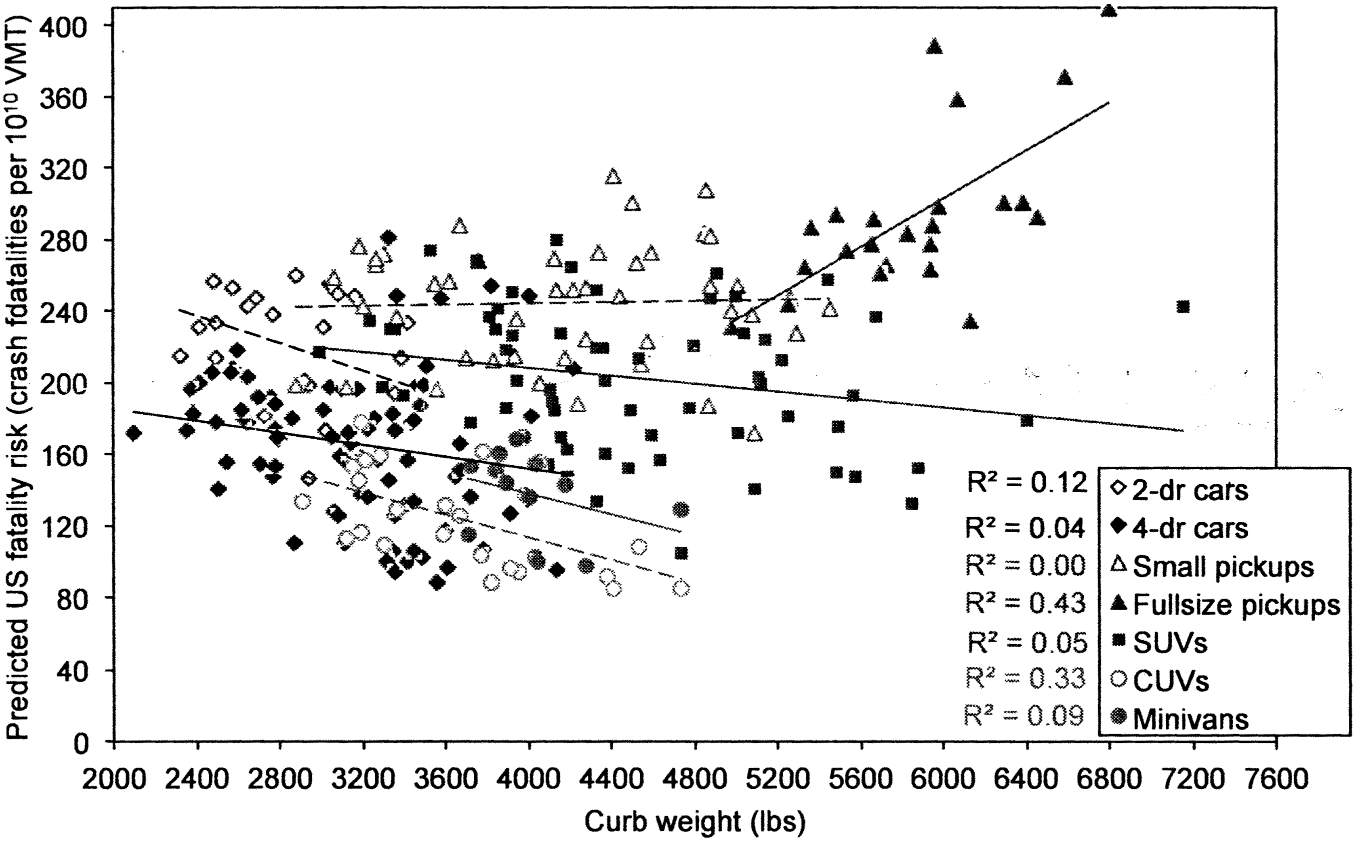
[199] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, April 1, 2010, Section II.G.3., page 139.

[200] And in 5 of the 27 crash and vehicle combinations, mass reduction increased risk in 5 deciles and decreased risk in 5 deciles.

design, differences in the drivers who choose such vehicles (beyond what can be explained by demographic variables such as age and gender), and statistical variation of fatality rates based on limited data for individual models. Differences in vehicle design can, and already do, mitigate some safety penalties from reduced mass; this is consistent with NHTSA's opinion that some of the changes in its regression results between the 2003 study and the 2011 study are due to the redesign or removal of certain smaller and lighter models of poor design.



f. Based on this information, what do the agencies consider to be the current state of statistical research on vehicle mass and safety?

The agencies believe that statistical analysis of historical crash data continues to be an informative and important tool in assessing the potential safety impacts of the proposed standards. The effect of mass reduction while maintaining footprint is a complicated topic and there are open questions whether future designs will reduce the historical correlation between weight and size. It is important to note that while the updated database represents more current vehicles with technologies more representative of vehicles on the road today, they still do not fully represent what vehicles will be on the road in the 2017–2025 timeframe. The vehicles manufactured in the 2000–2007 timeframe were not subject to footprint-based fuel economy standards. The agencies expect that the attribute-based standards will likely facilitate the design of vehicles such that manufacturers may reduce mass while maintaining footprint. Therefore, it is possible that the analysis for 2000–2007 vehicles may not be fully representative of the vehicles that will be on the road in 2017 and beyond.

While we recognize that statistical analysis of historical crash data may not be the only way to think about the future relationship between vehicle mass and safety, we also recognize that other assessment methods are also subject to uncertainties, which makes statistical analysis of historical data an important starting point if employed mindfully and recognized for how it can be useful and what its limitations may be.

NHTSA undertook the independent review of statistical studies and held the mass-safety workshop in February 2011 in order to help the agencies sort through the ongoing debates over what statistical analysis of historical data is actually telling us. Previously, the agencies have assumed that differences in results were due in part to inconsistent databases; by creating the updated common database and making it publicly available, we are hopeful that that aspect of the problem has been resolved, and moreover, the UMTRI review suggested that differences in data were probably less significant than the agencies may have thought. Statistical analyses of historical crash data should be examined for potential multicollinearity issues. The agencies will continue to monitor issues with multicollinearity in our analyses, and hope that outside researchers will do the same. And finally, based on the findings of the independent review, the agencies continue to be confident that Kahane's analysis is one of the best for the purpose of analyzing potential safety effects of future CAFE and GHG standards. UMTRI concluded that Kahane's approach is valid, and Kahane has continued and refined that approach for the current analysis. The NHTSA 2011 statistical fatality report finds directionally similar but less statistically significant relationships between vehicle mass, size, and footprint, as discussed above. Based on these findings, the agencies believe that in the future, fatalities due to mass reduction will be best reduced if mass reduction is concentrated in the heaviest vehicles. NHTSA considers part of the reason that more recent historical data shows a dampened effect in the relationship between mass reduction and safety is that all vehicles, including traditionally lighter ones, grew heavier during that timeframe (2000s). As lighter vehicles might become more prevalent in the fleet again over the next decade, it is possible that the trend could strengthen again. On the other hand, extensive use of new lightweight materials and optimized vehicle design may weaken the relationship. Future updated analyses will be necessary to determine how the effect of mass reduction on risk changes over time.

Both agencies agree that there are several identifiable safety trends already in place or expected to occur in the foreseeable future that are not accounted for in the study, since they were not in effect at the time that the vehicles in question were manufactured. For example, there are two important new safety standards that have already been issued and will be phasing in after MY 2008. FMVSS No. 126 (49 CFR § 571.126) requires electronic stability control in all new vehicles by MY 2012, and the upgrade to FMVSS 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, we anticipate continued improvements in driver (and passenger) behavior, such as higher safety belt use rates. All of these may tend to reduce the absolute number of fatalities. On the other hand, as crash avoidance technology improves, future statistical analysis of historical data may be complicated by a lower number of crashes. In summary, the agencies have relied on the coefficients in the Kahane 2011 study for estimating the potential safety effects of the proposed CAFE and GHG standards for MYs 2017–2025, based on our assumptions regarding the amount of mass reduction that could be used to meet the standards in a cost-effective way without adversely affecting safety. Section E below discusses the methodology used by the agencies in more detail; while the results of the safety effects analysis are less significant than the results in the MY 2012–2016 final rule, the agencies still believe that any statistically significant results warrant careful consideration of the assumptions about appropriate levels of mass reduction on which to base future CAFE and GHG standards, and have acted accordingly in developing the proposed standards.

4. How do the agencies think technological solutions might affect the safety estimates indicated by the statistical analysis?

As mass reduction becomes a more important technology option for manufacturers in meeting future CAFE and GHG standards, manufacturers will invest more and more resources in developing increasingly lightweight vehicle designs that meet their needs for manufacturability and the public's need for vehicles that are also safe, useful, affordable, and enjoyable to drive. There are many different ways to reduce mass, as discussed in Chapter 3 of this TSD and in Sections II, III, and IV of the preamble, and a considerable amount of information is available today on lightweight vehicle designs currently in production and that may be able to be put into production in the rulemaking timeframe. Discussion of lightweight material designs from NHTSA's workshop is presented below.

Besides ''lightweighting'' technologies themselves, though, there are a number of considerations when attempting to evaluate how future technological developments might affect the safety estimates indicated by the statistical analysis. As discussed in the first part of this chapter, for example, careful changes in design and/or materials used might mitigate some of the potential decrease in safety from mass reduction—through improved distribution of crash pulse energy, etc.—but these techniques can sometimes cause other problems, such as increased crash forces on vehicle occupants that have to be mitigated, or greater aggressivity against other vehicles in crashes. Manufacturers may develop new and better restraints—air bags, seat belts, etc.—to protect occupants in lighter vehicles in crashes, but NHTSA's current safety standards for restraint systems are designed based on the current fleet, not the yet-unknown future fleet. The agency will need to monitor trends in the crash data to see whether changes to the safety standards (or new safety standards) become necessary. Manufacturers are also increasingly investigating a variety of crash avoidance technologies—ABS, electronic stability control (ESC), lane departure warnings, vehicle-to-vehicle (V2V) communications—that, as they become more prevalent in the fleet, are expected to reduce the number of overall crashes, and fatal, crashes. Until these technologies are present in the fleet in greater numbers, however, it will be difficult to assess whether they can mitigate the observed relationship between vehicle mass and safety in the historical data.

Along with the California Air Resources Board (CARB), the agencies have initiated several projects to estimate the maximum potential for advanced materials and improved designs to reduce mass in the MY 2017–2021 timeframe, while continuing to meeting safety regulations and maintaining functionality of vehicles. Another NHTSA-sponsored study will estimate the effects of these design changes on overall fleet safety.

A. NHTSA has awarded a contract to Electricore, with EDAG and George Washington University (GWU) as subcontractors, to study the maximum feasible amount of mass reduction for a mid-size car—specifically, a Honda Accord. The study tore down a MY 2011 Honda Accord, studied each component and sub-system, and then redesigned each component and sub-system trying to maximize the amount of mass reduction with technologies that are considered feasible for 200,000 units per year production volume during the time frame of this rulemaking. Electricore and its sub-contractors are consulting industry leaders and experts for each component and sub-system when deciding which technologies are feasible. Electricore and its sub-contractors are also building detailed CAD/CAE/powertrain models to validate vehicle safety, stiffness, NVH, durability, drivability and powertrain performance. For OEM-supplied parts, a detailed cost model is being built based on a Technical Cost Modeling (TCM) approach developed by the Massachusetts Institute of Technology (MIT) Materials Systems Laboratory's research[201] to estimate the costs to OEMs for manufacturing parts. The cost will be broken down into each of the operations involved in the manufacturing; for example, for a sheet metal part, production costs will be estimated from the blanking of the steel coil to the final operation to fabricate the component. Total costs are then categorized into fixed cost, such as tooling, equipment, and facilities; and variable costs such as labor, material, energy, and maintenance. These costs will be assessed through an interactive process between the product designer, manufacturing engineers, and cost

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[201] Frank Field, Randolph Kirchain and Richard Roth, Process cost modeling: Strategic engineering and economic evaluation of materials technologies, JOM Journal of the Minerals, Metals and Materials Society, Volume 59, Number 10, 21–32. *Available at http://msl.mit.edu/pubs/docs/Field_KirchainCM_StratEvalMatls.pdf* (last accessed Aug. 22, 2011).

analysts. For OEM-purchased parts, the cost will be estimated by consultation with experienced cost analysts and Tier 1 system suppliers. This study will help to inform the agencies about the feasible amount of mass reduction and the cost associated with it. NHTSA intends to have this study completed and peer reviewed before July 2012, in time for it to play an integral role in informing the final rule.

B. EPA has awarded a similar contract to FEV, with EDAG and Monroe & Associates, Inc. as subcontractors, to study the maximum feasible amount of mass reduction for a mid-size CUV (cross over vehicle) specifically, a Toyota Venza. The study tears down a MY 2010 vehicle, studies each component and sub-system, and then redesigns each component and sub-system trying to maximize the amount of mass reduction with technologies that are considered feasible for high volume production for a 2017 MY vehicle. FEV in coordination with EDAG is building detailed CAD/CAE/powertrain models to validate vehicle safety, stiffness, NVH, durability, drivability and powertrain performance to assess the safety of this new design. This study builds upon the low development (20% mass reduction) design in the 2010 Lotus Engineering study ‘‘An Assessment of Mass Reduction Opportunities for a 2017–2020 Model Year Vehicle Program’’. This study builds upon the low development (20% mass reduction) design in the 2010 Lotus Engineering study ‘‘An Assessment of Mass Reduction Opportunities for a 2017–2020 Model Year Vehicle Program’’. This study will undergo a peer review. EPA intends to have this study completed and peer reviewed before July 2012, in time for it to play an integral role in informing the final rule.

C. California Air Resources Board (CARB) has awarded a contract to Lotus Engineering, to study the maximum feasible amount of mass reduction for a mid-size CUV (cross over vehicle) specifically, a Toyota Venza. The study will concentrate on the Body-in-White and closures in the high development design (40% mass reduction) in the Lotus Engineering study cited above. The study will provide an updated design with crash simulation, detailed costing and manufacturing feasibility of these two systems for a MY2020 high volume production vehicle. This study will undergo a peer review. EPA intends to have this study completed and peer reviewed before July 2012, in time for it to play an integral role in informing the final rule.

D. NHTSA has contracted with George Washington University (GWU) to build a fleet simulation model to study the impact and relationship of light-weight vehicle design and injuries and fatalities. This study will also include an evaluation of potential countermeasures to reduce any safety concerns associated with lightweight vehicles. NHTSA will include three light-weighted vehicle designs in this study: the one from Electricore/EDAG/GWU mentioned above, one from Lotus Engineering funded by California Air Resource Board for the second phase of the study, evaluating mass reduction levels around 35 percent of total vehicle mass, and two funded by EPA and the International Council on Clean Transportation (ICCT). This study will help to inform the agencies about the possible safety implications for light-weight vehicle designs and the appropriate counter-measures,[202] if applicable, for these designs, as well as the feasible amounts of mass reduction. All of these analyses are expected to be finished and peer-reviewed before July 2012, in time to inform the final rule.

a. NHTSA workshop on vehicle mass, size and safety

As stated above, in section C.2, on February 25, 2011, NHTSA hosted a workshop on mass reduction, vehicle size, and fleet safety at the Headquarters of the US Department of Transportation in Washington, DC. The purpose of the workshop was to provide the agencies with a broad understanding of current research in the field and provide stakeholders and the public with an opportunity to weigh in on this issue. The agencies also created a public docket to receive comments from interested parties that were unable to attend. The presentations were divided into two sessions that addressed the two expansive sets of issues. The first session explored statistical evidence of the roles of mass and size on safety, and is summarized in section C.2. The second session explored the engineering realities of structural crashworthiness, occupant injury and advanced vehicle design, and is summarized here. The speakers in the second session included Stephen Summers of NHTSA, Gregg Peterson of Lotus Engineering, Koichi Kamiji of Honda, John German of the International Council on Clean Transportation (ICCT), Scott Schmidt of the Alliance of Automobile Manufacturers, Guy Nusholtz of Chrysler, and Frank Field of the Massachusetts Institute of Technology.

The second session explored what degree of weight reduction and occupant protection are feasible from technical, economic, and manufacturing perspectives. Field emphasized that technical feasibility alone does not constitute feasibility in the context of vehicle mass reduction. Sufficient material production capacity and viable manufacturing processes are essential to economic feasibility. Both Kamiji and German noted that both good materials and good designs will be necessary to reduce fatalities. For example, German cited the examples of hexagonally structured aluminum columns, such as used in the Honda Insight, that can improve crash absorption at lower mass, and of high-strength steel components that can both reduce weight and improve safety. Kamiji made the point that widespread mass reduction will reduce the kinetic energy of all crashes which should produce some beneficial effect.

Summers described NHTSA's plans for a model to estimate fleetwide safety effects based on an array of vehicle-to-vehicle computational crash simulations of current and anticipated vehicle designs. In particular, three computational models of lightweight vehicles are under development. They are based on current vehicles that have been modified to substantially reduce mass. The most ambitious was the ‘‘high development’’ derivative of a Toyota Venza developed by Lotus Engineering and discussed by Mr. Peterson. Its structure currently contains about 75% aluminum, 12% magnesium, 8% steel, and 5% advanced composites. Peterson expressed confidence that the design had the potential to meet federal safety standards. Nusholtz emphasized that computational crash simulations involving more advanced materials were less reliable than those involving traditional metals such as aluminum and steel.

Nusholtz presented a revised data-based fleet safety model in which important vehicle parameters were modeled based on trends from current NCAP crash tests. For example, crash pulses and potential intrusion for a particular size vehicle were based on existing distributions. Average occupant deceleration was used to estimate injury risk. Through a range of simulations of modified vehicle fleets, he was able to estimate the net effects of various design strategies for lighter weight vehicles, such as various scaling approaches for vehicle stiffness or intrusion. The approaches were selected based on engineering requirements for modified

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[202] Countermeasures could potentially involve improved front end structure, knee bags, seat ramps, buckle pretensioners, and others.

vehicles. Transition from the current fleet was considered. He concluded that protocols resulting in safer transitions (*e.g.,* removing more mass from heavier vehicles with appropriate stiffness scaling according to a 3⁄2 power law) were not generally consistent with those that provide the greatest reduction in GHG production.

German discussed several important points on the future of mass reduction. Similar to Kahane's discussion of the difficulties of isolating the impact of weight reduction, German stated that other important variables, such as vehicle design and compatibility factors, must be held constant in order for size or weight impacts to be quantified in statistical analyses. He presented results that, compared to driver, driving influences, and vehicle design influences, the safety impacts of size and weight are small and difficult to quantify. He noted that several scenarios, such as rollovers, greatly favored the occupants of smaller and lighter cars once a crash occurred. He pointed out that if size and design are maintained, lower weight should translate into a lower total crash force. He thought that advanced material designs have the potential to ''decouple'' the historical correlation between vehicle size and weight, and felt that effective design and driver attributes may start to dominate size and weight issues in future vehicle models.

Other presenters noted industry's perspective of the effect of incentivizing weight reduction. Field highlighted the complexity of institutional changes that may be necessitated by weight reduction, including redesign of material and component supply chains and manufacturing infrastructure. Schmidt described an industry perspective on the complicated decisions that must be made in the face of regulatory change, such as evaluating goals, gains, and timing.

Field and Schmidt noted that the introduction of technical innovations is generally an innate development process involving both tactical and strategic considerations that balance desired vehicle attributes with economic and technical risk. In the absence of challenging regulatory requirements, a substantial technology change is often implemented in stages, starting with lower volume pilot production before a commitment is made to the infrastructure and supply chain modifications necessary for inclusion on a high-volume production model. Joining, damage characterization, durability, repair, and significant uncertainty in final component costs are also concerns. Thus, for example, the widespread implementation of high-volume composite or magnesium structures might be problematic in the short or medium term when compared to relatively transparent aluminum or high strength steel implementations. Regulatory changes will affect how these tradeoffs are made and these risks are managed.

Koichi Kamiji presented data showing in increased use of high strength steel in their Honda product line to reduced vehicle mass and increase vehicle safety. He stated that mass reduction is clearly a benefit in 42% of all fatal crashes because absolute energy is reduced. He followed up with slides showing the application of certain optimized it designs can improve safety even when controlling for weight and size.

A philosophical theme developed that explored the ethics of consciously allowing the total societal harm associated with mass reduction to approach the anticipated benefits of enhanced safety technologies. Although some participants agreed that there may eventually be specific fatalities that would not have occurred without downsizing, many also agreed that safety strategies will have to be adapted to the reality created by consumer choices, and that ''We will be ok if we let data on what works—not wishful thinking—guide our strategies.''

5. How have the agencies estimated safety effects for the proposed standards?

a. What was the agencies' methodology for estimating safety effects for the proposed standards?

As explained above, the agencies consider the 2011 statistical analysis of historical crash data by NHTSA to represent the best estimates of the potential relationship between mass reduction and fatality increases in the future fleet. This section discusses how the agencies used NHTSA's 2011 analysis to calculate specific estimates of safety effects of the proposed standards, based on the analysis of how much mass reduction manufacturers might use to meet the proposed standards.

Neither the proposed CAFE/GHG standards nor the agencies' analysis mandates mass reduction, or mandates that mass reduction occur in any specific manner. However, mass reduction is one of the technology applications available to the manufacturers and a degree of mass reduction is used by both agencies' models to determine the capabilities of manufacturers and to predict both cost and fuel consumption/emissions impacts of improved CAFE/GHG standards. We note that the amount of mass reduction selected for this rulemaking is based on our assumptions about how much is technologically feasible without compromising safety. While we are confident that manufacturers will build safe vehicles, we cannot predict with certainty that they will choose to reduce mass in exactly the ways that the agencies have analyzed in response to the standards. In the event that manufacturers ultimately choose to reduce mass and/or footprint in ways not analyzed or anticipated by the agencies, the safety effects of the rulemaking may likely differ from the agencies' estimates.

NHTSA utilized the 2011 Kahane study relationships between weight and safety, expressed as percent changes in fatalities per 100-pound weight reduction while holding footprint constant. However, as mentioned previously, there are several identifiable safety trends already occurring, or expected to occur in the foreseeable future, that are not accounted for in the study. For example, the two important new safety standards that were discussed above for electronic stability control and head curtain airbags, have already been issued and began phasing in after MY 2008. The recent shifts in market shares from pickups and SUVs to cars and CUVs may continue, or accelerate, if gasoline prices remain high, or rise further. The growth in vehicle miles travelled may continue to stagnate if the economy does not improve, or gasoline prices remain high. And improvements in driver (and passenger) behavior, such as higher safety belt use rates, may continue. All of these will tend to reduce the absolute number of fatalities in the future. The agency estimated the overall change in fatalities by calendar year after adjusting for ESC, Side Impact Protection, and other Federal safety standards and behavioral changes projected through this time period. The smaller percent changes in risk from mass reduction (from the 2011 NHTSA analysis), coupled with the reduced number of baseline fatalities, results in smaller absolute increases in fatalities than those predicted in the 2010 rulemaking.

NHTSA examined the impacts of identifiable safety trends over the lifetime of the vehicles produced in each model year. An estimate of these impacts was contained in a previous agency report.[203] The impacts were estimated on a year-by-year basis, but could be examined in a combined fashion. Using this method, we estimate a 12.6 percent reduction in fatality levels between 2007 and 2020 for the combination of safety standards and behavioral changes anticipated (ESC, head-curtain air bags, and increased belt use). Since the same safety standards are taking effect in the same years, the estimates derived from applying NHTSA fatality percentages to a baseline of 2007 fatalities were thus multiplied by 0.874 to account for changes that NHTSA believes will take place in passenger car and light truck safety between the 2007 baseline on-road fleet used for this particular safety analysis and year 2025.

To estimate the amount of mass reduction to apply in the rulemaking analysis, the agencies considered fleet safety effects for mass reduction. As previously discussed and shown in Table II–15, the Kahane 2011 study shows that applying mass reduction to CUVs and light duty trucks will generally decrease societal fatalities, while applying mass reduction to passenger cars will increase fatalities. The CAFE model uses coefficients from the Kahane study along with the mass reduction level applied to each vehicle model to project societal fatality effects in each model year. NHTSA used the CAFE model and conducted iterative modeling runs varying the maximum amount of mass reduction applied to each subclass in order to identify a combination that achieved a high level of overall fleet mass reduction while not adversely affecting overall fleet safety. These maximum levels of mass reduction for each subclass were then used in the CAFE model for the rulemaking analysis. The agencies believe that mass reduction of up to 20 percent is feasible on light trucks, CUVs and minivans,[204] but that less mass reduction should be implemented on other vehicle types to avoid increases in societal fatalities. For this proposal, NHTSA used the mass reduction levels shown in Table II–15.

Table II-15 Mass Reduction Levels Applied in CAFE Model

Absolute %	Subcompact and Subcompact Perf. PC	Compact and Compact Perf. PC	Midsize PC and Midsize Perf. PC	Large PC and Large Perf. PC	Minivan LT	Small, Midsize and Large LT
MR1*	0.0%	2.0%	1.5%	1.5%	1.5%	1.5%
MR2	0.0%	0.0%	5.0%	7.5%	7.5%	7.5%
MR3	0.0%	0.0%	0.0%	10.0%	10.0%	10.0%
MR4	0.0%	0.0%	0.0%	0.0%	15.0%	15.0%
MR5	0.0%	0.0%	0.0%	0.0%	20.0%	20.0%

Notes:

*MR1-MR5: different levels of mass reduction used in CAFE model

For the CAFE model, these percentages apply to a vehicle's total weight, including the powertrain. Table II–16 shows the amount of mass reduction in pounds for these percentage mass reduction levels for a typical vehicle weight in each subclass.

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[203] Countermeasures could potentially involve improved front end structure, knee bags, seat ramps, buckle pretensioners, and others.

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). Since 2008 was a recession year, it does not seem appropriate to use that as a baseline. We believe this same ratio should hold for this analysis which should compare 2025 to 2008. Thus, we are inclined to continue to use the same ratio.

[204] When applying mass reduction, NHSTA capped the maximum amount of mass reduction to 20 percent for any individual vehicle class. The 20 percent cap is the maximum amount of mass reduction the agencies believe to be feasible in MYs 2017–2025 time frame.

Table II-16 Examples of Mass Reduction in Pound for Different Vehicle Subclasses

Mass Reduction (lbs)	Subcompact and Subcompact Perf. PC	Compact and Compact Perf. PC	Midsize PC and Midsize Perf. PC	Large PC and Large Perf. PC	Minivan LT	Small LT	Midsize LT	Large LT
Typical Vehicle Weight (lbs)	2795	3359	3725	4110	4250	3702	4260	5366
MR1 (lbs)	0	67	56	62	64	56	64	80
MR2 (lbs)	0	0	186	308	319	278	320	402
MR3 (lbs)	0	0	0	411	425	370	426	537
MR4 (lbs)	0	0	0	0	638	555	639	805
MR5 (lbs)	0	0	0	0	850	740	852	1073

After applying the mass reduction levels in the CAFE model, Table II–17 shows the results of NHTSA's safety analysis separately for each model year.[205] These are estimated increases or decreases in fatalities over the lifetime of the model year fleet. A positive number means that fatalities are projected to increase, a negative number (indicated by parentheses) means that fatalities are projected to decrease. The results are significantly affected by the assumptions put into the Volpe model to take more weight out of the heavy LTVs, CUVs, and minivans than out of other vehicles. As the negative coefficients only appear for LTVs greater than 4,594 lbs., CUVs, and minivans, a statistically improvement in safety can only occur if more weight is taken out of these vehicles than passenger cars or smaller light trucks. Combining passenger car and light truck safety estimates for the proposed standards results in an increase in fatalities over the lifetime of the nine model years of MY 2017–2025 of 4 fatalities, broken up into an increase of 61 fatalities in passenger cars and 56 decrease in fatalities in light trucks. NHTSA also analyzed the results for different regulatory alternatives in Chapter IX of its PRIA; the difference in the results by alternative depends upon how much weight reduction is used in that alternative and the types and sizes of vehicles that the weight reduction applies to.

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[205] NHTSA has changed the definitions of a passenger car and light truck for fuel economy purposes between the time of the Kahane 2003 analysis and this proposed rule. About 1.4 million 2 wheel drive SUVs have been redefined as passenger cars instead of light trucks. The Kahane 2011 analysis continues with the definitions used in the Kahane 2003 analysis. Thus, there are different definitions between Tables IX–1 and IX–2 (which use the old definitions) and Table IX–3 (which uses the new definitions).

Table II-17 NHTSA Calculated Mass-Safety-Related Fatality Impacts of the Proposed Standards over the Lifetime of the Vehicles Produced in each Model Year

	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger cars	(2)	(0)	11	16	15	13	12	1	(2)	63
Light trucks	3	(7)	0	(13)	(8)	(15)	(12)	(8)	0	(56)
Total	1	(8)	12	3	7	(2)	0	(8)	(2)	4

Using the same coefficients from the 2011 Kahane study, EPA used the OMEGA model to conduct a similar analysis. After applying these percentage increases to the estimated weight reductions per vehicle size by model year assumed in the Omega model, Table II–18 shows the results of EPA's safety analysis separately for each model year. These are estimated increases or decreases in fatalities over the lifetime of the model year fleet. A positive number means that fatalities are projected to increase; a negative number means that fatalities are projected to decrease. For details, see the EPA RIA Chapter 3.

Table II-18 EPA Calculated Mass-Safety-Related Fatality Impacts of the Proposed Standards over the Lifetime of the Vehicles Produced in each Model Year

	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger cars	-3	-5	-8	-11	-14	8	32	58	86	143
Light trucks	-1	-1	-2	-2	-4	-35	-67	-99	-133	-343
Total	-3	-7	-10	-13	-18	-27	-34	-41	-47	-201

b. Why might the real-world effects be less than or greater than what the agencies have calculated?

As discussed above the ways in which future technological advances could potentially mitigate the safety effects estimated for this rulemaking: lightweight vehicles could be designed to be both stronger and not more aggressive; restraint systems could be improved to deal with higher crash pulses in lighter vehicles; crash avoidance technologies could reduce the number of overall crashes; roofs could be strengthened to improve safety in rollovers. As also stated above, however, while we are confident that manufacturers will strive to build safe vehicles, it will be difficult for both the agencies and the industry to know with certainty ahead of time how crash trends will change in the future fleet as lightweighted vehicles become more prevalent. Going forward, we will have to continue to monitor the crash data as well as changes in vehicle weight relative to what we expect.

Additionally, we note that the total amount of mass reduction used in the agencies' analysis for this rulemaking were chosen based on our assumptions about how much is technologically feasible without compromising safety. Again, while we are confident that manufacturers are motivated to build safe vehicles, we cannot predict with certainty that they will choose to reduce mass in exactly the ways that the agencies have analyzed in response to the standards. In the event that manufacturers ultimately choose to reduce mass and/or footprint in ways not analyzed by the agencies, the safety effects of the rulemaking may likely differ from the agencies' estimates.

The agencies acknowledge the proposal does not prohibit manufacturers from redesigning vehicles to change wheelbase and/or track width (footprint). However, as NHTSA explained in promulgating MY2008–2011 light truck CAFE standards and MY2011 passenger car and light truck CAFE standards, and as the agencies jointly explained in promulgating MY2012–2016 CAFE and GHG standards, the agencies believes such engineering changes are significant enough to be unattractive as a measure to undertake solely to reduce compliance burdens. Similarly, the agencies acknowledge that a manufacturer could, without actually reengineering specific vehicles to increase footprint, shift production toward those that perform well compared to their respective footprint-based targets. However, NHTSA and, more recently NHTSA and EPA have previously explained, because such production shifts would run counter to market demands, they would also be competitively unattractive. Based on this regulatory design, the analysis assumes this proposal will not have either of the effects described above.

As discussed in Chapter 2 of the Draft Joint TSD, the agencies note that the standard is flat for vehicles smaller than 41 square feet and that downsizing in this category could help achieve overall compliance, if the vehicles are desirable to consumers. The agencies note that less than 10 percent of MY2008 passenger cars were below 41 square feet, and due to the overall lower level of utility of these vehicles, and the engineering challenges involved in ensuring that these vehicles meet all applicable federal motor vehicle safety standards (FMVSS), we expect a significant increase in this segment of the market in the future is unlikely. Please see Chapter 2 of the Draft Joint TSD for additional discussion.

We seek comment on the appropriateness of the overall analytic assumption that the attribute-based aspect of the proposed standards will have no effect on the overall distribution of vehicle footprints. Notwithstanding the agencies current judgment that such deliberate reengineering or production shift are unlikely as pure compliance strategies, both agencies are considering the potential future application of vehicle choice models, and anticipate that doing so could result in estimates that market shifts induced by changes in vehicle prices and fuel economy levels could lead to changes in fleet's footprint distribution. However, neither agency is currently able to include vehicle choice modeling in our analysis.

As discussed in Chapter 2 of the Draft Joint TSD, the agencies note that the standard is flat for vehicles smaller than 41 square feet and that downsizing in this category could help achieve overall compliance, if the vehicles are desirable to consumers. The agencies note that less than 10 percent of MY2008 passenger cars were below 41 square feet, and due to the overall lower level of utility of these vehicles, and the engineering challenges involved in ensuring that these vehicles meet all applicable federal motor vehicle safety standards (FMVSS), we expect a significant increase in this segment of the market in the future is unlikely. Please see Chapter 2 of the Draft Joint TSD for additional discussion.

c. Do the agencies plan to make any changes in these estimates for the final rule?

As discussed above, the agencies have based our estimates of safety effects due to the proposed standards on Kahane's 2011 report. That report is currently undergoing peer review and is docketed for public review;[206] the peer review comments and response to peer review comments, along with any revisions to the report in response to that review, will also be docketed there. Depending on the results of the peer review, our calculation of safety effects for the final rule will also be revised accordingly. The agencies will also consider any comments received on the proposed rule, and determine at that time whether and how our estimates should be changed in response to those comments. Additional studies published by the agencies or other independent researchers as previously discussed will also be considered, along with any other relevant information.

III. EPA Proposal for MYs 2017–2025 Greenhouse Gas Vehicle Standards

A. Overview of EPA Rule

1. Introduction

Soon after the completion of the successful model years (MYs) 2012–2016 rulemaking in May 2010, the President, with support from the auto manufacturers, requested that EPA and NHTSA work to extend the National Program to MYs 2017–2025 light duty vehicles. The agencies were requested to develop ''a coordinated national program under the CAA (Clean Air Act) and the EISA (Energy Independence and Security Act of 2007) to improve fuel efficiency and to reduce greenhouse gas emissions of passenger cars and light-duty trucks of model years 2017–2025.'' [207] EPA's proposal grows directly out of our work with NHTSA and CARB in developing such a continuation of the National Program. This proposal provides important benefits to society and consumers in the form of reduced emissions of greenhouse gases (GHGs), reduced consumption of oil, and fuel savings for consumers, all at reasonable costs. It provides industry with the important certainty and leadtime needed to implement the technology changes that will achieve these benefits, as part of a harmonized set of federal requirements. Acting now to address the standards for MYs 2017–2025 will allow for the important continuation of the National Program that started with MYs 2012–2016.

EPA is proposing GHG emissions standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles (hereafter light vehicles) for MYs 2017 through 2025. These vehicle categories, which include cars, sport utility vehicles, minivans, and pickup trucks used for personal

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[206] Kahane, C. J. (2011). ''Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs,'', July 2011. The report is available in the NHTSA docket, NHTSA–2010–0152. You can access the docket at *http://www.regulations.gov/#!home* by typing 'NHTSA–2010–0152' where it says ''enter keyword or ID'' and then clicking on ''Search.''

[207] The Presidential Memorandum is found at: *http://www.whitehouse.gov/the-press-office/presidential-memorandum-regarding-fuel-efficiency-standards.*

transportation, are responsible for almost 60% of all U.S. transportation related GHG emissions.

If finalized, this proposal would be the second EPA rule to regulate light vehicle GHG emissions under the Clean Air Act (CAA), building upon the GHG emissions standards for MYs 2012–2016 that were established in 2010,[208] and the third rule to regulate GHG emissions from the transportation sector.[209] Combined with the standards already in effect for MYs 2012–2016, the proposed standards would result in MY 2025 light vehicles emitting approximately one-half of the GHG emissions of MY 2010 vehicles and would represent the most significant federal action ever taken to reduce GHG emissions (and improve fuel economy) in the U.S.

From a societal standpoint, the proposed GHG emissions standards are projected to save approximately 2 billion metric tons of GHG emissions and 4 billion barrels of oil over the lifetimes of those vehicles sold in MYs 2017–2025. EPA estimates that fuel savings will far outweigh higher vehicle costs, and that the net benefits to society will be in the range of $311 billion (at 7% discount rate) to $421 billion (3% discount) over the lifetimes of those vehicles sold in MYs 2017–2025. Just in calendar year 2040 alone, after the on-road vehicle fleet has largely turned over to vehicles sold in MY 2025 and later, EPA projects GHG emissions savings of 462 million metric tons, oil savings of 2.63 million barrels per day, and net benefits of $144 billion using the $22/ton CO_2 social cost of carbon value.

EPA estimates that these proposed standards will save consumers money. Higher costs for new technology, sales taxes, and insurance will add, on average in the first year, about $2100 for consumers who buy a new vehicle in MY 2025. But those consumers who drive their MY 2025 vehicle for its entire lifetime will save, on average, $5200 (7% discount rate) to $6600 (3% discount) in fuel savings, for a net lifetime savings of $3000–$4400. For those consumers who purchase their new MY 2025 vehicle with cash, the discounted fuel savings will offset the higher vehicle cost in less than 4 years, and fuel savings will continue for as long as the consumer owns the vehicle. Those consumers that buy a new vehicle with a 5-year loan will benefit from a monthly cash flow savings of $12 (or about $140 per year), on average, as the monthly fuel savings more than offsets the higher monthly payment due to the higher incremental vehicle cost.

The proposed standards are designed to allow full consumer choice, in that they are footprint-based, *i.e.,* larger vehicles have higher absolute GHG emissions targets and smaller vehicles have lower absolute GHG emissions targets. While the GHG emissions targets do become more stringent each year, the emissions targets have been selected to allow compliance by vehicles of all sizes and with current levels of vehicle attributes such as utility, size, safety, and performance. Accordingly, these proposed standards are projected to allow consumers to choose from the same mix of vehicles that are currently in the marketplace.

Section I above provides a comprehensive overview of the joint EPA/NHTSA proposal, including the history and rationale for a National Program that allows manufacturers to build a single fleet of light vehicles that can satisfy all federal and state requirements for GHG emissions and fuel economy, the level and structure of the proposed GHG emissions and corporate average fuel economy (CAFE) standards, the compliance flexibilities proposed to be available to manufacturers, the mid-term evaluation, and a summary of the costs and benefits of the GHG and CAFE standards based on a ‘‘model year lifetime analysis.’’

In this Section III, EPA provides more detailed information about EPA's proposed GHG emissions standards. After providing an overview of key information in this section (III.A), EPA discusses the proposed standards (III.B); the vehicles covered by the standards, various compliance flexibilities available to manufacturers, and a mid-term evaluation (III.C); the feasibility of the proposed standards (III.D); provisions for certification, compliance, and enforcement (III.E); the reductions in GHG emissions projected for the proposed standards and the associated effects of these reductions (III.F); the impact of the proposal on non-GHG emissions and their associated effects (III.G); the estimated cost, economic, and other impacts of the proposal (III.H); and various statutory and executive order issues (III.I).

2. Why is EPA proposing this Rule?

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

Greenhouse gases (GHGs) are gases in the atmosphere that effectively trap some of the Earth's heat that would otherwise escape to space. GHGs are both naturally occurring and anthropogenic. The primary GHGs 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. They become well mixed globally in the atmosphere and their concentrations accumulate when emissions exceed the rate at which natural processes remove GHGs from the atmosphere. The heating effect caused by the human-induced buildup of GHGs in the atmosphere is very likely the cause of most of the observed global warming over the last 50 years. The key effects of climate change observed to date and projected to occur in the future include, but are not limited to, more frequent and intense heat waves, more severe wildfires, degraded air quality, heavier and more frequent downpours and flooding, increased drought, greater sea level rise, more intense storms, harm to water resources, continued ocean acidification, harm to agriculture, and harm to wildlife and ecosystems. A more in depth explanation of observed and projected changes in GHGs and climate change, and the impact of climate change on health, society, and the environment is included in Section III.F below.

Mobile sources represent a large and growing share of U.S. GHG emissions 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 30% of all U.S. GHGs, and have been the source of the largest absolute increase in U.S. GHGs since 1990. Transportation sources, which do not include certain off highway sources such as farm and construction equipment, account for 27% of U.S. GHG emissions, and motor vehicles (CAA section 202(a)), 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.

Light duty vehicles emit carbon dioxide, methane, nitrous oxide and hydrofluorocarbons. Carbon dioxide (CO2) is the end product of fossil fuel combustion. During combustion, the carbon stored in the fuels is oxidized and emitted as CO2 and smaller amounts of other carbon compounds. Methane (CH4) emissions are a function of the methane content of the motor fuel, the amount of hydrocarbons passing uncombusted through the

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[208] 75 FR 25324 (May 7, 2010).

[209] 76 FR 57106 (September 15, 2011) established GHG emission standards for heavy-duty vehicles and engines for model years 2014–2018.

engine, and any post-combustion control of hydrocarbon emissions (such as catalytic converters). 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 (HC) emissions can promote the formation of N_2O. Hydrofluorocarbons (HFC) 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.

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.'' The Administrator has found that the elevated concentrations of a group of six GHGs in the atmosphere may reasonably be anticipated to endanger public health and welfare, and that emissions of GHGs from new motor vehicles and new motor vehicle engines contribute to this air pollution.

As a result of these findings, section 202(a) requires EPA to issue standards applicable to emissions of that air pollutant, and authorizes EPA to revise them from time to time. This preamble describes the proposed revisions to the current standards to control emissions of CO2 and HFCs from new light-duty motor vehicles.[210] For further discussion of EPA's authority under section 202(a), see Section I.D. of the preamble.

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

On December 15, 2009, EPA published its findings that elevated atmospheric concentrations of GHGs are reasonably anticipated to endanger the public health and welfare of current and future generations, and that emissions of GHGs from new motor vehicles contribute to this air pollution. Further information on these findings may be found at 74 FR 66496 (December 15, 2009) and 75 FR 49566 (Aug. 13, 2010).

3. What is EPA proposing?

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

EPA is proposing tailpipe carbon dioxide (CO_2) standards for cars and light trucks based on the CO_2 emissions-footprint curves for cars and light trucks that are shown above in Section I.B.3 and below in Section III.B. These curves establish different CO_2 emissions targets for each unique car and truck footprint value. Generally, the larger the vehicle footprint, the higher the corresponding vehicle CO_2 emissions target. Vehicle CO_2 emissions will be measured over the EPA city and highway tests. Under this proposal, various incentives and credits are available for manufacturers to demonstrate compliance with the standards. See Section I.B for a comprehensive overview of both the EPA CO_2 emissions-footprint standard curves and the various compliance flexibilities that are proposed to be available to the manufacturers in meeting the EPA tailpipe CO_2 standards.

EPA projects that the proposed tailpipe CO_2 emissions-footprint curves would yield a fleetwide average light vehicle CO_2 emissions compliance target level in MY 2025 of 163 grams per mile, which would represent an average reduction of 35 percent relative to the projected average light vehicle CO_2 level in MY 2016. On average, car CO_2 emissions would be reduced by about 5 percent per year, while light truck CO2 emissions would be reduced by about 3.5 percent per year from MY 2017 through 2021, and by about 5 percent per year from MY 2022 through 2025.

The following three tables, Table III–1 through Table III–3, summarize EPA's projections of what the proposed standards would mean in terms of projected CO_2 emissions reductions for passenger cars, light trucks, and the overall fleet combining passenger cars and light trucks for MYs 2017–2025. It is important to emphasize that these projections are based on technical assumptions by EPA about various matters, including the mix of cars and trucks, as well as the mix of vehicle footprint values, in the fleet in varying years. It is possible that the actual CO_2 emissions values will be either higher or lower than the EPA projections.

In each of these tables, the column ''Projected CO_2 Compliance Target'' represents our projected fleetwide average CO_2 compliance target value based on the proposed CO_2-footprint curve standards as well as the projected mixes of cars and trucks and vehicle footprint levels. This Compliance Target represents the projected fleetwide average of the projected standards for the various manufacturers.

The column(s) under ''Incentives'' represent the emissions impact of the proposed multiplier incentive for EV/PHEV/FCVs and the proposed pickup truck incentives. These incentives allow manufacturers to meet their Compliance Targets with CO2 emissions levels slightly higher than they would otherwise have to be, but do not reflect actual real-world CO_2 emissions reductions. As such they reduce the emissions reductions that the CO_2 standards would be expected to achieve.

The column ''Projected Achieved CO2'' is the sum of the CO_2 Compliance Target and the value(s) in the ''Incentive'' columns. This Achieved CO_2 value is a better reflection of the CO_2 emissions benefits of the standards, since it accounts for the incentive programs. One incentive that is not reflected in these tables is the 0 gram per mile compliance value for EV/PHEV/FCVs. The 0 gram per mile value accurately reflects the tailpipe CO_2 gram per mile achieved by these vehicles; however, the use of this fuel does impact the overall GHG reductions associated with the proposed standards due to fuel production and distribution-related upstream GHG emissions which are projected to be greater than the upstream GHG emissions associated with gasoline from oil. The combined impact of the 0 gram per mile and multiplier incentive for EV/PHEV/FCVs on overall program GHG emissions is discussed in more detail below in Section III.C.2.

The columns under ''Credits'' quantify the projected CO_2 emissions credits that we project manufacturers will achieve through improvements in air conditioner refrigerants and efficiency. These credits reflect real world emissions reductions, so they do not raise the levels of the Achieved CO_2 values, but they do allow manufacturers to comply with their compliance targets with 2-cycle test CO_2 emissions values

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[210] EPA is not proposing to amend the substantive standards adopted in the 2012–2016 light-duty vehicle rule for N_2O and CH_4, but is proposing revisions to the options that manufacturers have in meeting the N2O and CH4 standards, and to the timeframe for manufacturers to begin measuring N2O emissions. See Section III.B below.

higher than otherwise. One other credit program that could similarly affect the 2-cycle CO_2 values is the off-cycle credit program, but it is not included in this table due to the uncertainty inherent in projecting the future use of these technologies. The off-cycle credits, like A/C credits, reflect real world reductions, so they would not change the CO2 Achieved values.

The column ''Projected 2-cycle CO2'' is the projected fleetwide 2-cycle CO_2 emissions values that manufacturers would have to achieve in order to be able to comply with the proposed standards. This value is the sum of the projected fleetwide credit, incentive, and Compliance Target values.[211]

Table III-1 EPA Projections for Fleetwide Tailpipe Emissions Compliance with Proposed CO_2 Standards – Passenger Cars (Grams per mile)

		Incentives (1)		Credits (2)		
Model Year	Projected CO_2 Compliance Target	EV/PHEV/FCV Multiplier	Projected Achieved CO_2	A/C Refrigerant	A/C Efficiency	Projected 2-cycle CO_2
2016 (base)	225	--	225	5.4	4.8	235
2017	213	2.2	215	7.8	5.0	228
2018	202	2.1	205	9.3	5.0	219
2019	192	2.0	194	10.8	5.0	210
2020	182	1.5	184	12.3	5.0	201
2021	173	1.0	174	13.8	5.0	193
2022	165	--	165	13.8	5.0	184
2023	158	--	158	13.8	5.0	177
2024	151	--	151	13.8	5.0	169
2025	144	--	144	13.8	5.0	163

(1) The one incentive not reflected in this table is the 0 gram per mile compliance value for EV/PHEV/FCVs. See text for explanation.

(2) The one credit not reflected in this table is the off-cycle credit. See text for explanation.

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[211] For MY 2016, the Temporary Leadtime Allowance Alternative Standards are available to manufacturers. In the MYs 2012–2016 rule, we estimated the impact of this credit in MY 2016 to be 0.1 gram/mile. Due to the small magnitude, we have not included this in the following tables for the MY 2016 base year.

Table III-2 EPA Projections for Fleetwide Tailpipe Emissions Compliance with Proposed CO_2 Standards – Light Trucks

(Grams per mile)

		Incentives (1)				Credits (2)		
Model Year	Projected CO_2 Compliance Target	EV/PHEV/FCV Multiplier	Pickup Mild HEV + Perf	Pickup Strong HEV + Perf	Projected Achieved CO_2	A/C Refrigerant	A/C Efficiency	Projected 2-cycle CO_2
2016 (base)	298[212]	--	--	--	298	6.6	4.8	309
2017	295	0.0	0.3	0.0	295	7.0	5.0	307
2018	285	0.0	0.4	0.1	285	11.0	6.5	303
2019	277	0.1	0.6	0.2	278	13.4	7.2	299
2020	270	0.1	0.7	0.2	271	15.3	7.2	293
2021	250	0.0	0.8	0.4	251	17.2	7.2	275
2022	237	--	--	0.5	238	17.2	7.2	262
2023	225	--	--	0.6	226	17.2	7.2	250
2024	214	--	--	0.6	214	17.2	7.2	239
2025	203	--	--	0.7	204	17.2	7.2	228

(1) The one incentive not reflected in this table is the 0 gram per mile compliance value for EV/PHEV/FCVs. See text for explanation.

(2) The one credit not reflected in this table is the off-cycle credit. See text for explanation.

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[212] The projected fleet compliance levels for 2016 are different for trucks and the fleet than were projected in the 2012-2016 rule. Our assessment for this proposal is based on a predicted 2016 truck value of 297 g/mi. That is because the standards are footprint based and the fleet projections, hence the footprint distributions, change slightly with each update of our projections, as described below. In addition, the actual fleet compliance levels for any model year will not be known until the end of that model year based on actual vehicle sales.

Table III-3 EPA Projections for Fleetwide Tailpipe Emissions Compliance with Proposed CO_2 Standards –

Combined Cars and Trucks (Grams per mile)

		Incentives (1)				Credits (2)		
Model Year	Projected CO_2 Compliance Target	EV/PHEV/FCV Multiplier	Pickup Mild HEV + Perf	Pickup Strong HEV + Perf	Projected Achieved CO_2	A/C Refrigerant	A/C Efficiency	Projected 2-cycle CO_2
2016 (base)	250[213]	--	--	--	250	5.8	4.8	263
2017	243	1.4	0.1	0.0	245	7.5	5.0	257
2018	232	1.3	0.2	0.0	234	9.9	5.5	249
2019	223	1.3	0.2	0.1	224	11.7	5.8	242
2020	213	1.0	0.3	0.1	214	13.4	5.8	234
2021	200	0.6	0.3	0.1	201	15.0	5.8	222
2022	190	--	--	0.2	190	15.0	5.8	211
2023	181	--	--	0.2	181	15.0	5.8	202
2024	172	--	--	0.2	172	14.9 (3)	5.7 (3)	193
2025	163	--	--	0.2	163.6	14.9	5.7	184

(1) The one incentive not reflected in this table is the 0 gram per mile compliance value for EV/PHEV/FCVs. See text for explanation.

(2) The one credit not reflected in this table is the off-cycle credit. See text for explanation.

(3) The projected A/C refrigerant and A/C efficiency credits decline by 0.1 g/mi in MY 2024 due to a slight change in projected car-truck market shares.

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Table III–4 shows the projected real world CO_2 emissions and fuel economy values associated with the proposed CO_2 standards. These real world estimates, similar to values shown on new vehicle labels, reflect the fact that the way cars and trucks are operated in the real world generally results in higher CO_2 emissions and lower fuel economy than laboratory test results used to determine compliance with the standards, which are performed under tightly controlled conditions. There are many assumptions that must be made for these projections, and real world CO_2 emissions and fuel economy performance can vary based on many factors.

The real world tailpipe CO_2 emissions projections in Table III–4 are calculated starting with the projected 2-cycle CO_2 emissions values in Table III–1 through Table III–3, subtracting the air conditioner efficiency credits, and then multiplying by a factor of 1.25. The 1.25 factor is an approximation of the ratio of real world CO_2 emissions to 2-cycle test CO_2 emissions for the fleet in the

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[213] The projected fleet compliance levels for 2016 are different for trucks and the fleet than were projected in the 2012-2016 rule. Our assessment for this proposal is based on a predicted 2016 combined car and truck value of 252 g/mi. That is because the standards are footprint based and the fleet projections, hence the footprint distributions, change slightly with each update of our projections, as described below. In addition, the actual fleet compliance levels for any model year will not be known until the end of that model year based on actual vehicle sales.

recent past. It is not possible to know the appropriate factor for future vehicle fleets, as this factor will depend on many factors such as technology performance, driver behavior, climate conditions, fuel composition, etc. Issues associated with future projections of this factor are discussed in TSD 4. Air conditioner efficiency credits were subtracted from the 2-cycle CO_2 emissions values as air conditioning efficiency improvements will increase real world fuel economy. The real world fuel economy value is calculated by dividing 8887 grams of CO_2 per gallon of gasoline by the real world tailpipe CO_2 emissions value.

Table III-4 EPA Projections for the Average, Real World Fleetwide Tailpipe CO_2 Emissions and Fuel Economy Associated with the Proposed CO_2 Standards

Model Year	**Real World Tailpipe CO_2 (grams per mile)**			**Real World Fuel Economy (miles per gallon)**		
	Cars	Trucks	Cars + Trucks	Cars	Trucks	Cars + Trucks
2016 (base)	288	380	323	30.9	23.4	27.5
2017	279	378	315	31.9	23.5	28.2
2018	268	371	304	33.2	24.0	29.2
2019	256	365	295	34.7	24.3	30.1
2020	245	357	285	36.3	24.9	31.2
2021	235	335	270	37.8	26.5	32.9
2022	224	319	257	39.7	27.9	34.6
2023	215	304	245	41.3	29.2	36.3
2024	205	290	234	43.4	30.6	38.0
2025	198	276	223	44.9	32.2	40.0

As discussed both in Section I and later in this Section III, EPA either already has adopted or is proposing provisions for averaging, banking, and trading of credits, that allow annual credits for a manufacturer's over-compliance with its unique fleet-wide average standard, carry-forward and carry-backward of credits, the ability to transfer credits between a manufacturer's car and truck fleets, and credit trading between manufacturers. EPA is proposing a one-time carry-forward of any credits such that any credits generated in MYs 2010–2016 can be used through MY 2021. These provisions are not expected to change the emissions reductions achieved by the standards, but should significantly reduce the cost of achieving those reductions. The tables above do not reflect the year to year impact of these provisions. For example, EPA expects that many manufacturers may generate credits by over complying with the standards for cars, and transfer such credits to its truck fleet. Table III–1 (cars) and Table III–2 (trucks) do not reflect such transfers. If on an industry wide basis more credits are transferred from cars to trucks than vice versa, you would expect to achieve greater reductions from cars than reflected in Table III–1 (lower CO_2 gram/miles values) and less reductions from trucks than reflected in Table III–2 (higher CO_2 gram/mile values). Credit transfers between cars and trucks would not be expected to change the results for the combined fleet, reflected in Table III–3.

The proposed rule would also exclude from coverage a limited set of vehicles: emergency and police vehicles, and vehicles manufactured by small businesses. As discussed in Section III.B below, these exclusions have very limited impact on the total GHG emissions reductions from the light-duty vehicle fleet. We also do not anticipate significant impacts on total GHG emissions reductions from the proposed provisions allowing small volume manufacturers to petition EPA for alternative standards. See Section III.B.5 below.

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

i. Model Year Lifetime Analysis

Section I.C provides a comprehensive discussion of the projected benefits and costs associated with the proposed MYs 2017–2025 GHG and CAFE standards based on a ''model year lifetime'' analysis, *i.e.,* the benefits and costs associated with the lifetime operation of the new vehicles sold in these nine model years. It is important to note that while the incremental vehicle costs associated with MY 2017 vehicles will in fact occur in calendar year 2017, the benefits associated with MY 2017 vehicles will be split among all the calendar years from 2017 through the calendar year during which the last MY 2017 vehicle would be retired.

Table III–5 provides a summary of the GHG emissions and oil savings associated with the lifetime operation of all the vehicles sold in each model year. Cumulatively, for the nine model years from 2017 through 2025, the proposed standards are projected to save approximately 2 billion metric tons of GHG emissions and 4 billion barrels of oil.

Table III–6 provides a summary of the most important projected economic impacts of the proposed GHG emissions standards based on this model year lifetime analytical approach. These monetized dollar values are all discounted to the first year of each model year, then summed up across all model years. With a 3% discount rate, cumulative incremental vehicle technology cost for MYs 2017–2025 vehicles is $140 billion, fuel savings is $444 billion, other monetized benefits are $117 billion, and program net benefits are projected to be $421 billion. Using a 7% discount rate, the projected program net benefits are $311 billion.

As discussed previously, EPA recognizes that some of these same benefits and costs are also attributable to the CAFE standard contained in this joint proposal, although the GHG program achieves greater reductions of both GHG emissions and petroleum. More details associated with this model year lifetime analysis of the proposed GHG standards are presented in Sections III.F and III.H.

Table III-5 Summary of GHG Emissions and Oil Savings for Proposed CO_2 Standard Model Year Lifetime Analysis

	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	Cumulative MY 2017-2025
GHG Savings (MMT)	29	70	108	151	220	273	322	372	422	1,967
Oil Savings (Billion Barrels)	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.9	3.9

Table III-6 Summary of Key Projected Economic Impacts, on a Lifetime Present Value Basis, for Proposed CO2 Standard (1)

Model Year Lifetime Analysis (Billions of 2009 dollars)

	3% Discount Rate	7% Discount Rate
Incremental Vehicle Technology Cost	$140	$138
Societal Fuel Savings (2)	$444	$347
Other Benefits	$117	$101
Program Net Benefits	$421	$311

(1) Present value discounts all values to the first year of each MY, then sums those present values across MYs, in 2009 dollars.

(2) All fuel impacts are calculated with pre-tax fuel prices of $2.85 per gallon in calendar year 2017, rising to $3.18 per gallon in calendar year 2025, and $3.49 per gallon in calendar year 2040, and electricity prices of $0.10 per kWh in 2017 and 2025, and $0.11 per kWh in 2040, all in 2009 dollars.

ii. Calendar Year Analysis

In addition to the model year lifetime analysis projections summarized above, EPA also performs a ''calendar year'' analysis that projects the environmental and economic impacts associated with the proposed tailpipe CO_2 standards during specific calendar years out to 2050. This calendar year approach reflects the timeframe when the benefits would be achieved and the costs incurred. Because the EPA tailpipe CO_2 emissions standards will remain in effect unless and until they are changed, the projected impacts in this calendar year analysis beyond calendar year 2025 reflect vehicles sold in model years after 2025 (*e.g.,* most of the benefits in calendar year 2040 would be due to vehicles sold after MY 2025).

Table III–7 provides a summary of the most important projected benefits and costs of the proposed EPA GHG emissions standards based on this calendar year analysis. In calendar year 2025, EPA projects GHG savings of 151 million metric tons and oil savings of 0.83 million barrels per day. These would grow to 547 million metric tons of GHG savings and 3.12 million barrels of oil per day by calendar year 2050. Program net benefits are projected to be $18 billion in calendar year 2025, growing to $198 billion in calendar year 2050. Program net benefits over the 34-year period from 2017 through 2050 are projected to have a net present value in 2012 of $600 billion (7% discount rate) to $1.4 trillion (3% discount rate).

More details associated with this calendar year analysis of the proposed

GHG standards are presented in Sections III.F and III.H.

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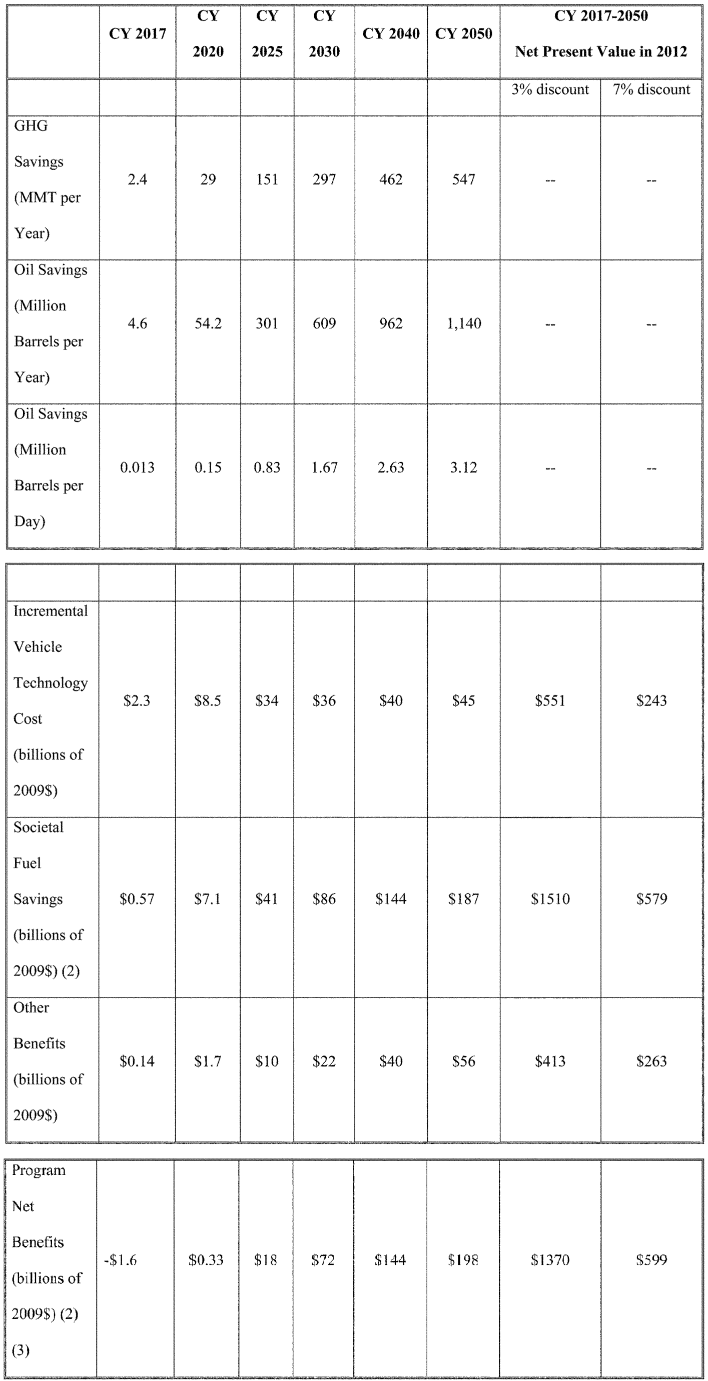
Table III-7 Summary of Key Projected Impacts for Proposed CO_2 Standard – Calendar Year (CY) Analysis (1)



	CY 2017	**CY 2020**	**CY 2025**	**CY 2030**	**CY 2040**	**CY 2050**	**CY 2017-2050 Net Present Value in 2012**	
							3% discount	7% discount
GHG Savings (MMT per Year)	2.4	29	151	297	462	547	--	--
Oil Savings (Million Barrels per Year)	4.6	54.2	301	609	962	1,140	--	--
Oil Savings (Million Barrels per Day)	0.013	0.15	0.83	1.67	2.63	3.12	--	--
Incremental Vehicle Technology Cost (billions of 2009$)	$2.3	$8.5	$34	$36	$40	$45	$551	$243
Societal Fuel Savings (billions of 2009$) (2)	$0.57	$7.1	$41	$86	$144	$187	$1510	$579
Other Benefits (billions of 2009$)	$0.14	$1.7	$10	$22	$40	$56	$413	$263
Program Net Benefits (billions of 2009$) (2) (3)	-$1.6	$0.33	$18	$72	$144	$198	$1370	$599

(1) Values in columns 2 through 7 are undiscounted annual values, values in columns 8 and 9 are discounted to a net present value in 2012.

(2) All fuel impacts are calculated with pre-tax fuel prices of $2.85 per gallon in calendar year 2017, rising to $3.18 per gallon in calendar year 2025, and $3.49 per gallon in calendar year 2040, and electricity prices of $0.10 per kWh in 2017 and 2025, and $0.11 per kWh in 2040, all in 2009 dollars.

(3) Assuming the 3% average SCC value and other benefits of the proposed program not presented in this table

Incremental Vehicle Technology Cost (billions of 2009$)	$2.3	$8.5	$34	$36	$40	$45	$551	$243
Societal Fuel Savings (billions of 2009$) (2)	$0.57	$7.1	$41	$86	$144	$187	$1510	$579
Other Benefits (billions of 2009$)	$0.14	$1.7	$10	$22	$40	$56	$413	$263
Program Net Benefits (billions of 2009$) (2) (3)	-$1.6	$0.33	$18	$72	$144	$198	$1370	$599

(1) Values in columns 2 through 7 are undiscounted annual values, values in columns 8 and 9 are discounted to a net present value in 2012.

(2) All fuel impacts are calculated with pre-tax fuel prices of $2.85 per gallon in calendar year 2017, rising to $3.18 per gallon in calendar year 2025, and $3.49 per gallon in calendar year 2040, and electricity prices of $0.10 per kWh in 2017 and 2025, and $0.11 per kWh in 2040, all in 2009 dollars.

(3) Assuming the 3% average SCC value and other benefits of the proposed program not presented in this table

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iii. Consumer Analysis

The model year lifetime and calendar year analytical approaches discussed above aggregate the environmental and economic impacts across the nationwide light vehicle fleet. EPA has also projected the average impact of the proposed GHG standards on individual consumers who own and drive MY 2025 light vehicles over their lifetimes.

Table III–8 shows, on average, several key consumer impacts associated with the proposed tailpipe CO_2 standard for

MY 2025 vehicles. Some of these factors are dependent on the assumed discount factors, and this table uses the same 3% and 7% discount factors used throughout this preamble. EPA uses AEO2011 fuel price projections of $3.25 per gallon in calendar year 2017, rising to $3.54 per gallon in calendar year 2025 and $3.85 per gallon in calendar year 2040.

EPA projects that the new technology necessary to meet the proposed MY 2025 standard would add, on average, an extra $1950 (including markup) to the sticker price of a new MY 2025 light-duty vehicle. Including higher vehicle sales taxes and first-year insurance costs, the projected incremental first-year cost to the consumer is about $2100 on average. The projected incremental lifetime vehicle cost to the consumer, reflecting higher insurance premiums over the life of the vehicle, is, on average, about $2200. For all of the consumers who drive MY 2025 light-duty vehicles, the proposed standards are projected to yield a net savings of $3000 (7% discount rate) to $4400 (3% discount) over the lifetime of the vehicle, as the discounted lifetime fuel savings of $5200–$6600 is 2.4 to 3 times greater than the $2200 incremental lifetime vehicle cost to the consumer.

Of course, many vehicles are owned by more than one consumer. The payback period and monthly cash flow approaches are two ways to evaluate the economic impact of the MY 2025 standard on those new car buyers who do not own the vehicle for its entire lifetime. Projected payback periods of 3.7–3.9 years means that, for a consumer that buys a new vehicle with cash, the discounted fuel savings for that consumer would more than offset the incremental lifetime vehicle cost in 4 years. If the consumer owns the vehicle beyond this payback period, the vehicle will save money for the consumer. For a consumer that buys a new vehicle with a 5-year loan, the monthly cash flow savings of $12 (or about $140 per year) shows that the consumer would benefit immediately as the monthly fuel savings more than offsets the higher monthly payment due to the higher incremental first-year vehicle cost.

The final entries in Table III–8 show the CO_2 and oil savings that would be associated with the MY 2025 vehicles on average, both on a lifetime basis and in the first full year of operation. On average, a consumer who owns a MY 2025 vehicle for its entire lifetime is projected to emit 20 fewer metric tons of CO_2 and consume 2200 fewer gallons of gasoline due to the proposed standards.

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Table III-8 Summary of Key Projected Consumer Impacts for Proposed MY 2025 CO_2 Standard (1) (2)

	3% Discount Rate	7% Discount Rate
Incremental Vehicle Technology Cost	$1950	
Incremental First-Year Vehicle Cost to Consumer (3)	$2100	
Incremental Lifetime Vehicle Cost to Consumer (4)	$2200	$2200
Lifetime Consumer Fuel Savings (5)	$6600	$5200
Lifetime Consumer Net Savings (6)	$4400	$3000
Payback Period for Cash Purchase (years)	3.7	3.9
Monthly Cash Flow Savings Based on 5-Year Loan	$12	
Annual Cash Flow Savings Based on 5-Year Loan	$140	
First Year CO_2 Savings (Metric Tons) (7)	1.6	
Lifetime CO_2 Savings (Metric Tons) (7)	20	
First Year Gasoline/Oil Savings (Gallons) (7)	180	
Lifetime Gasoline/Oil Savings (Gallons) (7)	2200	

(1) Average impact of all MY 2025 light vehicles, excluding rebound effect.

(2) Most values have been rounded to two significant digits in this summary table and therefore may be slightly different than tables elsewhere that report values to three or four significant digits.

(3) Incremental First-Year Vehicle Cost to Consumer includes the incremental vehicle technology cost, a 5.3% average nationwide sales tax, and a 1.85% increase in first-year insurance premiums.

(4) Incremental Lifetime Vehicle Cost to Consumer includes the incremental vehicle technology cost, a 5.3% average nationwide sales tax, and the discounted cost associated with incremental lifetime insurance premiums.

(5) All fuel impacts are calculated with fuel prices, including fuel taxes, of $3.25 per gallon in calendar year 2017, rising to $3.54 per gallon in calendar year 2025, and $3.85 per gallon in calendar year 2040, and electricity prices of $0.10 per kWh in 2017 and 2025, and $0.11 per kWh in 2040, all in 2009 dollars.

(6) Lifetime Consumer Fuel Savings minus Incremental Lifetime Vehicle Cost to Consumer.

(7) CO_2 and gasoline savings reflect vehicle tailpipe-only and do not include CO_2 and oil savings associated with fuel production and distribution.

First Year Gasoline/Oil Savings (Gallons) (7)	180
Lifetime Gasoline/Oil Savings (Gallons) (7)	2200

(1) Average impact of all MY 2025 light vehicles, excluding rebound effect.

(2) Most values have been rounded to two significant digits in this summary table and therefore may be slightly different than tables elsewhere that report values to three or four significant digits.

(3) Incremental First-Year Vehicle Cost to Consumer includes the incremental vehicle technology cost, a 5.3% average nationwide sales tax, and a 1.85% increase in first-year insurance premiums.

(4) Incremental Lifetime Vehicle Cost to Consumer includes the incremental vehicle technology cost, a 5.3% average nationwide sales tax, and the discounted cost associated with incremental lifetime insurance premiums.

(5) All fuel impacts are calculated with fuel prices, including fuel taxes, of $3.25 per gallon in calendar year 2017, rising to $3.54 per gallon in calendar year 2025, and $3.85 per gallon in calendar year 2040, and electricity prices of $0.10 per kWh in 2017 and 2025, and $0.11 per kWh in 2040, all in 2009 dollars.

(6) Lifetime Consumer Fuel Savings minus Incremental Lifetime Vehicle Cost to Consumer.

(7) CO_2 and gasoline savings reflect vehicle tailpipe-only and do not include CO_2 and oil savings associated with fuel production and distribution.

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

EPA has significant discretion under section 202(a) of the Act in how to structure the standards that apply to the emission of the air pollutant at issue here, the aggregate group of six GHGs, as well as to the content of such standards. See generally 74 FR at 49464–65. EPA statutory authority under section 202(a)(1) of the Clean Air Act (CAA) is discussed in more detail in Section I.D of the preamble. In this rulemaking, EPA is proposing a CO_2 tailpipe emissions standard that provides for credits based on reductions of HFCs, as the appropriate way to issue standards applicable to emissions of the single air pollutant, the aggregate group of six GHGs. EPA is not proposing to change the methane and nitrous oxide standards already in place (although EPA is proposing certain changes to the compliance mechanisms for these standards as explained in Section III.B below). EPA is not setting any standards for perfluorocarbons or sulfur hexafluoride, as they are not emitted by motor vehicles. The following is a summary of the basis for the proposed 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 proposing attribute-based light-duty car and truck standards that achieve large and important emissions reductions of GHGs. EPA has evaluated the technological feasibility of the 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 projects that manufacturers will be able to meet the standards by employing a wide variety of technologies that are already commercially available. EPA's analysis also takes into account certain flexibilities that will facilitate compliance. These flexibilities include averaging, banking, and trading of various types of credits. For a few very small volume manufacturers, EPA is proposing to allow manufacturers to petition for alternative standards.

EPA, as a part of its joint technology analysis with NHTSA, has performed what we believe is the most comprehensive federal vehicle technology analysis in history. We 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 vehicle 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 by this analysis to be within a reasonable range in light of the emissions reductions and benefits achieved. 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. As explained in Section III.D.6 below, EPA has also investigated potential standards both more and less stringent than those being proposed and has rejected them. Less stringent standards would forego emission reductions which are feasible, cost effective, and cost feasible, with short consumer payback periods. EPA judges that the proposed standards are appropriate and preferable to more stringent alternatives based largely on consideration of cost—both to manufacturers and to consumers—and the potential for overly aggressive penetration rates for advanced technologies relative to the penetration rates seen in the proposed standards, especially in the face of unknown degree of consumer acceptance of both the increased costs and the technologies themselves.

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 2017–2025 vehicles we estimate GHG reductions of approximately 2 billion metric tons and fuel reductions of about 4 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. We estimate the total net social benefits (lifetime present value discounted to the first year of the model year) over the life of MY 2017–2025 vehicles to be $421 billion with a 3% discount rate and $311 billion with a 7% discount rate.

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 given the present existence of the technologies on which the proposed rule is predicated and the substantial lead times afforded under the proposal (which by MY2025 allow for multiple vehicle redesign cycles and so affords opportunities for adding technologies in the most cost efficient manner, see 75 FR at 25407). 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 proposed rule. In summary, given the technical feasibility of the standard, the cost per vehicle in light of the savings in fuel costs over the lifetime 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 most of the technologies that 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, or will soon be commercialized by one or more major manufacturers. The vast majority of the emission reductions that 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 commercialization of more advanced technologies, such as PHEVs and EVs and strong hybrids as well. 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 several alternative standards, some more stringent than the promulgated standards and some less stringent.

See Section III.D.6 for EPA's analysis of alternative GHG emissions standards.

5. Other Related EPA Motor Vehicle Regulations

a. EPA's Recent Heavy-Duty GHG Emissions Rulemaking

EPA and NHTSA recently conducted a joint rulemaking to establish a comprehensive Heavy-Duty National Program that will reduce greenhouse gas emissions and fuel consumption for on-road heavy-duty vehicles beginning in MY 2014 (76 FR 57106 (September 15, 2011)). EPA's final carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) emissions standards, along with NHTSA's final fuel consumption standards, are tailored to each of three regulatory categories of heavy-duty vehicles: (1) Combination Tractors; (2) Heavy-duty Pickup Trucks and Vans; and (3) Vocational Vehicles. The rules include separate standards for the engines that power combination tractors and vocational vehicles. EPA also set hydrofluorocarbon standards to control leakage from air conditioning systems in combination tractors and heavy-duty pickup trucks and vans.

The agencies estimate that the combined standards will reduce CO_2 emissions by approximately 270 million metric tons and save 530 million barrels of oil over the life of vehicles sold during the 2014 through 2018 model years, providing $49 billion in net societal benefits when private fuel savings are considered. See 76 FR at 57125–27.

b. EPA's Plans for Further Standards for Light Vehicle Criteria Pollutants and Gasoline Fuel Quality

In the May 21, 2010 Presidential Memorandum, in addition to addressing GHGs and fuel economy, the President also requested that EPA examine its broader motor vehicle air pollution control program. The President requested that ''*[t]he Administrator of the EPA review for adequacy the current nongreenhouse gas emissions regulations for new motor vehicles, new motor vehicle engines, and motor vehicle fuels, including tailpipe emissions standards for nitrogen oxides and air toxics, and sulfur standards for gasoline. If the Administrator of the EPA finds that new emissions regulations are required, then I request that the Administrator of the EPA promulgate such regulations as part of a comprehensive approach toward regulating motor vehicles.*'' [214] EPA is currently in the process of conducting an assessment of the potential need for additional controls on light-duty vehicle non-GHG emissions and gasoline fuel quality. EPA has been actively engaging in technical conversations with the automobile industry, the oil industry, nongovernmental organizations, the states, and other stakeholders on the potential need for new regulatory action, including the areas that are specifically mentioned in the Presidential Memorandum. EPA will coordinate all future actions in this area with the State of California.

Based on this assessment, in the near future, EPA expects to propose a separate but related program that would, in general, affect the same set of new vehicles on the same timeline as would the proposed light-duty GHG emissions standards. It would be designed to address air quality problems with ozone and PM, which continue to be serious problems in many parts of the country, and light-duty vehicles continue to play a significant role.

EPA expects that this related program, called ''Tier 3'' vehicle and fuel standards, would among other things propose tailpipe and evaporative standards to reduce non-GHG pollutants from light-duty vehicles, including volatile organic compounds, nitrogen oxides, particulate matter, and air toxics. EPA's intent, based on extensive interaction to date with the automobile manufacturers and other stakeholders, is to propose a Tier 3 program that would allow manufacturers to proceed with

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[214] The Presidential Memorandum is found at: *http://www.whitehouse.gov/the-press-office/presidential-memorandum-regarding-fuel-efficiency-standards.*

coordinated future product development plans with a full understanding of the major regulatory requirements they will be facing over the long term. This coordinated regulatory approach would allow manufacturers to design their future vehicles so that any technological challenges associated with meeting both the GHG and Tier 3 standards could be efficiently addressed.

It should be noted that under EPA's current regulations, GHG emissions and CAFE compliance testing for gasoline vehicles is conducted using a defined fuel that does not include any amount of ethanol.[215] If the certification test fuel is changed to some ethanol-based fuel through a future rulemaking, EPA would be required under EPCA to address the need for a test procedure adjustment to preserve the level of stringency of the CAFE standards.[216] EPA is committed to doing so in a timely manner to ensure that any change in certification fuel will not affect the stringency of future GHG emission standards.

B. Proposed Model Year 2017–2025 GHG Standards for Light-duty Vehicles, Light-duty Trucks, and Medium duty Passenger Vehicles

EPA is proposing new emissions standards to control greenhouse gases (GHGs) from MY 2017 and later light-duty vehicles. EPA is proposing new emission standards 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. EPA is proposing to conduct a mid-term evaluation of the GHG standards and other requirements for MYs 2022–2025, as further discussed in Section III.B.3 below.

EPA is not proposing changes to the CH_4 and N_2O emissions standards, but is proposing revisions to the options that manufacturers have in meeting the CH_4 and N_2O standards, and to the timeframe for manufacturers to begin measuring N_2O emissions. These proposed changes are not intended to change the stringency of the CH_4 and N_2O standards, but are aimed at addressing implementation concerns regarding the standards.

The opportunity to earn credits toward the fleet-wide average CO_2 standards for improvements to air conditioning systems remains in place for MY 2017 and later, including improvements to address both hydrofluorocarbon (HFC) refrigerant losses (*i.e.,* system leakage) and indirect CO_2 emissions related to the air conditioning efficiency and load on the engine. The CO_2 standards proposed for cars and trucks take into account EPA's projection of the average amount of credits expected to be generated across the industry. EPA is proposing several revisions to the air conditioning credits provisions, as discussed in Section III.C.1.

The MY 2012–2016 Final Rule established several program elements that remain in place, where EPA is not proposing significant changes. The proposed standards described below would apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles (MDPVs). As an overall group, they are referred to in this preamble as light-duty 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.'' [217]

EPA is not proposing changes to the averaging, banking, and trading program elements, as discussed in Section III.B.4, with the exception of our proposal for a one-time carry-forward of any credits generated in MY 2010–2016 to be used anytime through MY2021. The previous rulemaking also established provisions for MY 2016 and later FFVs, where the emissions levels of these vehicles are based on tailpipe emissions performance and the amount of alternative fuel used. These provisions remain in place without change.

Several provisions are being proposed that allow manufacturer's to generate credits for use in complying with the standards or that provide additional incentives for use of advanced technology. These include credits for technology that reduces CO_2 emissions during off-cycle operation that is not reasonably accounted for by the 2-cycle tests used for compliance purposes. EPA is proposing various changes to this program to streamline its use compared to the MYs 2012–2016 program. These provisions are discussed in section III.C. In addition, EPA is proposing the use of multipliers to provide an incentive for the use of EVs, PHEVs, and FCVs, as well as a specified gram/mile credit for full size pick-up trucks that meet various efficiency performance criteria and/or include hybrid technology at a minimum level of production volumes. These provisions are also discussed in Section III.C. As discussed in those sections, while these additional credit provisions do not change the level of the standards proposed for cars and trucks, unlike the provisions for AC credits, they all support the reasonableness of the standards proposed for MYs 2017–2025.

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

EPA is proposing standards that are projected to require, on an average industry fleet wide basis, 163 grams/mile of CO_2 in model year 2025. The level of 163 grams/mile CO_2 would be equivalent on a mpg basis to 54.5 mpg, if this level was achieved solely through improvements in fuel efficiency.[218] [219] For passenger cars, the proposed footprint curves call for reducing CO_2 by 5 percent per year on average from the model year 2016 passenger car standard through model year 2025. In recognition of manufacturers' unique challenges in improving the GHG emissions of full-size pickup trucks as we transition from the MY 2016 standards to MY 2017 and later, while preserving the utility (*e.g.,* towing and payload capabilities) of those vehicles, EPA is proposing a lower annual rate of improvement for light-duty trucks in the early years of the program. For light-duty trucks, the footprint curves call for reducing CO_2 by 3.5 percent per year on average from the model year 2016 truck standard through model year 2021. EPA is also proposing to change the slopes of the CO_2-footprint curves for light-duty trucks from those in the 2012–2016 rule, in a manner that effectively means that the annual rate of improvement for smaller light-duty trucks in model years 2017 through 2021 would be higher than 3.5 percent, and the annual rate of improvement for larger light-duty trucks over the same time period would be lower than 3.5 percent to account for the unique challenges for improving the GHG of large light trucks while maintaining cargo hauling and towing utility. For model years 2022 through 2025, EPA is proposing a reduction of CO_2 for light-

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[215] *See* 40 CFR 86.113–94(a).

[216] EPCA requires that CAFE tests be determined from the EPA test procedures in place as of 1975, or procedures that give comparable results. 49 USC 32904(c).

[217] GHG emissions standards would use the same vehicle category definitions used for MYs 2012–2016 and as are used in the CAFE program.

[218] In comparison, the MY 2016 CO_2 standard is projected to achieve a national fleet-wide average, covering both cars and trucks, of 250 g/mile.

[219] Real-world CO_2 is typically 25 percent higher and real-world fuel economy is typically 20 percent lower than the CO_2 and CAFE values discussed here. The reference to CO_2 here refers to CO_2 equivalent reductions, as this level includes some reductions in emissions of greenhouse gases other than CO_2, from refrigerant leakage, as one part of the AC related reductions.

duty trucks of 5 percent per year on average starting from the model year 2021 truck standard.

EPA's proposed standards include EPA's projection of average industry wide CO_2-equivalent emission reductions from A/C improvements, where the proposed footprint curve is made more stringent by an amount equivalent to this projection of A/C credits. This projection of A/C credits builds on the projections from MYs 2012–2016, with the increases in credits mainly due to the full penetration of low GWP alternative refrigerant by MY 2021. The proposed car standards would begin with MY 2017, with a generally linear increase in stringency from MY 2017 through MY 2025 for cars. The truck standards have a more gradual increase for MYs 2017–2020 then more rapidly in MY 2021. For MYs 2021–2025, the truck standards increase in stringency generally in a linear fashion. EPA proposes to continue to have separate standards for cars and light trucks, and to have identical definitions of cars and trucks as NHTSA, in order to harmonize with CAFE standards. The tables in this section below provide overall fleet average levels that are projected for both cars and light trucks over the phase-in period which is estimated to correspond with the proposed standards. The actual fleet-wide average g/mi level that would 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 would be able to generate credits from cars and use them for compliance with the truck standard, or vice versa. 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 proposed schedule of standards acts as a phase-in to the MY 2025 standards, and reflects consideration of the appropriate lead-time and engineering redesign cycles for each manufacturer to implement the requisite emission reductions technology across its product line. Note that MY 2025 is the final model year in which the standards become more stringent. The MY 2025 CO_2 standards would remain in place for MY 2025 and later model years, until revised by EPA in a future rulemaking. EPA estimates that, on a combined fleet-wide national basis, the 2025 MY proposed standards would require a level of 163 g/mile CO_2. The derivation of the 163 g/mile estimate is described in Section III.B.2. EPA has estimated the overall fleet-wide CO_2-equivalent emission (target) levels that correspond with the proposed attribute-based standards, based on the projections of the composition of each manufacturer's fleet in each year of the program. Tables Table III–9 and Table III–10 provide these target estimates for each manufacturer.

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Table III-9 Estimated Fleet CO_2-equivalent Levels Corresponding to the Proposed Standards (Targets) for Cars (g/mile)

	2017	2018	2019	2020	2021	2022	2023	2024	2025
Aston Martin	210	200	190	180	171	163	156	149	142
BMW	216	205	195	185	175	168	160	153	146
Chrysler/Fiat	218	207	196	187	176	168	161	153	146
Daimler	226	215	205	194	184	176	168	161	153
Ferrari	222	211	201	191	181	173	165	158	150
Ford	218	207	196	187	177	169	162	154	147
Geely-Volvo	220	209	198	188	178	170	163	155	148
General Motors	217	206	196	186	176	168	161	153	146
Honda	210	200	189	180	170	163	155	148	142
Hyundai	211	201	190	181	171	163	156	149	142
Kia	213	202	192	182	172	165	157	150	143
Lotus	195	185	175	166	157	150	143	137	131
Mazda	210	200	190	180	171	163	156	149	142
Mitsubishi	207	197	187	177	168	160	153	146	139
Nissan	214	204	193	184	174	166	159	152	145
Porsche	195	185	175	166	157	150	143	137	131
Spyker-Saab	210	199	189	180	170	162	155	148	141
Subaru	204	194	184	174	165	158	151	144	137
Suzuki	196	186	177	167	158	151	144	138	132

Tata-JLR	237	225	214	203	193	184	176	168	161
Tesla	195	185	175	166	157	150	143	137	131
Toyota	209	199	189	179	169	162	155	148	141
Volkswagen	207	196	186	177	167	160	153	146	139

Table III-10 Estimated Fleet CO_2-equivelent Levels Corresponding to the Proposed Standards (Targets) for Light Trucks (g/mile)

	2017	2018	2019	2020	2021	2022	2023	2024	2025
Aston Martin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BMW	283	272	264	255	236	225	214	204	194
Chrysler/Fiat	293	283	275	266	246	234	223	212	201
Daimler	299	289	280	272	253	241	229	218	208
Ferrari	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ford	305	296	288	282	262	250	237	224	213
Geely-Volvo	278	266	258	250	231	220	209	199	189
General Motors	309	299	291	283	262	249	236	224	213
Honda	279	269	261	252	233	222	211	201	191
Hyundai	277	266	258	249	231	219	209	198	188
Kia	289	279	271	262	243	231	220	209	199
Lotus	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mazda	272	259	252	244	226	216	206	195	186
Mitsubishi	266	254	246	238	220	209	199	189	180

Nissan	293	282	274	266	248	236	224	212	202
Porsche	286	274	266	257	238	226	215	205	195
Spyker-Saab	278	265	258	249	230	219	208	198	188
Subaru	263	251	243	235	217	206	196	186	177
Suzuki	269	257	249	240	222	211	201	191	181
Tata-JLR	270	258	250	241	223	212	202	191	182
Tesla	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Toyota	292	281	273	266	246	234	222	211	200
Volkswagen	295	284	276	267	248	236	225	214	203

Companies with "N/A" do not presently have trucks in their fleet.

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These estimates were aggregated based on projected production volumes into the fleet-wide averages for cars, trucks, and the entire fleet, shown in Table III–11.[220] The combined fleet estimates are based on the assumption of a fleet mix of cars and trucks that vary over the MY 2017–2025 timeframe. This fleet mix distribution can be found in Chapter 1 of the join TSD.

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

Table III-11 Estimated Fleet-wide CO_2-equivalent Levels Corresponding to the Proposed Standards

	Cars	Trucks	Fleet
Model Year	CO_2 (g/mi)	CO_2 (g/mi)	CO_2 (g/mi)
2017	213	295	243
2018	202	285	232
2019	192	277	223
2020	182	270	213
2021	173	250	200
2022	165	237	190
2023	158	225	181
2024	151	214	172
2025 and later	144	203	163

As shown in Table III–11, fleet-wide CO_2-equivalent emission levels for cars under the approach are projected to decrease from 213 to 144 grams per mile between MY 2017 and MY 2025. Similarly, fleet-wide CO_2-equivalent emission levels for trucks are projected to decrease from 295 to 203 grams per mile. These numbers do not include the effects of other flexibilities and credits in the program.[221] The estimated achieved values can be found in Chapter 3 of the Regulatory Impact Analysis (RIA).

As noted above, EPA is proposing standards that would result in increasingly stringent levels of CO_2 control from MY 2017 though MY 2025. Applying the CO_2 footprint curves applicable in each model year to the vehicles (and their footprint distributions) expected to be sold in each model year produces progressively more stringent estimates of fleet-wide CO_2 emission targets. The standards achieve important CO_2 emissions reductions through the application of feasible control technology at reasonable cost, considering the needed lead time for this program and with proper consideration of manufacturer product redesign cycles. EPA has analyzed the feasibility of achieving the proposed CO_2 standards, based on projections of the adoption of technology to reduce emissions of CO_2, during the normal redesign process for cars and trucks, taking into account the effectiveness and cost of the technology. The results of the analysis are discussed in detail in Section III.D below and in the draft RIA. EPA also presents the overall estimated costs and benefits of the car and truck proposed CO_2 standards in Section III.H. In developing the proposal, EPA has evaluated the kinds of technologies that could be utilized by the automobile industry, as well as the associated costs for the industry and fuel savings for the consumer, the magnitude of the GHG and oil 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 places important weight on the fact that the proposed rule provides a long planning horizon to achieve the very challenging emissions standards being proposed, and provides manufacturers with certainty when planning future products. The time-frame and levels for the standards are expected to provide manufacturers the time needed to develop and incorporate technology that will achieve GHG reductions, and to do this as part of the normal vehicle redesign process. Further discussing of lead time, redesigns and feasibility can be found in Section III–D and Chapter 3 of the joint TSD.

In the MY 2012–2016 Final Rule, EPA established several provisions which will continue to apply for the proposed MY2017–2025 standards. Consistent with the requirement of CAA section 202(a)(1) that standards be applicable to vehicles ''for their useful life,'' CO_2 vehicle standards would apply for the useful life of the vehicle. Under section 202(i) of the Act, which authorized the Tier 2 standards, EPA established a useful life period of 10 years or 120,000

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[221] Nor do they reflect ABT.

miles, whichever first occurs, for all light-duty vehicles and light-duty trucks.[222] This useful life was applied to the MY 2012–2016 GHG standards and EPA is not proposing any changes to the useful life for MYs 2017–2025. Also, as with MYs 2012–2016, EPA proposes that the in-use emission standard would be 10% higher for a model than the emission levels used for certification and compliance with the fleet average that is based on the footprint curves. As with the MY2012–2016 standards, this will address issues of production variability and test-to-test variability. The in-use standard is discussed in Section II*I.E.* Finally, EPA is not proposing any changes to the test procedures over which emissions are measured and weighted to determine compliance with the standards. These procedures are the Federal Test Procedure (FTP or ''city'' test) and the Highway Fuel Economy Test (HFET or ''highway'' test).

2. What Are the Proposed CO_2 Attribute-based Standards?

As with the MY 2012–2016 standards, EPA is proposing separate car and truck standards, that is, vehicles defined as cars have one set of footprint-based curves for MY 2017–2025 and vehicles defined as trucks have a different set for MY 2017–2025. In general, for a given footprint the CO_2 g/mi target for trucks would be less stringent than for a car with the same footprint. EPA's approach for establishing the footprint curves for model years 2017 and later, including changes from the approach used for the MY2012–2016 footprint curves, is discussed in Section II.C and Chapter 2 of the joint TSD. The curves are described mathematically by a family of piecewise linear functions (with respect to vehicle footprint) that gradually and continually ramp down from the MY 2016 curve established in the previous rule. As Section II.C describes, EPA has modified the curves from 2016, particularly for trucks. To make this modification, we wanted to ensure that starting from the 2016 curve, there is a gradual transition to the new slopes and cut point (out to 74 sq ft from 66 sq ft). The transition is also designed to prevent the curve from one year from crossing the previous year's curve.

Written in mathematic notation, the form of the proposed function is as follows:[223]

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

[223] See proposed Regulatory text, which are the official coefficients and equation. The information proposed here is a summary version.

Passenger Car Target = min (b,max(a, c * footprint+d))

Coefficient	2017	2018	2019	2020	2021	2022	2023	2024	2025
a	194.7	184.9	175.3	166.1	157.2	150.2	143.3	136.8	130.5
b	262.7	250.1	238.0	226.2	214.9	205.5	196.5	187.8	179.5
c	4.53	4.35	4.17	4.01	3.84	3.69	3.54	3.40	3.26
d	8.9	6.5	4.2	1.9	-0.4	-1.1	-1.8	-2.5	-3.2

Light Truck Target = min(min (b,max(a, c * footprint+d)),min(f,max(e, g*footprint+h)

Coefficient	2017	2018	2019	2020	2021	2022	2023	2024	2025
a	238.1	226.8	219.5	211.9	195.4	185.7	176.4	167.6	159.1
b	347.2	341.7	338.6	336.7	334.8	320.8	305.6	291.0	277.1
c	4.87	4.76	4.68	4.57	4.28	4.09	3.91	3.74	3.58
d	38.3	31.6	27.7	24.6	19.8	17.8	16.0	14.2	12.5
e	246.4	240.9	237.8	235.9	234.0	234.0	234.0	234.0	234.0
f	347.4	341.9	338.8	336.9	335.0	335.0	335.0	335.0	335.0
g	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04
h	80.5	75.0	71.9	70.0	68.1	68.1	68.1	68.1	68.1

Figure 3 - Car Curves

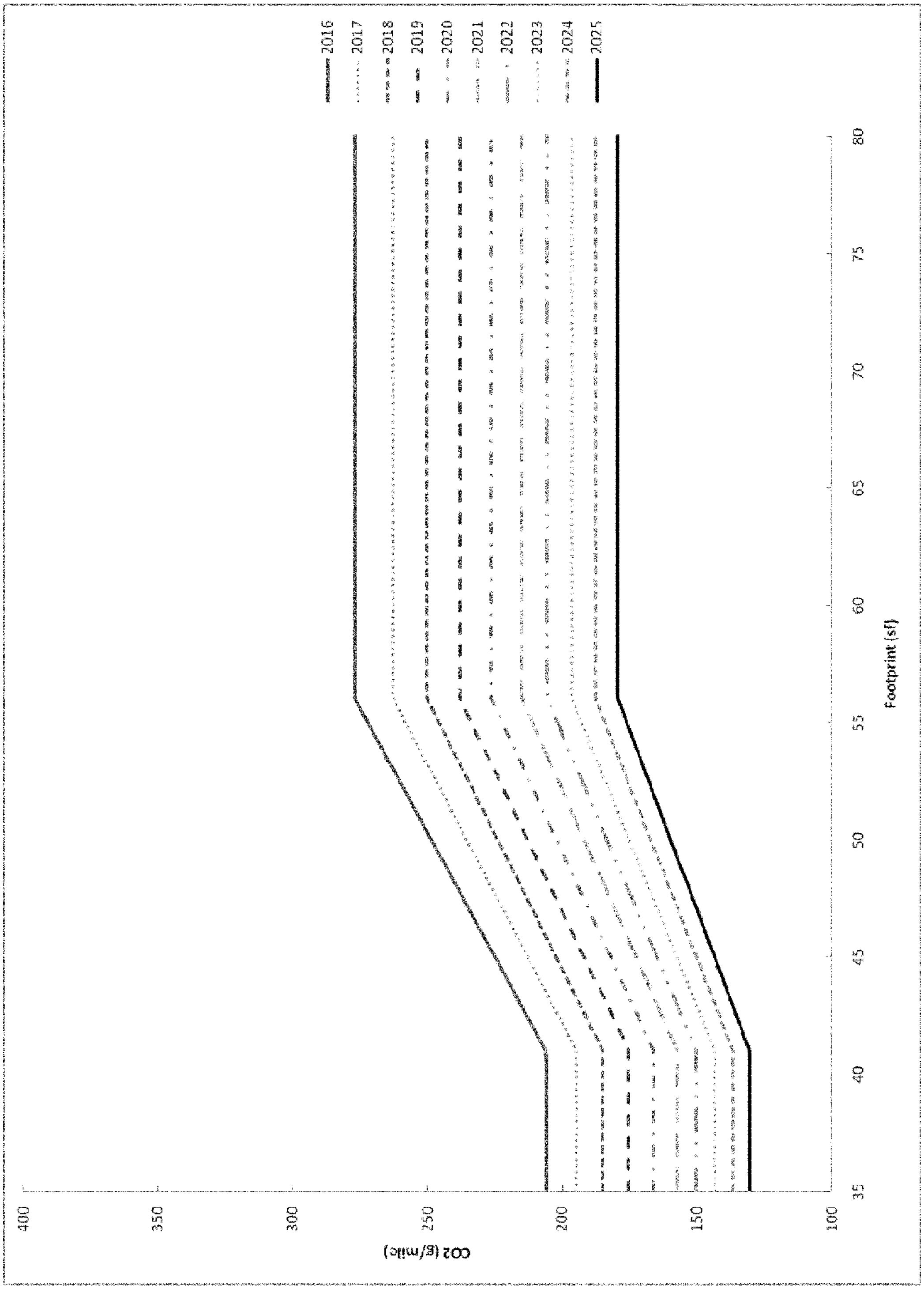
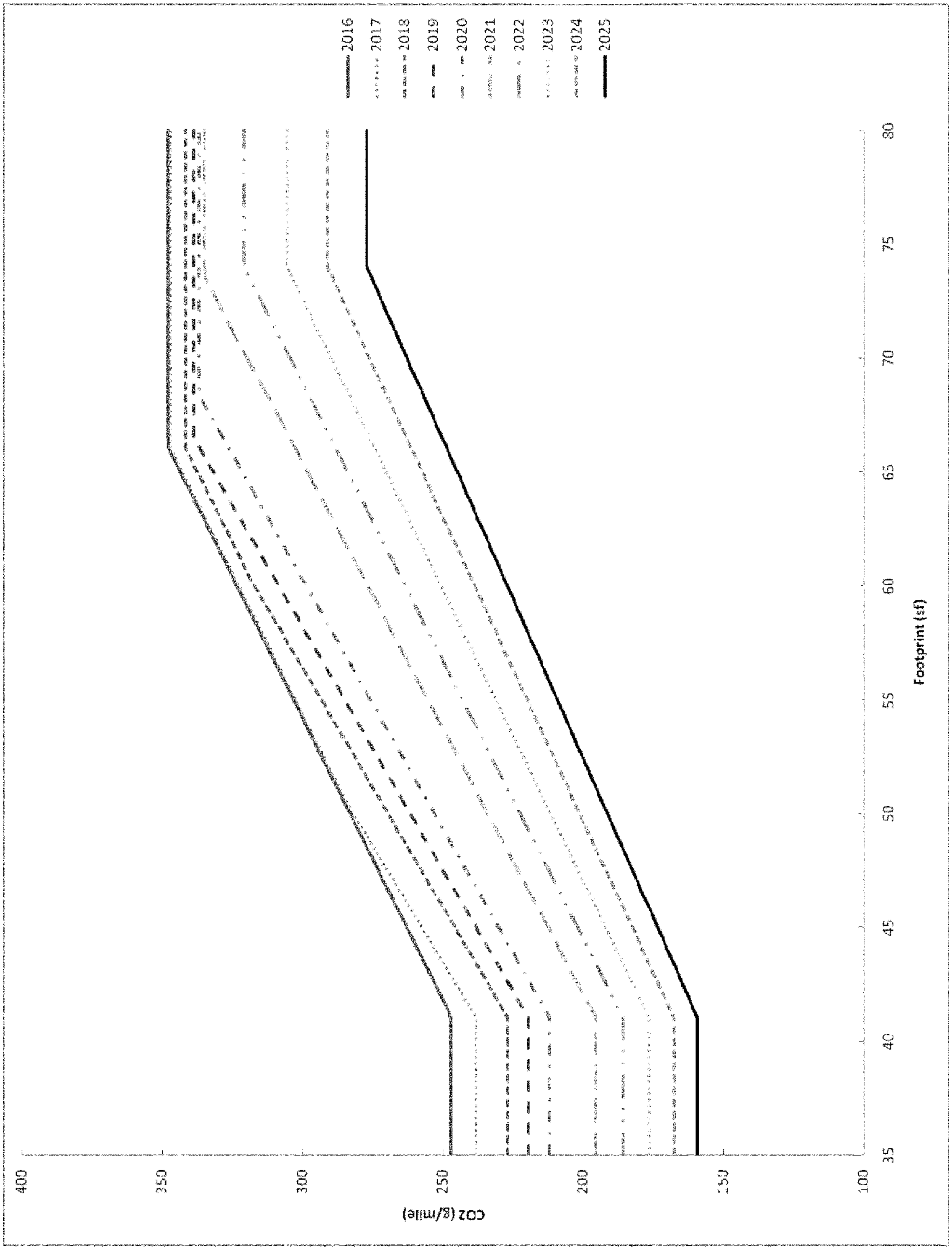


Figure 4 –Truck Curves



The car curves are largely similar to 2016 curve in slope. By contrast, the MY 2017 and later truck curves are steeper relative to the MY 2016 curve, but gradually flatten as a result of the multiplicative increase of the standards. As a further change from the MYs 2012–2016 rule, the truck curve does not reach the ultimate cutpoint of 74 sq ft until 2022. The gap between the 2020 curve and the 2021 curve is indicative of design of the truck standards described earlier, where a significant proportion of the increased stringency over the first five years occurs between MY 2020 and MY 2021. Finally, the gradual flattening of both the car and the trucks curves is noticeable. For further discussion of these topics, please see Section II.C and Chapter 2 of the joint TSD.

3. Mid-Term Evaluation

Given the long time frame at issue in setting standards for MY2022–2025 light-duty vehicles, and given NHTSA's obligation to conduct a separate rulemaking in order to establish final standards for vehicles for those model years, EPA and NHTSA will conduct a comprehensive mid-term evaluation and agency decision-making as described below. Up to date information will be developed and compiled for the evaluation, through a collaborative, robust and transparent process, including public notice and comment. The evaluation will be based on (1) A holistic assessment of all of the factors considered by the agencies in setting standards, including those set forth in the rule and other relevant factors, and (2) the expected impact of those factors on the manufacturers' ability to comply, without placing decisive weight on any particular factor or projection. The comprehensive evaluation process will lead to final agency action by both agencies.

Consistent with the agencies' commitment to maintaining a single national framework for regulation of vehicle emissions and fuel economy, the agencies fully expect to conduct the mid-term evaluation in close coordination with the California Air Resources Board (CARB). Moreover, the agencies fully expect that any adjustments to the standards will be made with the participation of CARB and in a manner that ensures continued harmonization of state and Federal vehicle standards.

EPA will conduct a mid-term evaluation of the later model year light-duty GHG standards (MY2022–2025). The evaluation will determine whether those standards are appropriate under section 202(a) of the Act. Under the regulations proposed today, EPA would be legally bound to make a final decision, by April 1, 2018, on whether the MY 2022–2025 GHG standards are appropriate under section 202(a), in light of the record then before the agency.

EPA, NHTSA and CARB will jointly prepare a draft Technical Assessment Report (TAR) to inform EPA's determination on the appropriateness of the GHG standards and to inform NHTSA's rulemaking for the CAFE standards for MYs 2022–2025. The TAR will examine the same issues and underlying analyses and projections considered in the original rulemaking, including technical and other analyses and projections relevant to each agency's authority to set standards as well as any relevant new issues that may present themselves. There will be an opportunity for public comment on the draft TAR, and appropriate peer review will be performed of underlying analyses in the TAR. The assumptions and modeling underlying the TAR will be available to the public, to the extent consistent with law.

EPA will also seek public comment on whether the standards are appropriate under section 202(a), *e.g.* comments to affirm or change the GHG standards (either more or less stringent). The agencies will carefully consider comments and information received and respond to comments in their respective subsequent final actions.

EPA and NHTSA will consult and coordinate in developing EPA's determination on whether the MY 2022–2025 GHG standards are appropriate under section 202(a) and NHTSA's NPRM.

In making its determination, EPA will evaluate and determine whether the MY2022–2025 GHG standards are appropriate under section 202(a) of the CAA based on a comprehensive, integrated assessment of all of the results of the review, as well as any public comments received during the evaluation, taken as a whole. The decision making required of the Administrator in making that determination is intended to be as robust and comprehensive as that in the original setting of the MY2017–2025 standards.

In making this determination, EPA will consider information on a range of relevant factors, including but not limited to those listed in the proposed rule and below:

1. Development of powertrain improvements to gasoline and diesel powered vehicles.
2. Impacts on employment, including the auto sector.
3. Availability and implementation of methods to reduce weight, including any impacts on safety.
4. Actual and projected availability of public and private charging infrastructure for electric vehicles, and fueling infrastructure for alternative fueled vehicles.
5. Costs, availability, and consumer acceptance of technologies to ensure compliance with the standards, such as vehicle batteries and power electronics, mass reduction, and anticipated trends in these costs.
6. Payback periods for any incremental vehicle costs associated with meeting the standards.
7. Costs for gasoline, diesel fuel, and alternative fuels.
8. Total light-duty vehicle sales and projected fleet mix.
9. Market penetration across the fleet of fuel efficient technologies.
10. Any other factors that may be deemed relevant to the review.

If, based on the evaluation, EPA decides that the GHG standards are appropriate under section 202(a), then EPA will announce that final decision and the basis for EPA's decision. The decision will be final agency action which also will be subject to judicial review on its merits. EPA will develop an administrative record for that review that will be no less robust than that developed for the initial determination to establish the standards. In the midterm evaluation, EPA will develop a robust record for judicial review that is the same kind of record that would be developed and before a court for judicial review of the adoption of standards.

Where EPA decides that the standards are not appropriate, EPA will initiate a rulemaking to adopt standards that are appropriate under section 202(a), which could result in standards that are either less or more stringent. In this rulemaking EPA will evaluate a range of alternative standards that are potentially effective and reasonably feasible, and the Administrator will propose the alternative that in her judgment is the best choice for a standard that is appropriate under section 202(a).[224] If EPA initiates a rulemaking, it will be a joint rulemaking with NHTSA. Any final action taken by EPA at the end of that rulemaking is also judicially reviewable.

The MY 2022–2025 GHG standards will remain in effect unless and until EPA changes them by rulemaking.

NHTSA intends to issue conditional standards for MYs 2022–2025 in the LDV rulemaking being initiated this fall for MY2017 and later model years. The CAFE standards for MYs 2022–2025 will be determined with finality in a subsequent, de novo notice and comment rulemaking conducted in full compliance with section 32902 of title 49 U.S.C. and other applicable law.

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[224] The provisions of CAA section 202(b)(1)(C) are not applicable to any revisions of the greenhouse standards adopted in a later rulemaking based on the mid-term evaluation. Section 202(b)(1)(C) refers to EPA's authority to revise ''any standard prescribed or previously revised under this subsection,'' and indicates that ''[a]ny revised standard'' shall require a reduction of emissions from the standard that was previously applicable. These provisions apply to standards that are adopted under subsection 202(b) of the Act and are later revised. These provisions are limited by their terms to such standards, and do not otherwise limit EPA's general authority under section 202(a) to adopt standards and revise them ''from time to time.'' Since the greenhouse gas standards are not adopted under subsection 202(b), section 202(b)(1)(C) does not apply to these standards or any subsequent revision of these standards.

Accordingly, NHTSA's development of its proposal in that later rulemaking will include the making of economic and technology analyses and estimates that are appropriate for those model years and based on then-current information.

Any rulemaking conducted jointly by the agencies or by NHTSA alone will be timed to provide sufficient lead time for industry to make whatever changes to their products that the rulemaking analysis deems feasible based on the new information available. At the very latest, the three agencies will complete the mid-term evaluation process and subsequent rulemaking on the standards that may occur in sufficient time to promulgate final standards for MYs 2022–2025 with at least 18 months lead time, but additional lead time may be provided.

EPA understands that California intends to propose a mid-term evaluation in its program that is coordinated with EPA and NHTSA and is based on a similar set of factors as outlined in this Appendix A. The rules submitted to EPA for a waiver under the CAA will include such a mid-term evaluation. EPA understands that California intends to continue promoting harmonized state and federal vehicle standards. EPA further understands that California's 2017–2025 standards to be submitted to EPA for a waiver under the Clean Air Act will deem compliance with EPA greenhouse gas emission standards, even if amended after 2012, as compliant with California's. Therefore, if EPA revises it standards in response to the mid-term evaluation, California may need to amend one or more of its 2022–2025 MY standards and would submit such amendments to EPA with a request for a waiver, or for confirmation that said amendments fall within the scope of an existing waiver, as appropriate.

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

In the MY 2012–2016 rule, EPA adopted credit provisions for credit carry-back, credit carry-forward, credit transfers, and credit trading. For EPA's purposes, these kinds of provisions are collectively termed Averaging, Banking, and Trading (ABT), and have 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.[225] As in the MY2012–2016 program, EPA is proposing basically the same 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. 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 cost or technical feasibility, allowing EPA to set a standard that is numerically more stringent. The ABT provisions are integral to the fleet averaging approach established in the MY 2012–2016 rule. EPA is proposing to change the credit carry-forward provisions as described below, but the program otherwise would remain in place unchanged for model years 2017 and later.

As noted above, the ABT provisions consist primarily of credit carry-back, credit carry-forward, credit transfers, and credit trading. A manufacturer may have a deficit at the end of a model year after averaging across its fleet using credit transfers between cars and trucks—that is, a manufacturer's fleet average level may fail to meet the required fleet average standard. Credit carry-back refers to using credits to offset any deficit in meeting the fleet average standards that had accrued in a prior model year. A deficit must be offset within 3 model years using credit carry-back provisions. After satisfying any needs to offset pre-existing debits within a vehicle category, remaining credits may be banked, or saved for use in future years. This is referred to as credit carry-forward. The EPCA/EISA statutory framework for the CAFE program includes a 5-year credit carry-forward provision and a 3-year credit carry-back provision. In the MYs 2012–2016 program, EPA chose to adopt 5-year credit carry-forward and 3-year credit carry-back provisions as a reasonable approach that maintained consistency between the agencies' provisions. EPA is proposing to continue with this approach in this rulemaking. (A further discussion of the ABT provisions can be found at 75 FR 25412–14 May 7, 2010).

Although the credit carry-forward and carry-back provisions would generally remain in place for MY 2017 and later, EPA is proposing to allow all unused credits generated in MY 2010–2016 to be carried forward through MY 2021. This amounts to the normal 5 year carry-forward for MY 2016 and later credits but provides additional carry-forward years for credits earned in MYs 2010–2015. Extending the life for MY 2010–2015 credits would provide greater flexibility for manufacturers in using the credits they have generated. These credits would help manufacturers resolve lead-time issues they might face in the model years prior to 2021 as they transition from the 2016 standards to the progressively more stringent standards for 2017 and later. It also provides an additional incentive to generate credits earlier, for example in MYs 2014 and 2015, because those credits may be used through 2021, thereby encouraging the earlier use of additional CO_2 reducing technology.

While this provision provides greater flexibility in how manufacturers use credits they have generated, it would not change the overall CO_2 benefits of the National Program, as EPA does not expect that any of the credits would have expired as they likely would be used or traded to other manufacturers. EPA believes the proposed approach provides important additional flexibility in the early years of the new MY2017 and later standards. EPA requests comments on the proposed approach for carrying over MY 2010–2015 credits through MY 2021.

EPA is not proposing to allow MY 2009 early credits to be carried forward beyond the normal 5 years due to concerns expressed during the 2012–2016 rulemaking that there may be the potential for large numbers of credits that could be generated in MY 2009 for companies that are over-achieving on CAFE and that some of these credits could represent windfall credits.[226] In response to these concerns, EPA placed restrictions the use of MY 2009 credits (for example, MY 2009 credits may not be traded) and does not believe expanding the use of MY 2009 credits would be appropriate. Under the MY 2012–2016 early credits program, manufacturers have until the end of MY 2011 (reports must be submitted by April 2012), when the early credits program ends, to submit early credit reports. Therefore, EPA does not yet have information on the amount of early MY2009 credits actually generated by manufacturers to assess whether or not they could be viewed as windfall. Nevertheless, because these concerns continue, EPA is proposing not to extend the MY 2009 credit transfers past the existing 5-years limit.

Transferring credits refers to exchanging credits between the two averaging sets, passenger cars and trucks, within a manufacturer. For

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[225] See 75 FR at 25412–413.

[226] 75 FR at 25442. Moreover, as pointed out in the earlier rulemaking, there can be no legitimate expectation that these 2009 MY credits could be used as part of a compliance strategy in model years after 2014, and thus no reason to carry forward the credits past 5 years due to action in reliance by manufacturers.

example, credits accrued by over-compliance with a manufacturer's car fleet average standard could be used to offset debits accrued due to that manufacturer not meeting the truck fleet average standard in a given year. Finally, accumulated credits may be traded to another manufacturer. In EPA's CO_2 program, there are no limits on the amount of credits that may be transferred or traded.

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 (except for the proposal discussed above for a one-time extended carry-forward of MY2010–2016 credits), CAFE allows five year carry-forward of credits and three year carry-back, per EISA. 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 under CAFE, and transferred credits may not be used to meet the CAFE minimum domestic passenger car standard, also per statute. CAFE allows credit trading, but again, traded credits cannot be used to meet the minimum domestic passenger car standard.

5. Small Volume Manufacturer Standards

In adopting the CO_2 standards for MY 2012–2016, EPA recognized that for very small volume manufacturers, the CO_2 standards adopted for MY 2012–2016 would be extremely challenging and potentially infeasible absent credits from other manufacturers. EPA therefore deferred small volume manufacturers (SVMs) with annual U.S. sales less than 5,000 vehicles from having to meet CO_2 standards until EPA is able to establish appropriate SVM standards. As part of establishing eligibility for the exemption, manufacturers must make a good faith effort to secure credits from other manufacturers, if they are reasonably available, to cover the emissions reductions they would have otherwise had to achieve under applicable standards.

These small volume manufacturers face a greater challenge in meeting CO_2 standards compared to large manufacturers because they only produce a few vehicle models, mostly focusing on high performance sports cars and luxury vehicles. These manufacturers have limited product lines across which to average emissions, and the few models they produce often have very high CO_2 levels. As SVMs noted in discussions, SVMs only produce one or two vehicle types but must compete directly with brands that are part of larger manufacturer groups that have more resources available to them. There is often a time lag in the availability of technologies from suppliers between when the technology is supplied to large manufacturers and when it is available to small volume manufacturers. Also, incorporating new technologies into vehicle designs costs the same or more for small volume manufacturers, yet the costs are spread over significantly smaller volumes. Therefore, SVMs typically have longer model life cycles in order to recover their investments. SVMs further noted that despite constraints facing them, SVMs need to innovate in order to differentiate themselves in the market and often lead in incorporating technological innovations, particularly lightweight materials.

In the MY 2012–2016 Final Rule, EPA noted that it intended to conduct a follow-on rulemaking to establish appropriate standards for these manufacturers. In developing this proposal, the agencies held detailed technical discussions with the manufacturers eligible for the exemption under the MY 2012–2016 program and reviewed detailed product plans of each manufacturer. EPA continues to believe that SVMs would face great difficulty meeting the primary CO_2 standards and that establishing challenging but less stringent SVM standards is appropriate given the limited products offering of SVMs. EPA believes it is important to establish standards that will require SVMs to continue to innovate to reduce emissions and do their ''fair share'' under the GHG program. However, selecting a single set of standards that would apply to all SVMs is difficult because each manufacturer's product lines vary significantly. EPA is concerned that a standard that would be appropriate for one manufacturer may not be feasible for another, potentially driving them from the domestic market. Alternatively, a less stringent standard may only cap emissions for some manufacturers, providing little incentive to reduce emissions.

Based on this, rather than conducting a separate rulemaking, as part of this MY 2017–2025 rulemaking EPA is proposing to allow SVMs to petition EPA for an alternative CO_2 standard for these model years. The proposed approach for SVM standards and eligibility requirements are described below. EPA is also requesting comments on extending eligibility for the proposed SVM standards to very small manufacturers that are owned by large manufacturers but are able to establish that they are operationally independent.

EPA considered a variety of approaches and believes a case-by-case approach for establishing SVM standards would be appropriate. EPA is proposing to allow eligible SVMs the option to petition EPA for alternative standards. An SVM utilizing this option would be required to submit data and information that the agency would use in addition to other available information to establish CO_2 standards for that specific manufacturer. EPA requests comments on all aspects of the proposed approach described in detail below.

a. Overview of Existing Case-by-Case Approaches

A case-by-case approach for establishing standards for SVMs has been adopted by NHTSA for CAFE, CARB in their 2009–2016 GHG program, and the European Union (EU) for European CO_2 standards. For the CAFE program, EPCA allows manufacturers making less than 10,000 vehicles per year worldwide to petition the agency to have an alternative standard set for them.[227] NHTSA has adopted alternative standards for some small volume manufacturers under these CAFE provisions and continually reviews applications as they are submitted.[228] Under the CAFE program, petitioners must include projections of the most fuel efficient production mix of vehicle configurations for a model year and a discussion demonstrating that the projections are reasonable. Petitioners must include, among other items, annual production data, efforts to comply with applicable fuel economy standards, and detailed information on vehicle technologies and specifications. The petitioner must explain why they have not pursued additional means that would allow them to achieve higher average fuel economy. NHTSA publishes a proposed decision in the **Federal Register** and accepts public comments. Petitions may be granted for up to three years.

For the California GHG standards for MYs 2009–2016, CARB established a process that would start at the beginning of MY2013, where small volume manufacturers would identify all MY

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[227] See 49 U.S.C. 32902(d) and 49 CFR Part 525. Under the CAFE program, manufacturers who manufacture less than 10,000 passenger cars worldwide annually may petition for an exemption from generally-applicable CAFE standards, in which case NHTSA will determine what level of CAFE would be maximum feasible for that particular manufacturer if the agency determines that doing so is appropriate.

[228] Alternative CAFE standards are provided in 49 CFR 531.5 (e).

2012 vehicle models certified by large volume manufacturers that are comparable to the SVM's planned MY 2016 vehicle models.[229] The comparison vehicles were to be selected on the basis of horsepower and power to weight ratio. The SVM was required to demonstrate the appropriateness of the comparison models selected. CARB would then provide a target CO_2 value based on the emissions performance of the comparison vehicles to the SVM for each of their vehicle models to be used to calculate a fleet average standard for each test group for MY2016 and later. Since CARB provides that compliance with the National Program for MYs 2012–2016 will be deemed compliance with the CARB program, it has not taken action to set unique SVM standards, but its program nevertheless was a useful model to consider.

The EU process allows small manufacturers to apply for a derogation from the primary CO_2 emissions reduction targets.[230] Applications for 2012 were required to be submitted by manufacturers no later than March 31, 2011, and the Commission will assess the application within 9 months of the receipt of a complete application. Applications for derogations for 2012 have been submitted by several manufacturers and non confidential versions are currently available to the public.[231] In the EU process, the SVM proposes an alternative emissions target supported by detailed information on the applicant's economic activities and technological potential to reduce CO_2 emissions. The application also requires information on individual vehicle models such as mass and specific CO_2 emissions of the vehicles, and information on the characteristics of the market for the types of vehicles manufactured. The proposed alternative emissions standards may be the same numeric standard for multiple years or a declining standard, and the alternative standards may be established for a maximum period of five years. Where the European Commission is satisfied that the specific emissions target proposed by the manufacturer is consistent with its reduction potential, including the economic and technological potential to reduce its specific emissions of CO_2, and taking into account the characteristics of the market for the type of car manufactured, the Commission will grant a derogation to the manufacturer.

b. EPA's Proposed Framework for Case-by-Case SVM Standards

EPA proposes that SVMs will become subject to the GHG program beginning with MY 2017. Starting in MY 2017, an SVM would be required to meet the primary program standards unless EPA establishes alternative standards for the manufacturer. EPA proposes that eligible manufacturers seeking alternative standards must petition EPA for alternative standards by July 30, 2013, providing the information described below. If EPA finds that the application is incomplete, EPA would notify the manufacturer and provide an additional 30 days for the manufacturer to provide all necessary information. EPA would then publish a notice in the **Federal Register** of the manufacturer's petition and recommendations for an alternative standard, as well as EPA's proposed alternative standard. Non confidential business information portions of the petition would be available to the public for review in the docket. After a period for public comment, EPA would make a determination on an alternative standard for the manufacturer and publish final notice of the determination in the **Federal Register** for the general public as well as the applicant. EPA expects the process to establish the alternative standard to take about 12 months once a complete application is submitted by the manufacturer.

EPA proposes that manufacturers would petition for alternative standards for up to 5 model years (*i.e.,* MYs 2017—2021) as long as sufficient information is available on which to base the alternative standards (see application discussion below). This initial round of establishing case-by-case standards would be followed by one or more additional rounds until standards are established for the SVM for all model years up to and including MY 2025. For the later round(s) of standard setting, EPA proposes that the SVM must submit their petition 36 months prior to the start of the first model year for which the standards would apply in order to provide sufficient time for EPA to evaluate and set alternative standards (*e.g.,* January 1, 2018 for MY 2022). The 36 month requirement would not apply to new market entrants, discussed in section III.C.5.e below. The subsequent case-by-case standard setting would follow the same notice and comment process as outlined above.

EPA also proposes that if EPA does not establish SVM standards for a manufacturer at least 12 months prior to the start of the model year in cases where the manufacturer provided all required information by the established deadline, the manufacturer may request an extension of the alternative standards currently in place, on a model year by model year basis. This would provide assurance to manufacturers that they would have at least 12 months lead time to prepare for the upcoming model year.

EPA requests comments on allowing SVMs to comply early with the MY 2017 SVM standards established for them. Manufacturers may want to certify to the MY 2017 standards in earlier model years (*e.g.,* MY 2015 or MY 2016). Under the MY 2012–2016 program, SVMs are eligible for an exemption from the standards as long as they have made a good faith effort to purchase credits. By certifying to the SVM alternative standard early in lieu of this exemption, manufacturers could avoid having to seek out credits to purchase in order to maintain this exemption. EPA would not allow certification for vehicles already produced by the manufacturer, so the applicability of this provision would be limited due to the timing of establishing the SVM standards. Manufacturers interested in the possibility of early compliance would be able to apply for SVM standards earlier than the required July 30, 2013 deadline proposed above. An early compliance option also may be beneficial for new manufacturers entering the market that qualify as SVMs.

c. Petition Data and Information Requirements

As described in detail in section I.D.2, EPA establishes motor vehicle standards under section 202(a) that are based on technological feasibility, and considering lead time, safety, costs and other impacts on consumers, and other factors such as energy impacts associated with use of the technology. EPA proposes to require that SVMs submit the data and information listed below which EPA would use, in addition to other relevant information, in determining an appropriate alternative standard for the SVM. EPA would also consider data and information provided by commenters during the comment process in determining the final level of the SVM's standards. As noted above, other case-by-case standard setting approaches have been adopted by NHTSA, the European Union, and CARB and EPA has considered the data requirements of those programs in developing the proposed data and information requirements detailed below. EPA

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[229] 13 CCR 1961.1(D).

[230] Article 11 of Regulation (EC) No 443/2009 and EU No 63/2011. See also ''Frequently asked questions on application for derogation pursuant to Aticle 11 of Regulation (EC) 443/2009.''

[231] *http://ec.europa.eu/clima/documentation/transport/vehicles/cars_en.htm.*

requests comments on the following proposed data requirements.

EPA proposes that SVMs would provide the following information as part of their petition for SVM standards:

Vehicle Model and Fleet Information

- MYs that the application covers—up to 5 MYs. Sufficient information must be provided to establish alternative standards for each year
- Vehicle models and sales projections by model for each MY
- Description of models (vehicle type, mass, power, footprint, expected pricing)
- Description of powertrain
- Production cycle for each model including new vehicle model introductions
- Vehicle footprint based targets and projected fleet average standard under primary program by model year

Technology Evaluation

- CO_2 reduction technologies employed or expected to be on the vehicle model(s) for the applicable model years, including effectiveness and cost information
  - —Including A/C and potential off-cycle technologies
- Evaluation of similar vehicles to those produced by the petitioning SVM and certified in MYs 2012–2013 (or latest 2 MYs for later applications) for each vehicle model including CO_2 results and any A/C credits generated by the models
  - —Similar vehicles must be selected based on vehicle type, horsepower, mass, power-to-weight, vehicle footprint, vehicle price range and other relevant factors as explained by the SVM
- Discussion of CO_2 reducing technologies employed on vehicles offered by the manufacturer outside of the U.S. market but not in the U.S., including why those vehicles/technologies are not being introduced in the U.S. market as a way of reducing overall fleet CO_2 levels
- Evaluation of technologies projected by EPA as technologies likely to be used to meet the MYs 2012–2016 and MYs 2017–2025 standards that are not projected to be fully utilized by the petitioning SVM and explanation of reasons for not using the technologies, including relevant cost information[232]

SVM Projected Standards

- The most stringent CO_2 level estimated by the SVM to be feasible and appropriate by model and MY and the technological and other basis for the estimate
- For each MY, projection of the lowest fleet average CO_2 production mix of vehicle models and discussion demonstrating that these projections are reasonable
- A copy of any applications submitted to NHTSA for MY 2012 and later alternative standards

Eligibility

- U.S. sales for previous three model years and projections for production volumes over the time period covered by the application
- Complete information on ownership structure in cases where SVM has ties to other manufacturers with U.S. vehicle sales

EPA proposes to weigh several factors in determining what CO_2 standards are appropriate for a given SVMs fleet. These factors would include the level of technology applied to date by the manufacturer, the manufacturer's projections for the application of additional technology, CO_2 reducing technologies being employed by other manufacturers including on vehicles with which the SVM competes directly and the CO_2 levels of those vehicles, and the technological feasibility and reasonableness of employing additional technology not projected by the manufacturer in the time-frame for which standards are being established. EPA would also consider opportunities to generate A/C and off-cycle credits that are available to the manufacturer. Lead time would be a key consideration both for the initial years of the SVM standard, where lead time would be shorter due to the timing of the notice and comment process to establish the standards, and for the later years where manufacturers would have more time to achieve additional CO_2 reductions.

d. SVM Credits Provisions

As discussed in Section III.B.4, EPA's program includes a variety of credit averaging, banking, and trading provisions. EPA proposes that these provisions would generally apply to SVM standards as well, with the exception that SVMs would not be allowed to trade credits to other manufacturers. Because SVMs would be meeting alternative, less stringent standards compared to manufacturers in the primary program, EPA proposes that SVM would not be allowed to trade (*i.e.,* sell or otherwise provide) CO_2 credits that the SVM generates against the SVM standards to other manufacturers. SVMs would be able to use credits purchased from other manufacturers generated in the primary program. Although EPA does not expect significant credits to be generated by SVMs due to the manufacturer-specific standard setting approach being proposed, SVMs would be able to generate and use credits internally, under the credit carry-forward and carry-back provisions. Under a case-by-case approach, EPA would not view such credits as windfall credits and not allowing internal banking could stifle potential innovative approaches for SVMs. SVMs would also be able to transfer credits between the car and light trucks categories.

e. SVM Standards Eligibility

i. Current SVMs

The MY 2012–2016 rulemaking limited eligibility for the SVM deferment to manufacturers in the U.S. market in MY 2008 or MY 2009 with U.S. sales of less than 5,000 vehicles per year. After initial eligibility has been established, the SVM remains eligible for the exemption if the rolling average of three consecutive model years of sales remains below 5,000 vehicles. Manufacturers going over the 5,000 vehicle rolling average limit would have two additional model years to transition to having to meet applicable CO_2 standards. Based on these eligibility criteria, there are three companies that qualify currently as SVMs under the MY2012–2016 standards: Aston Martin, Lotus, and McLaren.[233] These manufacturers make up much less than one percent of total U.S. vehicles sales, so the environmental impact of these alternative standards would be very small. EPA continues to believe that the 5,000 vehicle cut-point and rolling three year average approach is appropriate and proposes to retain it as a primary criterion for SVMs to remain eligible for SVM standards. The 5,000 vehicle threshold allows for some sales growth by SVMs, as the SVMs in the market today typically have annual sales of below 2,000 vehicles. However, EPA wants to ensure that standards for as few vehicles as possible are included in the SVM standards to minimize the environmental impact, 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 the primary standards. 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 expands in

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[232] See 75 FR 25444 (Section III.D) for MY 2012–2016 technologies and Section III.D below for discussion of projected MY 2017–2025 technologies.

[233] Under the MY 2012–2016 program, manufacturers must also make a good faith effort to purchase CO_2 credits in order to maintain eligibility for SVM status.

the U.S. market on a permanent basis such that they consistently sell more than 5,000 vehicles per year, they would likely increase their rolling average to above 5,000 and no longer be eligible. 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. As discussed below, EPA is not proposing to continue to tie eligibility to having been in the market in MY 2008 or MY 2009, or any other year and is instead proposing eligibility criteria for new SVMs newly entering the U.S. market.

ii. New SVMs (New Entrants to the U.S. Market)

As noted above, the SVM deferment under the MY 2012–2016 program included a requirement that a manufacturer had to have been in the U.S. vehicle market in MY 2008 or MY 2009. This provision ensured that a known universe of manufacturers would be eligible for the exemption in the short term and manufacturers would not be driven from the market as EPA proceeded to develop appropriate SVM standards. EPA is not proposing to include such a provision for the SVM standards eligibility criteria for MY 2017–2025. EPA believes that with SVM standards in place, tying eligibility to being in the market in a prior year is no longer necessary because SVMs will be required to achieve appropriate levels of emissions control. Also, it could serve as a potential market barrier to competition by hindering new SVMs from entering the U.S. market.

For new market entrants, EPA proposes that a manufacturer seeking an alternative standard for MY2017–2025 must apply and that standards would be established through the process described above. The new SVM would not be able to certify their vehicles until the standards are established and therefore EPA would expect the manufacturer to submit an application as early as possible but at least 30 months prior to when they expect to begin producing vehicles in order to provide enough time for EPA to evaluate standards and to follow the notice and comment process to establish the standards and for certification. In addition to the information and data described below, EPA proposes to require new market entrants to provide evidence that the company intends to enter the U.S. market within the time frame of the MY2017–2025 SVM standards. Such evidence would include documentation of work underway to establish a dealer network, appropriate financing and marketing plans, and evidence the company is working to meet other federal vehicle requirements such as other EPA emissions standards and NHTSA vehicle safety standards. EPA is concerned about the administrative burden that could be created for the agency by companies with no firm plans to enter the U.S. market submitting applications in order to see what standard might be established for them. This information, in addition to a complete application with the information and data outlined above, would provide evidence of the seriousness of the applicant. As part of this review, EPA reserves the right to not undertake its SVM standards development process for companies that do not exhibit a serious and documented effort to enter the U.S. market.

EPA remains concerned about the potential for gaming by a manufacturer that sells less than 5,000 vehicles in the first year, but with plans for significantly larger sales volumes in the following years. EPA believes that it would not be appropriate to establish SVM standards for a new market entrant that plans a steep ramp-up in U.S. vehicle sales. Therefore, EPA proposes that for new entrants, U.S. vehicle sales must remain below 5,000 vehicles for the first three years in the market. After the initial three years, the manufacturer must maintain a three year rolling average below 5,000 vehicles (*e.g.,* the rolling average of years 2, 3 and 4, must be below 5,000 vehicles). If a new market entrant does not comply with these provisions for the first five years in the market, vehicles sold above the 5,000 vehicle threshold would be found not to be covered by the alternative standards, and EPA expects the fleet average is therefore not in compliance with the standards and would be subject to enforcement action and also, the manufacturer would lose eligibility for the SVM standards until it has reestablished three consecutive years of sales below 5,000 vehicles.

By not tying the 5,000 vehicle eligibility criteria to a particular model year, it would be possible for a manufacturer already in the market to drop below the 5,000 vehicle threshold in a future year and attempt to establish eligibility. EPA proposes to treat such manufacturers as new entrants to the market for purposes of determining eligibility for SVM standards. However, the requirements to demonstrate that the manufacturer intends to enter the U.S. market obviously would not be relevant in this case, and therefore would not apply.

iii. Aggregation Requirements and an Operational Independence Concept

In determining eligibility for the MY 2012–2016 exemption, sales volumes must be aggregated across manufacturers 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. These are the same aggregation requirements used in other EPA small volume manufacturer provisions, such as those for other light-duty emissions standards.[234] EPA proposes to retain these aggregation provisions as part of the eligibility criteria for the SVM standards for MYs 2017–2025. Manufacturers also retain, no matter their size, the option to meet the full set of GHG requirements on their own, and do not necessarily need to demonstrate compliance as part of a corporate parent company fleet. However, as discussed below, EPA is seeking comments on allowing manufacturers that otherwise would not be eligible for the SVM standards due to these aggregation provisions, to demonstrate to the Administrator that they are ''operationally independent'' based on the criteria described below. Under such a concept, if the Administrator were to determine that a manufacturer was operationally independent, that manufacturer would be eligible for SVM standards.

During the 2012–2016 rule comment period, EPA received comments from Ferrari requesting that EPA allow a manufacturer to apply to EPA to establish SVM status based on the independence of its research, development, testing, design, and manufacturing from another firm that has ownership interest in that manufacturer. Ferrari is majority owned by Fiat and would be aggregated with other Fiat brands, including Chrysler, Maserati, and Alfa Romeo, for purposes of determining eligibility for SVM standards; therefore Ferrari does not meet the eligibility criteria for SVM status. However, Ferrari believes that it would qualify for such an ''operational independence'' concept, if such an option were provided. In the MY 2012–2016 Final Rule, EPA noted that it would further consider the issue of operational independence and seek public comments on this concept (see 75 FR 25420). In this proposal, EPA is

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[234] For other programs, the eligibility cut point for SVM flexibility is 15,000 vehicles rather than 5,000 vehicles.

requesting comment on the concept of operational independence. Specifically, we are seeking comment on expanding eligibility for the SVM standards to manufacturers who would have U.S. annual sales of less than 5,000 vehicles and based on a demonstration that they are ''operationally independent'' of other companies. Under such an approach, EPA would be amending the limitation for SVM corporate aggregation provisions such that a manufacturer that is more than 10 percent owned by a large manufacturer would be allowed to qualify for SVM standards on the basis of its own sales, because it operates its research, design, production, and manufacturing independently from the parent company.

In seeking public comment on this concept of operational independence, EPA particularly is interested in comments regarding the degree to which this concept could unnecessarily open up the SVM standards to several smaller manufacturers that are integrated into large companies—smaller companies that may be capable of and planning to meet the CO_2 standards as part of the larger manufacturer's fleet. EPA also seeks comment on the concern that manufacturers could change their corporate structure to take advantage of such provisions (that is, gaming). EPA is therefore requesting comment on approaches, described below, to narrowly define the operational independence criteria to ensure that qualifying companies are truly independent and to avoid gaming to meet the criteria. EPA also requests comments on the possible implications of this approach on market competition, which we believe should be fully explored through the public comment process. EPA acknowledges that regardless of the criteria for operational independence, a small manufacturer under the umbrella of a large manufacturer is fundamentally different from other SVMs because the large manufacturer has several options under the GHG program to bring the smaller subsidiary into compliance, including the use of averaging or credit transfer provisions, purchasing credits from another manufacturer, or providing technical and financial assistance to the smaller subsidiary. Truly independent SVMs do not have the potential access to these options, with the exception of buying credits from another manufacturer. EPA requests comments on the need for and appropriateness of allowing companies to apply for less stringent SVM standards based on sales that are not aggregated with other companies because of operational independence.

EPA is considering and requesting comments on the operational independence criteria listed below. These criteria are meant to establish that a company, though owned by another manufacturer, does not benefit operationally or financially from this relationship, and should therefore be considered independent for purposes of calculating the sales volume for the SVM program. Manufacturers would need to demonstrate compliance with all of these criteria in order to be found to be operationally independent. By ''related manufacturers'' below, EPA means all manufacturers that would be aggregated together under the 10 percent ownership provisions contained in EPA's current small volume manufacturer definition (*i.e.,* the parent company and all subsidiaries where there is 10 percent or greater ownership).

EPA would need to determine, based on the information provided by the manufacturer in its application, that the manufacturer currently meets the following criteria and has met them for at least 24 months preceding the application submittal:

1. No financial or other support of economic value was provided by related manufacturers for purposes of design, parts procurement, R&D and production facilities and operation. Any other transactions with related manufacturers must be conducted under normal commercial arrangements like those conducted with other parties. Any such transactions shall be at competitive pricing rates to the manufacturer.
2. Maintains separate and independent research and development, testing, and production facilities.
3. Does not use any vehicle powertrains or platforms developed or produced by related manufacturers.
4. Patents are not held jointly with related manufacturers.
5. Maintains separate business administration, legal, purchasing, sales, and marketing departments; maintains autonomous decision making on commercial matters.
6. Overlap of Board of Directors is limited to 25 percent with no sharing of top operational management, including president, chief executive officer (CEO), chief financial officer (CFO), and chief operating officer (COO), and provided that no individual overlapping director or combination of overlapping directors exercises exclusive management control over either or both companies.
7. Parts or components supply agreements between related companies must be established through open market process and to the extent that manufacturer sells parts/components to non-related auto manufacturers, it does so through the open market at competitive pricing.

In addition to the criteria listed above, EPA also requests comments on the following programmatic elements and framework. EPA requests comments on requiring the manufacturer applying for operational independence to provide an attest engagement from an independent auditor verifying the accuracy of the information provided in the application.[235] EPA foresees possible difficulty verifying the information in the application, especially if the company is located overseas. The principal purpose of the attest engagement would be to provide an independent review and verification of the information provided. EPA also would require that the application be signed by the company president or CEO. After EPA approval, the manufacturer would be required to report within 60 days any material changes to the information provided in the application. A manufacturer would lose eligibility automatically after the material change occurs. However, EPA would confirm that the manufacturer no longer meets one or more of the criteria and thus is no longer considered operationally independent, and would notify the manufacturer. EPA would provide two model years lead time for the manufacturer to transition to the primary program. For example, if the manufacturer lost eligibility sometime in calendar year 2018 (based on when the material change occurs), the manufacturer would need to meet primary program standards in MY 2021.

In addition, EPA requests comments on whether or not a manufacturer losing eligibility should be able to re-establish itself as operationally independent in a future year and over what period of time they would need to meet the criteria to again be eligible. EPA requests comments on, for example, whether or not a manufacturer meeting the criteria for three to five consecutive years should be allowed to again be considered operationally independent.

6. Nitrous Oxide, Methane, and CO_2-equivalent Approaches

a. Standards and Flexibility

For light-duty vehicles, as part of the MY 2012–2016 rulemaking, EPA finalized standards for nitrous oxide (N_2O) of 0.010 g/mile and methane (CH_4) of 0.030 g/mile for MY 2012 and

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[235] EPA has required attest engagements as part of its Reformulated Fuels program. See 40 CFR § 80.1164 and § 80.1464.

later vehicles. 75 FR at 25421–24. The light-duty vehicle standards for N_2O and CH_4 were established to cap emissions, where current levels are generally significantly below the cap. The cap would prevent future emissions increases, and were generally not expected to result in the application of new technologies or significant costs for the manufacturers for current vehicle designs. EPA also finalized an alternative CO_2 equivalent standard option, which manufacturers may choose to use in lieu of complying with the N_2O and CH_4 cap standards. The CO_2-equivalent standard option allows manufacturers to fold all 2-cycle weighted N_2O and CH_4 emissions, on a CO_2-equivalent basis, along with CO_2 into their CO_2 emissions fleet average compliance level.[236] The applicable CO_2 fleet average standard is not adjusted to account for the addition of N_2O and CH_4. For flexible fueled vehicles, the N_2O and CH_4 standards must be met on both fuels (*e.g.,* both gasoline and E–85).

After the light-duty standards were finalized, manufacturers raised concerns that for a few of the vehicle models in their existing fleet they were having difficulty meeting the N_2O and/or CH_4 standards, in the near-term. In such cases, manufacturers would still have the option of complying using the CO_2 equivalent alternative. On a CO_2 equivalent basis, folding in all N_2O and CH_4 emissions could add up to 3–4 g/mile to a manufacturer's overall fleet-average CO_2 emissions level because the alternative standard must be used for the entire fleet, not just for the problem vehicles. The 3–4 g/mile assumes all emissions are actually at the level of the cap. See 75 FR at 74211. This could be especially challenging in the early years of the program for manufacturers with little compliance margin because there is very limited lead time to develop strategies to address these additional emissions. Some manufacturers believe that the current CO_2-equivalent fleet-wide option ''penalizes'' them by requiring them to fold in both CH_4 and N_2O emissions for their entire fleet, even if they have difficulty meeting the cap on only one vehicle model.

In response to these concerns, as part of the heavy-duty GHG rulemaking, EPA requested comment on and finalized provisions allowing manufacturers to use CO_2 credits, on a CO_2-equivalent basis, to meet the light-duty N_2O and CH_4 standards.[237] Manufacturers have the option of using CO_2 credits to meet N_2O and CH_4 standards on a test group basis as needed for MYs 2012–2016. In their public comments to the proposal in the heavy-duty package, manufacturers urged EPA to extend this flexibility indefinitely, as they believed this option was more advantageous than the CO_2-equivalent fleet wide option (discussed previously) already provided in the light-duty program, because it allowed manufacturers to address N_2O and CH_4 separately and on a test group basis, rather than across their whole fleet. Further, manufacturers believed that since this option is allowed under the heavy-duty standards, allowing it indefinitely in the light-duty program would make the light- and heavy-duty programs more consistent. In the Final Rule for Heavy-Duty Vehicles, EPA noted that it would consider this issue further in the context of new standards for MYs 2017–2025 in the planned future light-duty vehicle rulemaking. 76 FR at 57194.

EPA has further considered this issue and is proposing to allow the additional option of using CO_2 credits to meet the light-duty vehicle N_2O and CH_4 standards to extend for all model years beyond MY 2016. EPA understands manufacturer concerns that if they use the CO_2-equivalent option for meeting the GHG standards, they would be penalized by having to incorporate all N_2O and CH_4 emissions across their entire fleet into their CO_2-equivalent fleet emissions level determination. EPA continues to believe that allowing CO_2 credits to meet CH_4 and N_2O standards on a CO_2-equivalent basis is a reasonable approach to provide additional flexibility without diminishing overall GHG emissions reductions.

EPA is also requesting comments on establishing an adjustment to the CO_2-equivalent standard for manufacturers selecting the CO_2-equivalent option established in the MY 2012–2016 rulemaking. Manufacturers would continue to be required to fold in all of their CH_4 and N_2O emissions, along with CO_2, into their CO_2-equivalent levels. They would then apply the agency-established adjustment factor to the CO_2-equivalent standard. For example, if the adjustment for CH_4 and N_2O combined was 1 to 2 g/mile CO_2-equivalent (taking into account the GWP of N_2O and CH_4), manufacturers would determine their CO_2 fleet emissions standard and add the 1 to 2 g/mile adjustment factor to it to determine their CO_2-equivalent standard. The adjustment factor would slightly increase the amount of allowed fleet average CO_2-equivalent emissions for the manufacturer's fleet. The purpose of this adjustment would be so manufacturers do not have to offset the typical N_2O and CH_4 vehicle emissions, while holding manufacturers responsible for higher than average N_2O and CH_4 emissions levels.

At this time, EPA is not proposing an adjustment value due to a current lack of N_2O test data on which to base the adjustment for N_2O. As discussed below, EPA and manufacturers are currently evaluating N_2O measurement equipment and insufficient data is available at this time on which to base an appropriate adjustment. For CH_4, manufacturers currently provide data during certification, and based on current vehicle data a fleet-wide adjustment for CH_4 in the range of 0.14 g/mile appears to be appropriate.[238] EPA requests comments on this concept and requests city and highway cycle N_2O data on current Tier 2 vehicles which could help serve as the basis for the adjustment.

EPA continues to believe that it would not be appropriate to base the adjustment on the cap standards because such an approach could have the effect of undermining the stringency of the CO_2 standards, as many vehicles would likely have CH_4 and N_2O levels much lower than the cap standards. EPA believes that if an appropriate adjustment could be developed and applied, it would help alleviate manufacturers' concerns discussed above and make the CO_2-equivalent approach a more viable option.

b. N_2O Measurement

For the N_2O standard, EPA finalized provisions in the MY 2012–2016 rule allowing manufacturers to support an application for a certificate by supplying a compliance statement based on good engineering judgment, in lieu of N_2O test data, through MY 2014. EPA required N_2O testing starting with MY 2015. See 75 FR at 25423. This flexibility provided manufacturers with lead time needed to make necessary

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[236] The global warming potentials (GWP) used in this rule are consistent with the 100-year time frame values in the 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). At this time, the 100-year GWP values from the 1996 IPCC Second Assessment Report (SAR) are used in the official U.S. greenhouse gas inventory submission to the United Nations Framework Convention on Climate Change (per the reporting requirements under that international convention, which were last updated in 2006) . N_2O has a 100-year GWP of 298 and CH_4 has a 100-year GWP of 25 according to the 2007 IPCC AR4.

[237] See 76 FR at 57193–94.

[238] Average city/highway cycle CH_4 emissions based on MY2010–2012 gasoline vehicles certification data is about 0.0056 g/mile; multiplied by the methane GWP of 25, this level would result in a 0.14 g/mile adjustment. See memo to the docket, ''Analysis of Methane (CH_4) Certification Data for Model Year 2010–2012 Vehicles.''

facilities changes and install N_2O measurement equipment.

Since the final rule, manufacturers have raised concerns that the lead-time provided to begin N_2O measurement is not sufficient, as their research and evaluation of N_2O measurement instrumentation has involved a greater level of effort than previously expected. There are several analyzers available today for the measurement of N_2O. Over the last year since the MY 2012–2016 standards were finalized, EPA has continued to evaluate instruments for N_2O measurement and now believes instruments not evaluated during the 2012–2016 rulemaking have the potential to provide more precise emissions measurement and believe it would be prudent to provide manufacturers with additional time to evaluate, procure, and install equipment in their test cells.[239] Therefore, EPA believes that the manufacturer's concerns about the need for additional lead-time have merit, and is proposing to extend the ability for manufacturers to use compliance statements based on good engineering judgment in lieu of test data through MY 2016. Beginning in MY 2017, manufacturers would be required to measure N_2O emissions to verify compliance with the standard. This approach, if finalized, will provide the manufacturers with two additional years of lead-time to evaluate, procure, and install N_2O measurement systems throughout their certification laboratories.

7. Small Entity Exemption

In the MY 2012–2016 rule, EPA exempted entities from the GHG emissions standard, if the entity met the Small Business Administration (SBA) size criteria of a small business as described in 13 CFR 121.201.[240] This includes both U.S.-based and foreign small entities in three distinct categories of businesses for light-duty vehicles: small manufacturers, independent commercial importers (ICIs), and alternative fuel vehicle converters. EPA is proposing to continue this exemption for the MY 2017–2025 standards. EPA will instead consider appropriate GHG standards for these entities as part of a future regulatory action.

EPA has identified about 21 entities that fit the Small Business Administration (SBA) size criterion of a small business. EPA estimates there currently are approximately four small manufacturers including three electric vehicle small manufacturers that have recently entered the market, eight ICIs, and nine alternative fuel vehicle converters in the light-duty vehicle market. EPA estimates that these small entities comprise less than 0.1 percent of the total light-duty vehicle sales in the U.S., and therefore the exemption will have a negligible impact on the GHG emissions reductions from the standards. Further detail regarding EPA's assessment of small businesses is provided in Regulatory Flexibility Act Section III.J.3.

At least one small business manufacturer, Fisker Automotive, in discussions with EPA, has suggested that small businesses should have the option of voluntarily opting-in to the GHG standards. This manufacturer sells electric vehicles, and sees a potential market for selling credits to other manufacturers. EPA believes that there could be several benefits to this approach, as it would allow small businesses an opportunity to generate revenue to offset their technology investments and encourage commercialization of the innovative technology, and it would benefit any manufacturer seeking those credits to meet their compliance obligations. EPA is proposing to allow small businesses to waive their small entity exemption and opt-in to the GHG standards. Upon opting in, the manufacturer would be subject to all of the requirements that would otherwise be applicable. This would allow small entity manufacturers to earn CO_2 credits under the program, which may be an especially attractive option for the new electric vehicle manufacturers entering the market. EPA proposes to make the opt-in available starting in MY 2014, as the MY 2012, and potentially the MY 2013, certification process will have already occurred by the time this rulemaking is finalized. EPA is not proposing to retroactively certify vehicles that have already been produced. However, EPA proposes that manufacturers certifying to the GHG standards for MY 2014 would be eligible to generate credits for vehicles sold in MY 2012 and MY 2013 based on the number of vehicles sold and the manufacturer's footprint-based standard under the primary program that would have otherwise applied to the manufacturer if it were a large manufacturer. This approach would be similar to that used by EPA for early credits generated in MYs 2009–2011, where manufacturers did not certify vehicles to CO_2 standards in those years but were able to generate credits. See 75 FR at 25441. EPA believes it is appropriate to provide these credits to small entities, as the credits would be available to large manufacturers producing similar vehicles, and the credits further encourage manufacturers of advanced technology vehicles such as EVs. In addition to benefiting these small businesses, this option also has the potential to expand the pool of credits available to be purchased by other manufacturers. EPA proposes that manufacturers waiving their small entity exemption would be required to meet all aspects of the GHG standards and program requirements across their entire product line. EPA requests comments on the small business provisions described above.

8. Additional Leadtime Issues

The 2012–2016 GHG vehicle standards include Temporary Leadtime Allowance Alternative Standards (TLAAS) which provide alternative standards to certain intermediate sized manufacturers (those with U.S. sales between 5,000 and 400,000 during model year 2009) to accommodate two situations: manufacturers which traditionally paid fines instead of complying with CAFE standards, and limited line manufacturers facing special compliance challenges due to less flexibility afforded by averaging, banking and trading. See 75 FR at 25414–416. EPA is not proposing to continue this program for MYs 2017–2025. First, the allowance was premised on the need to provide adequate lead time, given the (at the time the rule was finalized) rapidly approaching MY 2012 deadline, and given that manufacturers were transitioning from a CAFE regime that allows fine-paying, to a Clean Air Act regime that does not. That concern is no longer applicable, given that there is ample lead time before the MY 2017 standards. More important, the Temporary Lead Time Allowance was just that—temporary—and EPA provided it to allow manufacturers to transition to full compliance in later model years. See 75 FR at 25416. EPA is thus not proposing to continue this provision.

In the context of the increasing stringency of standards in the latter phase of the program (*e.g.,* MY 2022–2025), one manufacturer suggested that EPA should consider providing limited line, intermediate volume manufacturers additional time to phase into the standards. The concern raised is that such limited line manufacturers face unique challenges securing competitive supplier contracts for new technologies, and have fewer vehicle lines to allocate the necessary upfront investment and risk inherent with new technology introduction. This

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[239] "Data from the evaluation of instruments that measure Nitrous Oxide (N_2O)," Memorandum from Chris Laroo to Docket EPA–HQ–OAR–2010–0799, October 31, 2011.

[240] See final regulations at 40 CFR 86.1801–12(j).

manufacturer believes that as the standards become increasingly stringent in future years requiring the investment in new or advanced technologies, intermediate volume limited line manufacturers may have to pay a premium to gain access to these technologies which would put them at a competitive disadvantage. EPA seeks comment on this issue, and whether there is a need to provide some type of additional leadtime for intermediate volume limited line manufacturers to meet the latter year standards.

In the context of the increasing stringency of standards starting in MY 2017, as discussed, EPA is not proposing a continuation of the TLAAS. TLAAS was available to firms with a wide range of U.S. sales volumes (between 5,000 and 400,000 in MY 2009). One company with U.S. sales on the order of 25,000 vehicles per year has indicated that it believes that the CO_2 standards in today's proposal for MY 2017–2025 would present significant technical challenges for their company, due to the relatively small volume of products it sells in the U.S., limited ability to average across their limited line fleet, and the performance-oriented nature of its vehicles. This firm indicated that absent access several years in advance to CO_2 credits that it could purchase from other firms, this firm would need to significantly change the types of products they currently market in the U.S. beginning in model year 2017, even if it adds substantial CO_2 reducing technology to its vehicles. EPA requests comment on the potential need to include additional flexibilities for companies with U.S. vehicle sales on the order of 25,000 units per year, and what types of additional flexibilities would be appropriate. Potential flexibilities could include an extension of the TLAAS program for lower volume companies, or a one-to-three year delay in the applicable model year standard (*e.g.,* the proposed MY 2017 standards could be delayed to begin in MY 2018, MY 2019, or MY 2020). Commenters suggesting that additional flexibilities may be needed are encouraged to provide EPA with data supporting their suggested flexibilities.

9. Police and Emergency Vehicle Exemption From CO_2 Standards

Under EPCA, manufacturers are allowed to exclude police and other emergency vehicles from their CAFE fleet and all manufacturers that produce emergency vehicles have historically done so. EPA received comments in the MY 2012–2016 rulemaking that these vehicles should be exempt from the GHG emissions standards and EPA committed to further consider the issue in a future rulemaking.[241] After further consideration of this issue, EPA proposes to exempt police and other emergency vehicles from the CO_2 standards starting in MY 2012.[242] EPA believes it is appropriate to provide an exemption for these vehicles because of the unique features of vehicles designed specifically for law enforcement and emergency response purposes, which have the effect of raising their GHG emissions, as well as for purposes of harmonization with the CAFE program. EPA proposes to exempt vehicles that are excluded under EPCA and NHTSA regulations which define emergency vehicle as ''a motor vehicle manufactured primarily for use as an ambulance or combination ambulance-hearse or for use by the United States Government or a State or local government for law enforcement, or for other emergency uses as prescribed by regulation by the Secretary of Transportation.'' [243]

The unique features of these vehicles result in significant added weight including: heavy-duty suspensions, stabilizer bars, heavy-duty/dual batteries, heavy-duty engine cooling systems, heavier glass, bullet-proof side panels, and high strength sub-frame. Police pursuit vehicles are often equipped with specialty steel rims and increased rolling resistance tires designed for high speeds, and unique engine and transmission calibrations to allow high-power, high-speed chases. Police and emergency vehicles also have features that tend to reduce aerodynamics, such as emergency lights, increased ground clearance, and heavy-duty front suspensions.

EPA is concerned that manufacturers may not be able to sufficiently reduce the emissions from these vehicles, and would be faced with a difficult choice of compromising necessary vehicle features or dropping vehicles from their fleets, as they may not have credits under the fleet averaging provisions necessary to cover the excess emissions from these vehicles as standards become more stringent. Without the exemption, there could be situations where a manufacturer is more challenged in meeting the GHG standards simply due to the inclusion of these higher emitting emergency vehicles. Technical feasibility issues go beyond those of other high-performance vehicles and there is a clear public need for law enforcement and emergency vehicles that meet these performance characteristics as these vehicles must continue to be made available in the market. MY 2012–2016 standards, as well as MY 2017 and later standards would be fully harmonized with CAFE regarding the treatment of these vehicles. EPA requests comments on its proposal to exempt emergency vehicles from the GHG standards.

10. Test Procedures

EPA is considering revising the procedures for measuring fuel economy and calculating average fuel economy for the CAFE program, effective beginning in MY 2017, to account for three impacts on fuel economy not currently included in these procedures—increases in fuel economy because of increases in efficiency of the air conditioner; increases in fuel economy because of technology improvements that achieve ''off-cycle'' benefits; and incentives for use of certain hybrid technologies in full size pickup trucks, and for the use of other technologies that help those vehicles exceed their targets, in the form of increased values assigned for fuel economy. As discussed in section IV of this proposal, NHTSA would take these changes into account in determining the maximum feasible fuel economy standard, to the extent practicable. In this section, EPA discusses the legal framework for considering these changes, and the mechanisms by which these changes could be implemented. EPA invites comment on all aspects of this concept, and plans to adopt this approach in the final rule if it determines the changes are appropriate after consideration of all comments on these issues.

These changes would be the same as program elements that are part of EPA's greenhouse gas performance standards, discussed in section III.B.1 and 2, above. EPA is considering adopting these changes for A/C efficiency and off-cycle technology because they are based on technology improvements that affect real world fuel economy, and the incentives for light-duty trucks will promote greater use of hybrid technology to improve fuel economy in these vehicles. In addition, adoption of these changes would lead to greater coordination between the greenhouse gas program under the CAA and the fuel economy program under EPCA. As discussed below, these three elements would be implemented in the same

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[241] 75 FR 25409.

[242] Manufacturers would exclude police and emergency vehicles from fleet average calculations (both for determining fleet compliance levels and fleet standards) starting in MY 2012. Because this would have the effect of making the fleet standards easier to meet for manufacturers, EPA does not believe there would be lead time issues associated with the exemption, even though it would take effect well into MY 2012.

[243] 49 U.S.C. 32902(e).

manner as in the EPA's greenhouse gas program—a vehicle manufacturer would have the option to generate these fuel economy values for vehicle models that meet the criteria for these ''credits,'' and to use these values in calculating their fleet average fuel economy.

a. Legal Framework

EPCA provides that:

> (c) Testing and calculation procedures. The Administrator [of EPA] shall measure fuel economy for each model and calculate average fuel economy for a manufacturer under testing and calculation procedures prescribed by the Administrator. However * * *, the Administrator shall use the same procedures for passenger automobiles the Administrator used for model year 1975 * * *, or procedures that give comparable results. 49 U.S.C. 32904(c)

Thus, EPA is charged with developing and adopting the procedures used to measure fuel economy for vehicle models and for calculating average fuel economy across a manufacturer's fleet. While this provision provides broad discretion to EPA, it contains an important limitation for the measurement and calculation procedures applicable to passenger automobiles. For passenger automobiles, EPA has to use the same procedures used for model year 1975 automobiles, or procedures that give comparable results.[244] This limitation does not apply to vehicles that are not passenger automobiles. The legislative history explains that:

> Compliance by a manufacturer with applicable average fuel economy standards is to be determined in accordance with test procedures established by the EPA Administrator. Test procedures so established would be the procedures utilized by the EPA Administrator for model year 1975, or procedures which yield comparable results. The words ''or procedures which yield comparable results'' are intended to give EPA wide latitude in modifying the 1975 test procedures to achieve procedures that are more accurate or easier to administer, so long as the modified procedure does not have the effect of substantially changing the average fuel economy standards. H.R. Rep. No. 94–340, at 91–92 (1975).[245]

EPA measures fuel economy for the CAFE program using two different test procedures—the Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFET). These procedures originated in the early 1970's, and were intended to generally represent city and highway driving, respectively. These two tests are commonly referred to as the ''2-cycle'' test procedures for CAFE. The FTP is also used for measuring compliance with CAA emissions standards for vehicle exhaust. EPA has made various changes to the city and highway fuel economy tests over the years. These have ranged from changes to dynamometers and other mechanical elements of testing, changes in test fuel properties, changes in testing conditions, to changes made in the 1990s when EPA adopted additional test procedures for exhaust emissions testing, called the Supplemental Federal Test Procedures (SFTP).

When EPA has made changes to the FTP or HFET, we have evaluated whether it is appropriate to provide for an adjustment to the measured fuel economy results, to comply with the EPCA requirement for passenger cars that the test procedures produce results comparable to the 1975 test procedures. These adjustments are typically referred to as a CAFE or fuel economy test procedure adjustment or adjustment factor. In 1985 EPA evaluated various test procedure changes made since 1975, and applied fuel economy adjustment factors to account for several of the test procedure changes that reduced the measured fuel economy, producing a significant CAFE impact for vehicle manufacturers. 50 FR 27172 (July 1, 1985). EPA defined this significant CAFE impact as any change or group of changes that has at least a one tenth of a mile per gallon impact on CAFE results. Id. at 27173. EPA also concluded in this proceeding that no adjustments would be provided for changes that removed the manufacturer's ability to take advantage of flexibilities in the test procedure and derive increases in measured fuel economy values which were not the result of design improvements or marketing shifts, and which would not result in any improvement in real world fuel economy. EPA likewise concluded that test procedure changes that provided manufacturers with an improved ability to achieve increases in measured fuel economy based on real world fuel economy improvements also would not warrant a CAFE adjustment. Id. at 27172, 27174, 27183. EPA adopted retroactive adjustments that had the effect of increasing measured fuel economy (to offset test procedure changes that reduced the measured fuel economy level) but declined to apply retroactive adjustments that reduced fuel economy.

The DC Circuit reviewed two of EPA's decisions on CAFE test procedure adjustments. *Center for Auto Safety et al.* v. *Thomas,* 806 F.2d 1071 (1986). First, the Court rejected EPA's decision to apply only positive retroactive adjustments, as the appropriateness of an adjustment did not depend on whether it increased or decreased measured fuel economy results. Second, the Court upheld EPA's decision to not apply any adjustment for the change in the test setting for road load power. The 1975 test procedure provided a default setting for road load power, as well as an optional, alternative method that allowed a manufacturer to develop an alternative road load power setting. The road load power setting affected the amount of work that the engine had to perform during the test, hence it affected the amount of fuel consumed during the test and the measured fuel economy. EPA changed the test procedure by replacing the alternative method in the 1975 procedure with a new alternative coast down procedure. Both the original and the replacement alternative procedures were designed to allow manufacturers to obtain the benefit of vehicle changes, such as changes in aerodynamic design, that improved real world fuel economy by reducing the amount of work that the engine needed to perform to move the vehicle. The Center for Auto Safety (CAS) argued that EPA was required to provide a test procedure adjustment for the new alternative coast down procedure as it increased measured fuel economy compared to the values measured for the 1975 fleet. In 1975, almost no manufacturers made use of the then available alternative method, while in later years many manufacturers made use of the option once it was changed to the coast down procedure. CAS argued this amounted to a change in test procedure that did not achieve comparable results, and therefore

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[244] For purposes of this discussion, EPA need not determine whether the changes relating to A/C efficiency, off-cycle, and light-duty trucks involve changes to procedures that measure fuel economy or procedures for calculating a manufacturer's average fuel economy. The same provisions apply irrespective of which procedure is at issue. This discussion generally refers to procedures for measuring fuel economy for purposes of convenience, but the same analysis applies whether a measurement or calculation procedure is involved.

[245] Unlike the House Bill, the Senate bill did not restrict EPA's discretion to adopt or revise test procedures. Senate Bill 1883, section 503(6). However, the Senate Report noted that:

> The fuel economy improvement goals set in section 504 are based upon the representative driving cycles used by the Environmental Protection Agency to determine automobile fuel economies for model year 1975. In the event that these driving cycles are changed in the future, it is the intent of this legislation that the numerical miles per gallon values of the fuel economy standards be revised to reflect a stringency (in terms of percentage-improvement from the baseline) that is the same as the bill requires in terms of the present test procedures. S. Rep. No. 94–179, at 19 (1975).

In Conference, the House version of the bill was adopted, which contained the restriction on EPA's authority.

required a test procedure adjustment. CAS did not contest that the coast down method and the prior alternative method achieved comparable results.

The DC Circuit rejected CAS' arguments, stating that:

> The critical fact is that a procedure that credited reductions in a vehicle's road load power requirements achieved through improved aerodynamic design was available for MY1975 testing, and those manufacturers, however few in number, that found it advantageous to do so, employed that procedure. The manifold intake procedure subsequently became obsolete for other reasons, but its basic function, to measure real improvements in fuel economy through more aerodynamically efficient designs, lived on in the form of the coast down technique for measuring those aerodynamic improvements. We credit the EPA's finding that increases in measured fuel economy because of the lower road load settings obtainable under the coast down method, were increases ''likely to be observed on the road,'' and were *not* ''unrepresentative artifact[s] of the dynamometer test procedure.'' Such real improvements are exactly what Congress meant to measure when it afforded the EPA flexibility to change testing and calculating procedures. We agree with the EPA that no retroactive adjustment need be made on account of the coast down technique. *Center for Auto Safety et al* v. *EPA,* 806 F.2d 1071, 1077 (DC Cir. 1986)

Some years later, in 1996, EPA adopted a variety of test procedure changes as part of updating the emissions test procedures to better reflect real world operation and conditions. 61 FR 54852 (October 22, 1996). EPA adopted new test procedures to supplement the FTP, as well as modifications to the FTP itself. For example, EPA adopted a new supplemental test procedure specifically to address the impact of air conditioner use on exhaust emissions. Since this new test directly addressed the impact of A/C use on emissions, EPA removed the specified A/C horsepower adjustment that had been in the FTP since 1975. Id. at 54864, 54873. Later EPA determined that there was no need for CAFE adjustments for the overall set of test procedures changes to the FTP, as the net effect of the changes was no significant change in CAFE results.

As evidenced by this regulatory history, EPA's traditional approach is to consider the impact of potential test procedure changes on CAFE results for passenger automobiles and determine if a CAFE adjustment factor is warranted to meet the requirement that the test procedure produce results comparable to the 1975 test procedure. This involves evaluating the magnitude of the impact on measured fuel economy results. It also involves evaluating whether the change in measured fuel economy reflects real word fuel economy impacts from changes in technology or design, or whether it is an artifact of the test procedure or test procedure flexibilities such that the change in measured fuel economy does not reflect a real world fuel economy impact.

In this case, allowing credits for improvements in air conditioner efficiency and off-cycle efficiency for passenger cars would lead to an increase (*i.e.,* improvement) in the fuel economy results for the vehicle model. The impact on fuel economy and CAFE results clearly could be greater than one tenth of a mile per gallon (the level that EPA has previously indicated as having a substantial impact). The increase in fuel economy results would reflect real world improvements in fuel economy and not changes that are just artifacts of the test procedure or changes that come from closing a loophole or removing a flexibility in the current test procedure. However, these changes in procedure would not have the ''critical fact'' that the *CAS* Court relied upon—the existence of a 1975 test provision that was designed to account for the same kind of fuel economy improvements from changes in A/C or off-cycle efficiency. Under EPA's traditional approach, these changes would appear to have a significant impact on CAFE results, would reflect real world changes in fuel economy, but would not have a comparable precedent in the 1975 test procedure addressing the impact of these technology changes on fuel economy. EPA's traditional approach would be expected to lead to a CAFE adjustment factor for passenger cars to account for the impact of these changes.

However, EPA is considering whether a change in approach is appropriate based on the existence of similar EPA provisions for the greenhouse gas emissions procedures and standards. In the past, EPA has determined whether a CAFE adjustment factor for passenger cars would be appropriate in a context where manufacturers are subject to a CAFE standard under EPCA and there is no parallel greenhouse gas standard under the CAA. That is not the case here, as MY2017–2025 passenger cars will be subject to both CAFE and greenhouse gas standards. As such, EPA is considering whether it is appropriate to consider the impact of a CAFE procedure change in this broader context standard.

The term ''comparable results'' is not defined in section 32904(c), and the legislative history indicates that it is intended to address changes in procedure that result in a substantial change in the average fuel economy standard. As explained above, EPA has considered a change of one-tenth of a mile per gallon as having a substantial impact, based in part on the one tenth of a mile per gallon rounding convention in the statute for CAFE calculations. 48 FR 56526, 56528 fn.14 (December 21, 1983). A change in the procedure that changes fuel economy results to this or a larger degree has the effect of changing the stringency of the CAFE standard, either making it more or less stringent. A change in stringency of the standard changes the burden on the manufacturers, as well as the fuel savings and other benefits to society expected from the standard. A CAFE adjustment factor is designed to account for these impacts.

Here, however, there is a companion EPA standard for greenhouse gas emissions. In this case, the changes would have an impact on the fuel economy results and therefore the stringency of the CAFE standard, but would not appear to have a real world impact on the burden placed on the manufacturers, as the provisions would be the same as provisions in EPA's greenhouse gas standards. Similarly it would not appear to have a real world impact on the fuel savings and other benefits of the National Program which would remain identical. If that is the case, then it would appear reasonable to interpret section 32904(c) in these circumstances as not restricting these changes in procedure for passenger automobiles. The fuel economy results would be considered ''comparable results'' to the 1975 procedure as there would not be a substantial impact on real world CAFE stringency and benefits, given the changes in procedure are the same as provisions in EPA's companion greenhouse gas procedures and standards. EPA invites comment on this approach to interpreting section 32904(c), as well as the view that this would not have a substantial impact on either the burden on manufacturers or the benefits of the National Program.

EPA is also considering an alternative interpretation. Under this interpretation, the reference to the 1975 procedures in section 32904(c) would be viewed as a historic reference point, and not a codification of any specific procedures or fuel economy improvement technologies. The change in procedure would be considered within EPA's broad discretion to prescribe reasonable testing and calculation procedures, as these changes reflect real world improvements in design and accompanying real world improvements in fuel economy. The changes in procedure would reflect real world fuel economy improvements and increase harmonization with EPA's greenhouse gas program. Since the changes in procedure have an impact on fuel economy results and could have an impact on the stringency of the CAFE standard, EPA could consider two different approaches to offsetting the change in stringency.

In one approach EPA could maintain the stringency of the 2-cycle (FTP and HFET) CAFE standard by adopting a corresponding adjustment factor to the test results, ensuring that the stringency of the CAFE standard was not substantially changed by the change in procedure. This would be the traditional approach EPA has followed. Another approach would be for NHTSA to maintain the stringency of the 2-cycle CAFE standard by increasing that standard's stringency to offset any reduction in stringency associated with changes that increase fuel economy values. The effect of this adjustment to the standard would be to maintain at comparable levels the amount of CAFE to be achieved using technology whose effects on fuel economy are accounted for as measured under the 1975 test procedures. The effect of the adjustment to the standard would also typically be an additional amount of CAFE that would have to be achieved, for example by technology whose effects on fuel economy are not accounted for under the 1975 test procedures. Under this interpretation, this would maintain the level of stringency of the 2-cycle CAFE standard that would be adopted for passenger cars absent the changes in procedure. As with the interpretation discussed above, this alternative interpretation would be a major change from EPA's past interpretation and practice. In this joint rulemaking the alternative interpretation would apply to changes in procedure that are the same as the companion EPA greenhouse gas program. However, that would not be an important element in this alternative interpretation, which would apply irrespective of the similarity with EPA's greenhouse gas procedures and standards. EPA invites comment on this alternative interpretation.

The discussion above focuses on the procedures for passenger cars, as section 32904(c) only limits changes to the CAFE test and calculation procedures for these automobiles. There is no such limitation on the procedures for light-trucks. The credit provisions for improvements in air conditioner efficiency and off-cycle performance would apply to light-trucks as well. In addition, the limitation in section 32904(c) does not apply to the provisions for credits for use of hybrids in light-trucks, if certain criteria are met, as these provisions apply to light-trucks and not passenger automobiles.

b. Implementation of This Approach

As discussed in section IV, NHTSA would take these changes in procedure into account in setting the applicable CAFE standards for passenger cars and light-trucks, to the extent practicable. As in EPA's greenhouse gas program, the allowance of AC credits for cars and trucks results in a more stringent CAFE standard than otherwise would apply (although in the CAFE program the AC credits would only be for AC efficiency improvements, since refrigerant improvements do not impact fuel economy). The allowance of off-cycle credits has been considered in setting the CAFE standards for passenger car and light-trucks and credits for hybrid use in light pick-up trucks has not been expressly considered in setting the CAFE standards for light-trucks, because the agencies did not believe that it was possible to quantify accurately the extent to which manufacturers would rely on those credits, but if more accurate quantification were possible, NHTSA would consider incorporating those incentives into its stringency determination.

EPA further discusses the criteria and test procedures for determining AC credits, off-cycle technology credits, and hybrid/performance-based credits for full size pickup trucks in Section III.C below.

C. Additional Manufacturer Compliance Flexibilities

1. Air Conditioning Related Credits

A/C is virtually standard equipment in new cars and trucks today. Over 95% of the new cars and light trucks in the United States are equipped with A/C systems. Given the large number of vehicles with A/C in use in today's light duty vehicle fleet, their impact on the amount of energy consumed and on the amount of refrigerant leakage that occurs due to their use is significant.

EPA proposes that manufacturers be able to comply with their fleetwide average CO_2 standards described above by generating and using credits for improved (A/C) systems. Because such improved A/C technologies tend to be relatively inexpensive compared to other GHG-reducing technologies, EPA expects that most manufacturers would choose to generate and use such A/C compliance credits as a part of their compliance demonstrations. For this reason, EPA has incorporated the projected costs of compliance with A/C related emission reductions into the overall cost analysis for the program. As discussed in section II.F, and III.B.10, EPA, in coordination with NHTSA, is also proposing that manufacturers be able to include fuel consumption reductions resulting from the use of A/C efficiency improvements in their CAFE compliance calculations. Manufacturers would generate ''fuel consumption improvement values'' essentially equivalent to EPA CO_2 credits, for use in the CAFE program. The proposed changes to the CAFE program to incorporate A/C efficiency improvements are discussed below in section III.C.1.b.

As in the 2012–2016 final rule, EPA is structuring the A/C provisions as optional credits for achieving compliance, not as separate standards. That is, unlike standards for N_2O and CH_4, there are no separate GHG standards related to AC related emissions. Instead, EPA provides manufacturers the option to generate A/C GHG emission reductions that could be used as part of their CO_2 fleet average compliance demonstrations. As in the 2012–2016 final rule, EPA also included projections of A/C credit generation in determining the appropriate level of the proposed standards.[246]

In the time since the analyses supporting the 2012–2016 FRM were completed, EPA has re-assessed its estimates of overall A/C emissions and the fraction of those emissions that might be controlled by technologies that are or will be available to manufacturers.[247] As discussed in more detail in Chapter 5 of the Joint TSD (see Section 5.1.3.2), the revised estimates remain very similar to those of the earlier rule. This includes the leakage of refrigerant during the vehicle's useful life, as well as the subsequent leakage associated with maintenance and servicing, and with disposal at the end of the vehicle's life (also called ''direct emissions''). The refrigerant universally used today is HFC–134a with a global warming potential (GWP) of 1,430.[248] Together these leakage emissions are equivalent to CO_2 emissions of 13.8 g/

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[246] See Section II.F above and Section IV below for more information on the use of such credits in the CAFE program.

[247] The A/C-related emission inventories presented in this paragraph are discussed in Chapter 4 of the Draft RIA.

[248] The global warming potentials (GWP) used in this rule are consistent with the 100-year time frame values in the 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). At this time, the 1996 IPCC Second Assessment Report (SAR) 100-year GWP values are used in the official U.S. greenhouse gas inventory submission to the United Nations Framework Convention on Climate Change (per the reporting requirements under that international convention, which were last updated in 2006).

mi for cars and 17.2 g/mi for trucks. (Due to the high GWP of HFC–134a, a small amount of 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.) EPA also estimates that A/C efficiency-related emissions (also called ''indirect'' A/C emissions), account for CO_2–equivalent emissions of 11.9 g/mi for cars and 17.1 g/mi for trucks.[249] Chapter 5 of the Joint TSD (see Section 5.1.3.2) discusses the derivation of these estimates.

Achieving GHG reductions in the most cost-effective ways is a primary goal of the program, and EPA believes that allowing manufacturers to comply with the proposed standards by using credits generated from incorporating A/C GHG-reducing technologies is a key factor in meeting that goal.[250] EPA accounts for projected reductions from A/C related credits in developing the standards (curve targets), and includes these emission reductions in estimating the achieved benefits of the program. See Section II.D above.

Manufacturers can make very feasible improvements to their A/C systems to reduce leakage and increase efficiency. Manufacturers can reduce A/C leakage emissions by using components that tend to limit or eliminate refrigerant leakage. Also, manufacturers can significantly reduce the global warming impact of leakage emissions by adopting systems that use an alternative, low-GWP refrigerant, acceptable under EPA's SNAP program, as discussed below, especially if systems are also designed to minimize leakage.[251] Manufacturers can also increase the overall efficiency of the A/C system and thus reduce A/C-related CO_2 emissions. This is because the A/C system 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.

As with the earlier GHG rule, EPA is proposing two separate credit approaches to address leakage reductions and efficiency improvements independently. A leakage reduction credit would take into account the various technologies that could be used to reduce the GHG impact of refrigerant leakage, including the use of an alternative refrigerant with a lower GWP. An efficiency improvement credit would account for the various types of hardware and control of that hardware available to increase the A/C system efficiency. To generate credits toward compliance with the fleet average CO_2 standard, manufacturers would 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 A/C efficiency would be highly cost-effective and technologically feasible for light-duty vehicles in the 2017–2025 timeframe. EPA proposes to maintain much of the existing framework for quantifying, generating, and using A/C Leakage Credits and Efficiency Credits. EPA expects that most manufacturers would choose to use these A/C credit provisions, although some may choose not to do so. Consistent with the 2012–2016 final rule, the proposed standard reflects this projected widespread penetration of A/C control technology.

The following table summarizes the maximum credits the EPA proposes to make available in the overall A/C program.

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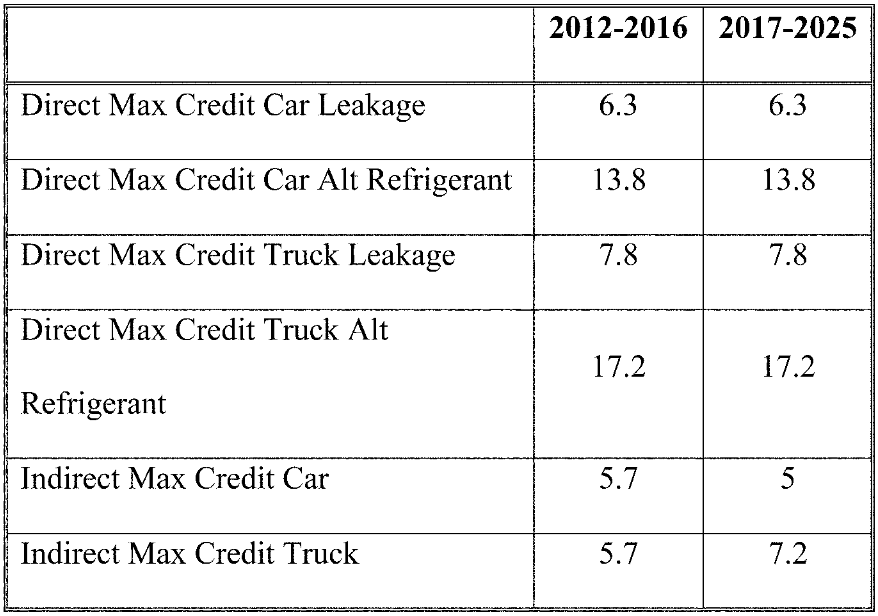
[247] The A/C-related emission inventories presented in this paragraph are discussed in Chapter 4 of the Draft RIA.

[248] The global warming potentials (GWP) used in this rule are consistent with the 100-year time frame values in the 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). At this time, the 1996 IPCC Second Assessment Report (SAR) 100-year GWP values are used in the official U.S. greenhouse gas inventory submission to the United Nations Framework Convention on Climate Change (per the reporting requirements under that international convention, which were last updated in 2006).

[249] Indirect emissions are additional CO_2 emitted due to the load of the A/C system on the engine.

Table III-12 Summary of Maximum Per-Vehicle Credit for A/C (in g/mi)



	2012-2016	2017-2025
Direct Max Credit Car Leakage	6.3	6.3
Direct Max Credit Car Alt Refrigerant	13.8	13.8
Direct Max Credit Truck Leakage	7.8	7.8
Direct Max Credit Truck Alt Refrigerant	17.2	17.2
Indirect Max Credit Car	5.7	5
Indirect Max Credit Truck	5.7	7.2

The next table shows the credits on a model year basis that EPA projects that manufacturers will generate on average (starting with the ending values from the 2012–2016 final rule). In the 2012–2016 rule, the total average car and total average truck credits accounted for the difference between the GHG and CAFE standards.

Table III-13 Projected Average Credits

	Car Credit leakage avg	**Car Credit efficiency avg**	Total Car Credit avg	**Truck Credit leakage avg**	**Truck Credit efficiency avg**	Total Truck Credit avg	Fleet Avg Combined Car & Truck Credit
2016	5.4	4.8	**10.2**	6.6	4.8	**11.5**	**10.6**
2017	7.8	5.0	**12.8**	7.0	5.0	**12.1**	**12.5**
2018	9.3	5.0	**14.3**	11.0	6.5	**17.5**	**15.5**
2019	10.8	5.0	**15.8**	13.4	7.2	**20.6**	**17.5**
2020	12.3	5.0	**17.3**	15.3	7.2	**22.5**	**19.1**
2021	13.8	5.0	**18.8**	17.2	7.2	**24.4**	**20.7**
2022	13.8	5.0	**18.8**	17.2	7.2	**24.4**	**20.7**
2023	13.8	5.0	**18.8**	17.2	7.2	**24.4**	**20.7**
2024	13.8	5.0	**18.8**	17.2	7.2	**24.4**	**20.7**
2025	13.8	5.0	**18.8**	17.2	7.2	**24.4**	**20.7**

The year-on-year progression of credits was determined as follows. The credits are assumed to increase starting from their MY 2016 value at a rate approximately commensurate with the increasing stringency of the 2017–2025 GHG standards, but not exceeding a 20% penetration rate increase in any given year, until the maximum credits are achieved by 2021. EPA expects that manufacturers would be changing over to alternative refrigerants at the time of complete vehicle redesign, which occurs about every 5 years, though in confidential meetings, some manufacturers/suppliers have informed EPA that a modification of the hardware for some alternative refrigerant systems may be able to be done between redesign periods. Given the significant number of credits for using low GWP refrigerants, as well as the variety of alternative refrigerants that appear to be available, EPA believes that a total phase-in of alternative refrigerants is likely to begin in the near future and be completed by no later than 2021 (as shown in Table III–13 above). EPA requests comment on our assumptions for the phase-in rate for alternative refrigerants.

The progression of the average credits (relative to the maximum) also defines the relative year-on-year costs as described in Chapter 3 of the Joint TSD. The costs are proportioned by the ratio of the average credit in any given year to the maximum credit. This is nearly equivalent to proportioning costs to technology penetration rates as is done for all the other technologies. However because the maximum efficiency credits for cars and trucks have changed since the 2012–2016 rule, proportioning to the credits provides a more realistic and smoother year-on-year sequencing of costs.[252]

EPA seeks comment on all aspects of the A/C credit program, including changes from the current A/C credit program and the details in the Joint TSD.

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[252] In contrast, the technology penetration rates could have anomalous (and unrealistic) discontinuities that would be reflected in the cost progressions. This issue is only specific to A/C credits and costs and not to any other technology analysis in this proposal.

a. Air Conditioning Leakage (''Direct'') Emissions and Credits

i. Quantifying A/C Leakage Credits for Today's Refrigerant

As previously discussed, EPA proposes to continue the existing leakage credit program, with minor modifications. Although in general EPA continues to prefer performance-based standards whenever possible, A/C leakage is very difficult to accurately measure in a laboratory test, due to the typical slowness of such leaks and the tendency of leakage to develop unexpectedly as vehicles age. At this time, no appropriate performance test for refrigerant leakage is available. Thus, as in the existing MYs 2012–2016 program, EPA would associate each available leakage-reduction technology with associated leakage credit value, which would be added together to quantify the overall system credit, up to the maximum available credit. EPA's Leakage Credit method is drawn from the SAE J2727 method (HFC–134a Mobile Air Conditioning System Refrigerant Emission Chart, August 2008 version), which in turn was based on results from the cooperative ''IMAC'' study.[253] EPA is proposing to incorporate several minor modifications that SAE is making to the J2727 method, but these do not affect the proposed credit values for the technologies. Chapter 5 of the joint TSD includes a full discussion of why EPA is proposing to continue the design-based ''menu'' approach to quantifying Leakage Credits, including definitions of each of the technologies associated with the values in the menu.

In addition to the above ''menu'' for vehicles using the current high-GWP refrigerant (HFC–134a), EPA also proposes to continue to provide the leakage credit calculation for vehicles using an alternative, lower-GWP refrigerant. This provision was also a part of the MYs 2012–2016 rule. As with the earlier rule, the agency is including this provision because shifting to lower-GWP alternative refrigerants would significantly reduce the climate-change concern about HFC–134a refrigerant leakage by reducing the direct climate impacts. Thus, the credit a manufacturer could generate is a function of the degree to which the GWP of an alternative refrigerant is less than that of the current refrigerant (HFC–134a).

In recent years, the global industry has given serious attention primarily to three of the alternative refrigerants: HFO–1234yf, HFC–152a, and carbon dioxide (R–744). Work on additional low GWP alternatives continues. HFO1234yf, has a GWP of 4, HFC–152a has a GWP of 124 and CO_2 has a GWP of 1.[254] Both HFC–152a and CO_2 are produced commercially in large amounts and thus, supply of refrigerant is not a significant factor preventing adoption.[255] HFC–152a has been shown to be comparable to HFC–134a with respect to cooling performance and fuel use in A/C systems.[256]

In the MYs 2012–2016 GHG rule, a manufacturer using an alternative refrigerant would receive no credit for leakage-reduction technologies. At that time, EPA believed that from the perspective of primary climate effect, leakage of a very low GWP refrigerant is largely irrelevant. However, there is now reason to believe that the need for repeated recharging (top-off) of A/C systems with another, potentially costly refrigerant could lead some consumers and/or repair facilities to recharge a system designed for use with an alternative, low GWP refrigerant with either HFC–134a or another high GWP refrigerant. Depending on the refrigerant, it may still be feasible, although not ideal, for systems designed for a low GWP refrigerant to operate on HFC–134a; in particular, the A/C system operating pressures for HFO–1234yf and HFC–152a might allow their use. Thus, the need for repeated recharging in use could slow the transition away from the high-GWP refrigerant even though recharging with a refrigerant different from that already in the A/C system is not authorized under current regulations.[257]

For alternative refrigerant systems, EPA is proposing to add to the existing credit calculation approach for alternative-refrigerant systems a provision that would provide a disincentive for manufacturers if systems designed to operate with HFO–1234yf, HFC–152a, R744, or some other low GWP refrigerant incorporated fewer leakage-reduction technologies. A system with higher annual leakage could then be recharged with HFC–134a or another refrigerant with a GWP higher than that with which the vehicle was originally equipped (*e.g.,* HFO–1234yf, CO_2, or HFC–152a). Some stakeholders have suggested that EPA take precautions to address the potential for HFC–134a to replace HFO–1234yf, for example, in vehicles designed for use with the new refrigerant (*see* comment and response section of EPA's SNAP rule on HFO–1234yf*,* 76 FR 17509; March 29, 2011).[258] In EPA's proposed disincentive provision, manufacturers would avoid some or all of a deduction in their Leakage Credit of about 2 g/mi by maintaining the use of low-leak components after a transition to an alternative refrigerant.

ii. Issues Raised by a Potential Broad Transition to Alternative Refrigerants

As described previously, use of alternative, lower-GWP refrigerants for mobile use reduces the climate effects of leakage or release of refrigerant through the entire life-cycle of the A/C system. Because the impact of direct emissions of such refrigerants on climate is significantly less than that for the current refrigerant HFC–134a, release of these refrigerants into the atmosphere through direct leakage, as well as release due to maintenance or vehicle scrappage, is predictably less of a concern than with the current refrigerant. As discussed above, there remains a concern, even with a low-GWP refrigerant, that some repairs may repeatedly result in the replacement of the lower-GWP refrigerant from a leaky A/C system with a readily-available, inexpensive, high-GWP refrigerant.

For a number of years, the automotive industry has explored lower-GWP refrigerants and the systems required for them to operate effectively and efficiently, taking into account refrigerant costs, toxicity, flammability, environmental impacts, and A/C system costs, weight, complexity, and efficiency. European Union regulations require a transition to alternative refrigerants with a GWP of 150 or less for motor vehicle air conditioning. The European Union's Directive on mobile

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[253] Society of Automotive Engineers, ''IMAC Team 1—Refrigerant Leakage Reduction, Final Report to Sponsors,'' 2006. This document is available in Docket EPA–HQ–OAR–2010–0799.

[254] IPCC 4th Assessment Report.

[255] The U.S. has one of the largest industrial quality CO_2 production facilities in the world (Gale Group, 2011). HFC–152a is used widely as an aerosol propellant in many commercial products and thus potentially available for refrigerant use in motor vehicle A/C. Production volume for non-confidential chemicals reported under the 2006 Inventory Update Rule. Chemical: Ethane, 1,1-difluoro-. Aggregated National Production Volume: 50 to <100 million pounds. [US EPA; Non-Confidential 2006 Inventory Update Reporting. National Chemical Information. Ethane, 1,1-difluoro- (75–37–6). Available from, as of September 21, 2009: *http://cfpub.epa.gov/iursearch/index.cfm?s=chem&err=t.*

[256] United Nations Environment Program, Technology and Economic Assessment Panel, ''Assessment of HCFCs and Environmentally Sound Alternatives,'' TEAP 2010 Progress Report, Volume 1, May 2010. *http://www.unep.ch/ozone/Assessment_Panels/TEAP/Reports/TEAP_Reports/teap-2010-progress-report-volume1-May2010.pdf.* This document is available in Docket EPA–HQ–OAR–2010–0799.

[257] See appendix D to 40 CFR part 82, subpart G.

[258] Regulations in Appendix D to Subpart G of 40 CFR part 82 prohibit topping off the refrigerant in a motor vehicle A/C system with a different refrigerant.

air-conditioning systems (MAC Directive[259]) aims at reducing emissions of specific fluorinated greenhouse gases in the air-conditioning systems fitted to passenger cars (vehicles under EU category M1) and light commercial vehicles (EU category N1, class 1).

The main objectives of the EU MAC Directive are: to control leakage of fluorinated greenhouse gases with a global warming potential (GWP) higher than 150 used in this sector; and to prohibit by a specified date the use of higher GWP refrigerants in MACs. The MAC Directive is part of the European Union's overall objectives to meet commitments made under the UNFCCC's Kyoto Protocol. This transition starts with new car models in 2011 and continues with a complete transition to manufacturing all new cars with low GWP refrigerant by January 1, 2017.

One alternative refrigerant has generated significant interest in the automobile manufacturing industry and it appears likely to be used broadly in the near future for this application. This refrigerant, called HFO–1234yf, has a GWP of 4. The physical and thermodynamic properties of this refrigerant are similar enough to HFC–134a that auto manufacturers would need to make relatively minor technological changes to their vehicle A/C systems in order to manufacture and market vehicles capable of using HFO–1234yf. Although HFO–1234yf is flammable, it requires a high amount of energy to ignite, and is expected to have flammability risks that are not significantly different from those of HFC–134a or other refrigerants found acceptable subject to use conditions (76 FR 17494–17496, 17507; March 29, 2011).

There are some drawbacks to the use of HFO–1234yf. Some technological changes, such as the addition of an internal heat exchanger in the A/C system, may be necessary to use HFO–1234yf. In addition, the anticipated cost of HFO–1234yf is several times that of HFC–134a. At the time that EPA's Significant New Alternatives Policy (SNAP) program issued its determination allowing the use of HFO–1234yf in motor vehicle A/C systems, the agency cited estimated costs of $40 to $60 per pound, and stated that this range was confirmed by an automobile manufacturer (76 FR 17491; March 29, 2011) and a component supplier.[260] By comparison, HFC–134a currently costs about $2 to $4 per pound.[261] The higher cost of HFO–1234yf is largely because of limited global production capability at this time. However, because it is more complicated to produce the molecule for HFO–1234yf, it is unlikely that it will ever be as inexpensive as HFC–134a is currently. In Chapter 5 of the TSD (see Section 5.1.4), the EPA has accounted for this additional cost of both the refrigerant as well as the hardware upgrades.

Manufacturers have seriously considered other alternative refrigerants in recent years. One of these, HFC–152a, has a GWP of 124.[262] HFC–152a is produced commercially in large amounts.[263] HFC–152a has been shown to be comparable to HFC–134a with respect to cooling performance and fuel use in A/C systems.[264] HFC–152a is flammable, listed as A2 by ASHRAE.[265] Air conditioning systems using this refrigerant would require engineering strategies or devices in order to reduce flammability risks to acceptable levels (*e.g.,* use of release valves or secondary-loop systems). In addition, CO_2 can be used as a refrigerant. It has a GWP of 1, and is widely available commercially.[266] Air conditioning systems using CO_2 would require different designs than other refrigerants, primarily due to the higher operating pressures that are required. Reesearch continues exploring the potential for these alternative refrigerants for automotive applications. Finally, EPA is aware that the chemical and automobile manufacturing industries continue to consider additional refrigerants with GWPs less than 150. For example, SAE International is currently running a cooperative research program looking at two low GWP refrigerant blends, with the program to complete in 2012.[267] The producers of these blends have not to date applied for SNAP approval. However, we expect that there may well be additional alternative refrigerants available to vehicle manufacturers in the next few years.

(1) Related EPA Actions to Date and Potential Actions Concerning Alternative Refrigerants

EPA is addressing potential environmental and human health concerns of low-GWP alternative refrigerants through a number of actions. The SNAP program has issued final rules regulating the use of HFC–152a and HFO–1234yf in order to reduce their potential risks (June 12, 2008, 73 FR 33304; March 29, 2010, 76 FR 17488). The SNAP rule for HFC–152a allows its use in new motor vehicle A/C systems where proper engineering strategies and/or safety devices are incorporated into the system. The SNAP rules for both HFC–152a and HFO–1234yf require meeting safety requirements of the industry standard SAE J639. With both refrigerants, EPA expects that manufacturers conduct and keep on file failure mode and effect analysis for the motor vehicle A/C system, as stated in SAE J1739. EPA has also proposed a rule that would allow use of carbon dioxide as a refrigerant subject to use conditions for motor vehicle A/C systems (September 21, 2006; 71 FR 55140). EPA expects to finalize a rule for use of carbon dioxide in motor vehicle A/C systems in 2012.

Under Section 612(d) of the Clean Air Act, any person may petition EPA to add alternatives to or remove them from the list of acceptable substitutes for ozone depleting substances. The National Resource Defense Council (NRDC) submitted a petition on behalf of NRDC, the Institute for Governance & Sustainable Development (IGSD), and the Environmental Investigation Agency-US (EIA–US) to EPA under Clean Air Act Section 612(d), requesting that the Agency remove HFC–134a from the list of acceptable substitutes and add it to the list of unacceptable (prohibited) substitutes for motor vehicle A/C, among other uses.[268] EPA has found this

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[259] 2006/40/EC.

[260] Automotive News, April 18, 2011.21.

[261] Ibid.

[262] IPCC 4th Assessment Report.

[263] HFC–152a is used widely as an aerosol propellant in many commercial products and may potentially be available for refrigerant use in motor vehicle A/C systems. Aggregated national production volume is estimated to be between 50 and 100 million pounds. [US EPA; Non-Confidential 2006 Inventory Update Reporting. National Chemical Information.]

[264] May 2010 TEAP XXI/9 Task Force Report, *http://www.unep.ch/ozone/Assessment_Panels/TEAP/Reports/TEAP_Reports/teap-2010-progress-report-volume1–May2010.pdf.*

[265] A wide range of concentrations has been reported for HFC–152a flammability where the gas poses a risk of ignition and fire (3.7%–20% by volume in air) (Wilson, 2002). EPA finalized a rule in 2008 listing HFC–152a as acceptable subject to use conditions in motor vehicle air-conditioning, one of these restricting refrigerant concentrations in the passenger compartment resulting from leaks above the lower flammability limit of 3.7% (see 71 FR 33304; June 12, 2008).

[266] The U.S. has one of the largest industrial quality CO_2 production facilities in the world (Gale Group, 2011).

[267] "Recent Experiences in MAC System Development: 'New Alternative Refrigerant Assessment' Technical Update. Enrique Peral-Antunez, Renault. Presentation at SAE Alternative Refrigerant and System Efficiency Symposium. September, 2011. Available online at *http://www.sae.org/events/aars/presentations/2011/Enrique%20Peral%20Renault%20Recent%20Experiences%20in%20MAC%20System%20Dev.pdf*.

[268] NRDC *et al.* Re: Petition to Remove HFC–134a from the List of Acceptable Substitutes under the Significant New Alternatives Policy Program (November 16, 2010).

petition complete specifically for use of HFC–134a in new motor vehicle A/C systems for use in passenger cars and light duty vehicles. EPA intends to initiate a separate notice and comment rulemaking in response to this petition in the future.

EPA expects to address potential toxicity issues with the use of CO_2 as a refrigerant in automotive A/C systems in the upcoming final SNAP rule mentioned above. CO_2 has a workplace exposure limit of 5000 pm on a 8-hour time-weighted average.[269] EPA has also addressed potential toxicity issues with HFO–1234yf through a significant new use rule (SNUR) under the Toxic Substances Control Act (TSCA) (October 27, 2010; 75 FR 65987). The SNUR for HFO–1234yf allows its use as an A/C refrigerant for light-duty vehicles and light-duty trucks, and found no significant toxicity issues with that use. As mentioned in the NPRM for a VOC exemption for HFO–1234yf, ''The EPA considered the results of developmental testing available at the time of the final SNUR action to be of some concern, but not a sufficient basis to find HFO–1234yf unacceptable under the SNUR determination. As a result, the EPA requested additional toxicity testing and issued the SNUR for HFO–1234yf. The EPA has received and is presently reviewing the results of the additional toxicity testing. The EPA continues to believe that HFO–1234yf, when used in new automobile air conditioning systems in accordance with the use conditions under the SNAP rule, does not result in significantly greater risks to human health than the use of other available substitutes.'' (76 FR 64063, October 17, 2011). HFC–152a is considered relatively low in toxicity and comparable to HFC–134a, both of which have a workplace environmental exposure limit from the American Industrial Hygiene Association of 1000 ppm on an 8-hour time-weighted average (73 FR 33304; June 12, 2008).

EPA has issued a proposed rule, proposing to exempt HFO–1234yf from the definition of ''volatile organic compound'' (VOC) for purposes of preparing State implementation Plans (SIPs) to attain the national ambient air quality standards for ozone under Title I of the Clean Air Act (October 17, 2011; 76 FR 64059). VOCs are a class of compounds that can contribute to ground level ozone, or smog, in the presence of sunlight. Some organic compounds do not react enough with sunlight to create significant amounts of smog. EPA has already determined that a number of compounds, including the current automotive refrigerant, HFC–134a as well as HFC–152a, are low enough in photochemical reactivity that they do not need to be regulated under SIPs. CO_2 is not considered a volatile organic compound (VOC) for purposes of preparing SIPs.

(2) Vehicle Technology Requirements for Alternative Refrigerants

As discussed above, significant hardware changes could be needed to allow use of HFC–152a or CO_2, because of the flammability of HFC–152a and because of the high operating pressure required for CO_2. In the case of HFO–1234yf, manufacturers have said that A/C systems for use with HFO–1234yf would need a limited amount of additional hardware to maintain cooling efficiency compared to HFC–134a. In particular, A/C systems may require an internal heat exchanger to use HFO–1234yf, because HFO–1234yf would be less effective in A/C systems not designed for its use. Because EPA's SNAP ruling allows only for its use in new vehicles, we expect that manufacturers would introduce cars using HFO–1234yf only during complete vehicle redesigns or when introducing new models.[270] EPA expects that the same would be true for other alternative refrigerants that are potential candidates (*e.g.,* HFC–152a and CO_2). This need for complete vehicle redesign limits the potential pace of a transition from HFC–134a to alternative refrigerants. In meetings with EPA, manufacturers have informed EPA that, in the case of HFO–1234yf, for example, they would need to upgrade their refrigerant storage facilities and charging stations on their assembly lines. During the transition period between the refrigerants, some of these assembly lines might need to have the infrastructure for both refrigerants simultaneously since many lines produce multiple vehicle models. Moreover, many of these plants might not immediately have the facilities or space for two refrigerant infrastructures, thus likely further increasing necessary lead time. EPA took these kinds of factors into account in estimating the penetration of alternative refrigerants, and the resulting estimated average credits over time shown in Table III–13.

Switching to alternative refrigerants in the U.S. market continues to be an attractive option for automobile manufacturers because vehicles with low GWP refrigerant could qualify for a significantly larger leakage credit. Manufacturers have expressed to EPA that they would plan to place a significant reliance on, or in some cases believe that they would need, alternative refrigerant credits for compliance with GHG fleet emission standards starting in MY 2017.

(3) Alternative Refrigerant Supply

EPA is aware that another practical factor affecting the rate of transition to alternative refrigerants is their supply. As mentioned above, both HFC–152a and CO_2 are being produced commercially in large quantities and thus, although their supply chain does not at this time include auto manufacturers, it may be easier to increase production to meet additional demand that would occur if manufacturers adopt either as a refrigerant. However, for the newest refrigerant listed under the SNAP program, HFO–1234yf, supply is currently limited. There are currently two major producers of HFO–1234yf, DuPont and Honeywell, that are licensed to produce this chemical for the U.S. market. Both companies will likely provide most of their production for the next few years from a single overseas facility, as well as some production from small pilot plants. The initial emphasis for these companies is to provide HFO–1234yf to the European market, where regulatory requirements for low GWP refrigerants are already in effect. These same companies have indicated that they plan to construct a new facility in the 2014 timeframe and intend to issue a formal announcement about that facility close to the end of this calendar year. This facility should be designed to provide sufficient production volume for a worldwide market in coming years. EPA expects that the speed of the transition to alternative refrigerants in the U.S. may depend on how rapidly chemical manufacturers are able to provide supply to automobile manufacturers sufficient to allow most or all vehicles sold in the U.S. to be built using the alternative refrigerant.

One manufacturer (GM) has announced its intention to begin introducing vehicle models using HFO–

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[269] The 8-hour time-weighted average worker exposure limit for CO_2 is consistent with OSHA's PEL–TWA, and ACGIH'S TLV–TWA of 5,000 ppm (0.5%).

[270] Some suppliers and manufacturers have informed us that some vehicles may be able to upgrade A/C systems during a refresh of an existing model (between redesign years). However, this is highly dependent on the vehicle, space constraints behind the dashboard, and the manufacturing plant, so an upgrade may be feasible for only a select few models.

1234yf as early as MY 2013.[271] EPA is not aware of other companies that have made a public commitment to early adoption of HFO–1234yf or other alternative refrigerants. As described above, we expect that in most cases a change-over to systems designed for alternative refrigerants would be limited to vehicle product redesign cycles, typically about every 5 years. Because of this, the pace of introduction is likely to be limited to about 20% of a manufacturer's fleet per year. In addition, the current uncertainty about the availability of supply of the new refrigerant in the early years of introduction into vehicles in the U.S. vehicles, also discussed above, means that the change-over may not occur at every vehicle redesign point. Thus, even with the announced intention of this one manufacturer to begin early introduction of an alternative refrigerant, EPA's analysis of the overall industry trend will assume minimal penetration of the U.S. vehicle market before MY 2017.

Table III–13 shows that, starting from MY 2017, virtually all of the expected increase in generated credits would be due to a gradual increase in penetration of alternative refrigerants. In earlier model years, EPA attributes the expected increase in Leakage Credits to improvements in low-leak technologies.

(4) Projected Potential Scenarios for Auto Industry Changeover to Alternative Refrigerants

As discussed above, EPA is planning on issuing a proposed SNAP rulemaking in the future requesting comment on whether to move HFC–134a from the list of acceptable substitutes to the list of unacceptable (prohibited) substitutes. However, the agency has not determined the specific content of that proposal, and the results of any final action are unknowable at this time. EPA recognizes that a major element of that proposal will be the evaluation of the time needed for a transition for automobile manufacturers away from HFC–134a. Thus, there could be multiple scenarios for the timing of a transition considered in that future proposed rulemaking. Should EPA finalize a rule under the SNAP program that prohibits the use of HFC–134a in new vehicles, the agency plans to evaluate the impacts of such a SNAP rule to determine whether it would be necessary to consider revisions to the availability and use of the compliance credit for MY 2017–2025.

For purposes of this proposed GHG rule, EPA is assuming the current status, where there are no U.S. regulatory requirements for manufacturers to eliminate the use of HFC–134a for newly manufactured vehicles. Thus, the agency would expect that the market penetration of alternatives will proceed based on supply and demand and the strong incentives in this proposal. Given the combination of clear interest from automobile manufacturers in switching to an alternative refrigerant, the interest from HFO–1234yf alternative refrigerant manufacturers to expand their capacity to produce and market the refrigerant, and current commercial availability of HFC–152a and CO_2, EPA believes it is reasonable to project that supply would be adequate to support the orderly rate of transition to an alternative refrigerant described above. As mentioned earlier, at least one U.S. manufacturer already has plans to introduce models using the alternative refrigerant HFO–1234yf beginning in MY 2013. However, it is not certain how widespread the transition to a alternative refrigerants will be in the U.S., nor how quickly that transition will occur in the absence of requirements or strong incentives.

There are other situations that could lead to an overall fleet changeover from HFC–134a to alternative refrigerants. For example, the governments of the U.S., Canada, and Mexico have proposed to the Parties to the *Montreal Protocol on Substances that Deplete the Ozone Layer* that production of HFCs be reduced over time. The North American Proposal to amend the Montreal Protocol allows the global community to make near-term progress on climate change by addressing this group of potent greenhouse gases. The proposal would result in lower emissions in developed and developing countries through the phase-down of the production and consumption of HFCs. If an amendment were adopted by the Parties, then switching from HFC–134a to alternative refrigerants would likely become an attractive option for decreasing the overall use and emissions of high-GWP HFCs, and the Parties would likely initiate or expand policies to incentivize suppliers to ramp up the supply of alternative refrigerants. Options for reductions would include transition from HFCs, moving from high to lower GWP HFCs, and reducing charge sizes.

EPA requests comment on the implications for the program of the refrigerant transition scenario assumed for the analyses supporting this NPRM; that is, where there are no U.S. regulatory requirements for manufacturers to eliminate the use of HFC–134a for newly manufactured vehicles. EPA requests comment on factors that may affect the industry demand for refrigerant and its U.S. and international supply.

b. Air Conditioning Efficiency (''Indirect'') Emissions and Credits

In addition to the A/C leakage credits discussed above, EPA is proposing credits for improving the efficiency of—and thus reducing the CO_2 emissions from—A/C systems. Manufacturers have available a number of very cost-effective technology options that can reduce these A/C-related CO_2 emissions, which EPA estimates are currently on average 11.9 g/mi for cars and 17.1 for trucks nationally.[272] When manufacturers incorporate these technologies into vehicles that clearly result in reduced CO_2 emissions, EPA believes that A/C Efficiency Credits are warranted. Based on extensive industry testing and EPA analysis, the agency proposes that eligible efficiency-improving technologies be limited to up to a maximum 42% improvement,[273] which translates into a maximum credit value of 5.0 g/mi for cars and 7.2 g/mi for trucks.

As discussed further in Section III.C.1.b.iii below, under its EPCA authority, EPA is proposing, in coordination with NHTSA, to allow manufacturers to generate fuel consumption improvement values for purposes of CAFE compliance based on the use of A/C efficiency technologies. EPA is proposing that both the A/C efficiency credits under EPA's GHG program and the A/C efficiency fuel consumption improvement values under the CAFE program would be based on the same methodologies and test procedures, as further described below.

i. Quantifying A/C Efficiency Credits

In the 2012–2016 rule, EPA proposed that A/C Efficiency Credits be calculated based on the efficiency-improving

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[271] General Motors Press Release, July 23, 2010. ''GM First to Market Greenhouse Gas-Friendly Air Conditioning Refrigerant in U.S''.

[272] EPA derived these estimates using a sophisticated new vehicle simulation tool that EPA has developed since the completion of the MYs 2012–2016 final rule. Although results are very similar to those in the earlier rule, EPA believes they represent more accurate estimates. Chapter 5 of the Joint TSD presents a detailed discussion of the development of the simulation tool and the resulting emissions estimates.

[273] The cooperative IMAC study mentioned above concluded that these emissions can be reduced by as much as 40% through the use of these technologies. In addition, EPA has concluded that improvements in the control software for the A/C system, including more precise control of such components as the radiator fan and compressor, can add another 2% to the emission reductions. In total, EPA believes that a total maximum improvement of 42% is available for A/C systems.

technologies included in the vehicle. The design-based approach, associating each technology with a specific credit value, was a surrogate for a using a performance test to determine credit values. Although EPA generally prefers measuring actual emissions performance to a design-based approach, measuring small differences in A/C CO_2 emissions is very difficult, and an accurate test procedure capable of determining such differences was not available.

In conjunction with the (menu or) design-based calculation, EPA continues to believe it is important to verify that the technologies installed to generate credits are improving the efficiency of the A/C system. In the 2012–2016 rule, EPA required that manufacturers submit data from an A/C CO_2 Idle Test as a prerequisite to accessing the design-based credit calculation method. Beginning in MY 2014, manufacturers wishing to generate the A/C Efficiency Credits need to meet a CO_2 emissions threshold on the Idle Test.

As manufacturers have begun to evaluate the Idle Test requirements, they have made EPA aware of an issue with the test's original design. In the MYs 2012–2016 rule, EPA received comments that the Idle Test did not properly capture the efficiency impact of some of the technologies on the Efficiency Credit menu list. EPA also received comments that idle operation is not typical of real-world driving. EPA acknowledges that both of these comments have merit. At the time of the MY 2012–2016 rule, we expected that many manufacturers would be able to demonstrate improved efficiency with technologies like forced cabin air recirculation or electronically-controlled, and variable-displacement compressors., But under idle conditions, testing by manufacturers has shown that the benefits from these technologies can be difficult to quantify. Also, recent data provided by the industry shows that some vehicles that incorporate higher-efficiency A/C technologies are not able to consistently reach the CO_2 threshold on the current Idle Test. The available data also indicates that meeting the threshold tends to be more difficult for vehicles with smaller-displacement engines.[274] EPA continues to believe that there are some technologies that do have their effectiveness demonstrated during idle and that idle is a significant fraction of real-world operation.[275]

Although EPA believes some adjustments in the Idle Test are warranted and is proposing such adjustments, the agency also believes that a reasonable degree of verification is still needed, to demonstrate that that A/C efficiency-improving technologies for which manufacturers are basing credits are indeed implemented properly and are reducing A/C-related fuel consumption. EPA continues to believe that the Idle Test is a reasonable measure of some A/C-related CO_2 emissions as there is significant real-world driving activity at idle, and it significantly exercises a number of the A/C technologies from the menu. Therefore, EPA proposes to maintain the use of Idle Test as a prerequisite for generating Efficiency Credits for MYs 2014–2016. However, in order to provide reasonable verification while encouraging the development and use of efficiency-improving technologies, EPA proposes to revise the CO_2 threshold. Specifically, the agency proposes to scale the magnitude of the threshold to the displacement of the vehicle's engine, with smaller-displacement engines having a higher ''grams per minute'' threshold than larger-displacement engines. Thus, for vehicles with smaller-displacement engines, the threshold would be less stringent. The revised threshold would apply for MYs 2014–2016, and can be used (optionally) instead of the flat gram per minute threshold that applies for MYs 2014, through 2016.[276] In addition to revising the threshold, EPA proposes to relax the average ambient temperature and humidity requirements, due to the difficulty in controlling the year-round humidity in test cells designed for FTP testing. EPA requests comment on the proposed continued use of the Idle Test as a tool to validate the function of a vehicle's A/C efficiency-improving technologies, and on the revised CO_2 threshold and ambient requirements.

As stated above, EPA still considers the Idle Test to be a reasonable measure of some A/C-related CO_2 emissions. However, there are A/C efficiency-improving technologies that cannot be fully evaluated with the Idle Test. In addition to proposing the revised Idle Test, EPA proposes that manufacturers have the option of reporting results from a new transient A/C test in place of the Idle Test, for MYs 2014–2016. In the year since the previous GHG rule was finalized, EPA, CARB, and a consortium of auto manufacturers (USCAR) have developed a new transient test procedure that can measure the effect of the operation of the overall A/C system on CO_2 emissions and fuel economy. The new test, known as ''AC17'' (for Air Conditioning, 2017), and described in detail in Chapter 5 of the Joint TSD, is essentially a combination of the existing SC03 and HWFET test procedures, which, with the proposed modifications, would exercise the A/C system (and new technologies) under conditions representing typical U.S. driving and climate.

Some aspects of the AC17 test are still being developed and improved, but the basic procedure is sufficiently complete for EPA to propose it as a reporting option alternative to the Idle Test threshold in 2014, and a replacement for the Idle Test in 2017, as a prerequisite for generating Efficiency Credits. In model years 2014 to 2016, the AC17 test would be used to demonstrate that a vehicle's A/C system is delivering the efficiency benefits of the new technologies, and the menu will still be utilized. Manufacturers would run the AC17 test procedure on each vehicle platform that incorporates the new technologies, with the A/C system off and then on, and then report these test results to the EPA. This reporting option would replace the need for the Idle Test. In addition to reporting the test results, EPA will require that manufactures provide detailed vehicle and A/C system information for each vehicle tested (*e.g.* vehicle class, model type, curb weight, engine size, transmission type, interior volume, climate control type, refrigerant type, compressor type, and evaporator/condenser characteristics).

For model years 2017 and beyond, the A/C Idle Test menu and threshold requirement would be eliminated and be replaced with the AC17 test, as a prerequisite for access to the credit menu. For vehicle models which manufacturers are applying for A/C efficiency credits, the AC17 test would be run to validate that the performance and efficiency of a vehicle's A/C technology is commensurate to the level of credit for which the manufacturer is applying. To determine whether the efficiency improvements of these technologies are being realized on the vehicle, the results of an AC17 test performed on a new vehicle model would be compared to a ''baseline'' vehicle which does not incorporate the efficiency-improving technologies. If the difference between the new vehicle's AC17 test result and the baseline vehicle test result is greater than or equal to the amount of menu credit for

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[274] Chapter 5 of the Joint TDS provides details about the manufacturers' testing of these vehicles.

[275] More discussion of real world idle operation can be found below and in chapter 5 of the joint TSD in the description of stop-start off cycle credits.

[276] Chapter 5 of the Joint TSD describes the available data relevant to testing on the Idle Test and to the design of the displacement-weighted revised threshold in more detail.

which the manufacturer is applying, then the menu credit amount would be generated. However, if the difference in test results did not demonstrate the full menu-based potential of the technology, a partial credit could still be generated. This partial credit would be proportional to how far the difference in results was from the expected menu-based credit (*i.e.,* the sum of the individual technology credits). The baseline vehicle is defined as one with characteristics which are similar to the new vehicle, except that it is not equipped with the efficiency-improving technologies (or they are de-activated). EPA is seeking comment on this approach to qualifying for A/C efficiency credits.

The AC17 test requires a significant amount of time for each test (nearly 4 hours) and must be run in expensive SC03-capable facilities. EPA believes that the purpose of the test—to validate that A/C CO_2 reductions are indeed occurring and hence that the manufacturer is eligible for efficiency credits—would be met if the manufacturer performs the new test on a limited subset of test vehicles. EPA proposes that manufacturers wishing to use the AC17 test to validate a vehicle's A/C technology be required to test one vehicle from each platform. For this purpose, ''platform'' would be defined as a group of vehicles with common body floorplan, chassis, engine, and transmission.[277] EPA requests comment on the new test and its proposed use. EPA also requests comment on using the AC17 test to quantify efficiency credits, instead of the menu. EPA is also seeking comment on an option starting in MY 2017, to have the AC17 test be used in a similar fashion as the Idle Test, such that if the CO_2 measurements are below a certain threshold value, then credit would be quantified based on the menu. EPA also seeks comment on eliminating the idle test in favor of reporting only the AC17 test for A/C efficiency credits starting as early as MY 2014.

ii. Potential Future Use of the New A/C Test for Credit Quantification

As described above, EPA is proposing to use the AC17 test as a prerequisite to generating A/C Efficiency Credits. The test is well-suited for this purpose since it can accurately measure the difference in the increased CO_2 emissions that occur when the A/C system is turned on vs. when it is turned off. This difference in the ''off-on'' CO_2 emissions, along with details about the vehicle and its A/C system design, will help inform EPA as to how these efficiency-improving technologies perform on a wide variety of vehicle types.

However, the test is limited in its ability to accurately quantify the amount of credit that would be warranted by an improved A/C system on a particular vehicle. This is because to determine an absolute—rather than a relative—difference in CO_2 effect for an individual vehicle design would require knowledge of the A/C system CO_2 performance for that exact vehicle, but without those specific A/C efficiency improvements installed. This would be difficult and costly, since two test vehicles (or a single vehicle with the components removed and replaced) would be necessary to quantify this precisely. Even then, the inherent variability between such tests on such a small sample in such an approach might not be statistically robust enough to confidently determine a small absolute CO_2 emissions impact between the two vehicles.

As an alternative to comparing new vehicle AC17 test with a ''baseline'' (described above), in Chapter 5 of the Joint TSD, EPA discusses a potential method of more accurately quantifying the credit. This involves comparing the efficiencies of individual components outside the vehicles, through ''bench'' testing of components supplemented by vehicle simulation modeling to relate that component's performance to the complete vehicle. EPA believes that such approaches may eventually allow the AC17 test to be used as part of a more complicated series of test procedures and simulations, to accurately quantify the A/C CO_2 effect of an individual vehicle's A/C technology package. However, EPA believes that this issue is beyond the scope of this proposed rule since there are many challenges associated with measuring small incremental decreases in fuel consumption and CO_2 emissions compared to the relatively large overall fuel consumption rate and CO_2 emissions. The agency does encourage comment, including test data, on how the AC17 test could be enhanced in order to measure the individual and collective impact of different A/C efficiency-improving technologies on individual vehicle designs and thus to quantify Efficiency Credits. EPA especially seeks comment on a more complex procedure, also discussed in Chapter 5 of the Joint TSD, that uses a combination of bench testing of components, vehicle simulation models, and dynamometer testing to quantify Efficiency Credits. Specifically, the agencies request comment on how to define the baseline configuration for bench testing. The agencies also request comment on the use of the Lifecycle Climate Performance Model (LCCP), or alternatively, the use of an EPA simulation tool to convert the test bench results to a change in fuel consumption and CO_2 emissions.

iii. A/C Efficiency Fuel Consumption Improvement Values in the CAFE Program

As described in section II.F and above, EPA is proposing to use the AC17 test as a prerequisite to generating A/C Efficiency Credits starting in MY 2017. EPA is proposing, in coordination with NHTSA, for the first time under its EPCA authority to allow manufacturers to use this same test procedure to generate fuel consumption improvement values for purposes of CAFE compliance based on the use of A/C efficiency technologies. As described above, the CO_2 credits would be determined from a comparison of the new vehicle compared to an older ''baseline vehicle.'' For CAFE, EPA proposes to convert the total CO_2 credits due to A/C efficiency improvements from metric tons of CO_2 to a fleetwide CAFE improvement value. The fuel consumption improvement values are presented to give the reader some context and explain the relationship between CO_2 and fuel consumption improvements. The fuel consumption improvement values would be the amount of fuel consumption reduction achieved by that vehicle, up to a maximum of 0.000563 gallons/mi fuel consumption improvement value for cars and a 0.000586 gallons/mi fuel consumption improvement value for trucks.[278] If the difference between the new vehicle and baseline results does not demonstrate the full menu-based potential of the technology, a partial credit could still be generated. This partial credit would be proportional to how far the difference in results was from the expected menu-based credit (*i.e.,* the sum of the individual technology credits). The table below presents the proposed CAFE fuel consumption improvement values for

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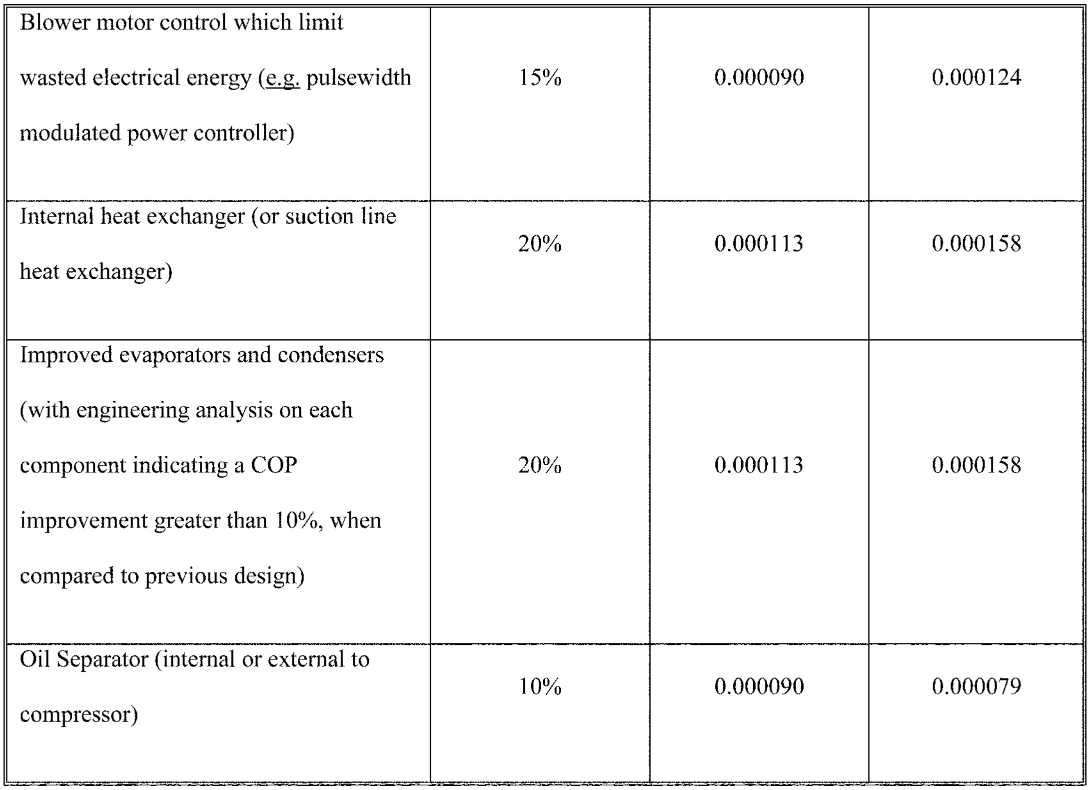
[277] A single platform may encompass a larger group of fuel economy label classes or car lines (40 CFR § 600.002–93), such as passenger cars, compact utility vehicles, and station wagons The specific vehicle selection requirements for manufacturers using this testing are laid out in the regulations associated with this NPRM.

[278] Note that EPA's proposed calculation methodology in 40 CFR 600.510–12 does not use vehicle-specific fuel consumption adjustments to determine the CAFE increase due to the various incentives allowed under the proposed program. Instead, EPA would convert the total CO_2 credits due to each incentive program from metric tons of CO_2 to a fleetwide CAFE improvement value. The fuel consumption values are presented to give the reader some context and explain the relationship between CO_2 and fuel consumption improvements.

each of the efficiency-reducing air conditioning technologies considered in this proposal. More detail is provided on the calculation of indirect A/C CAFE fuel consumption improvement values in chapter 5 of the joint TSD. EPA is proposing definitions of each of the technologies in the table below which are discussed in Chapter 5 of the draft joint TSD to ensure that the air conditioner technology used by manufacturers seeking these values corresponds with the technology used to derive the fuel consumption improvement values.

Table III-14 Proposed Fuel Consumption Improvement Values for A/C Efficiency

Technology Description	**Estimated reduction in A/C CO_2 Emissions and Fuel Consumption**	**Car A/C Efficiency Fuel Consumption Improvement (gallon / mi)**	**Truck A/C Efficiency Fuel Consumption Improvement (gallon / mi)**
Reduced reheat, with externally-controlled, variable-displacement compressor	30%	0.000169	0.000248
Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable displacement compressor	20%	0.000113	0.000158
Default to recirculated air with closed-loop control of the air supply (sensor feedback to control interior air quality) whenever the outside ambient temperature is 75 °F or higher (although deviations from this temperature are allowed based on additional analysis)	30%	0.000169	0.000248
Default to recirculated air with open-loop control of the air supply (no sensor feedback) whenever the outside ambient temperature is 75 °F or higher (although deviations from this temperature are allowed if accompanied by an engineering analysis)	20%	0.000113	0.000158



Blower motor control which limit wasted electrical energy (e.g. pulsewidth modulated power controller)	15%	0.000090	0.000124
Internal heat exchanger (or suction line heat exchanger)	20%	0.000113	0.000158
Improved evaporators and condensers (with engineering analysis on each component indicating a COP improvement greater than 10%, when compared to previous design)	20%	0.000113	0.000158
Oil Separator (internal or external to compressor)	10%	0.000090	0.000079

2. Incentive for Electric Vehicles, Plug-in Hybrid Electric Vehicles, and Fuel Cell Vehicles

a. Rationale for Temporary Regulatory Incentives for Electric Vehicles, Plug-in Hybrid Electric Vehicles, and Fuel Cell Vehicles

EPA has identified two vehicle powertrain-fuel combinations that have the future potential to transform the light-duty vehicle sector by achieving near-zero greenhouse gas (GHG) emissions and oil consumption in the longer term, but which face major near-term market barriers such as vehicle cost, fuel cost (in the case of fuel cell vehicles), the development of low-GHG fuel production and distribution infrastructure, and/or consumer acceptance.

- Electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) which would operate exclusively or frequently on grid electricity that could be produced from very low GHG emission feedstocks or processes.
- Fuel cell vehicles (FCVs) which would operate on hydrogen that could be produced from very low GHG emissions feedstocks or processes.

As in the 2012–2016 rule, EPA is proposing temporary regulatory incentives for the commercialization of EVs, PHEVs, and FCVs. EPA believes that these advanced technologies represent potential game-changers with respect to control of transportation GHG emissions as they can combine an efficient vehicle propulsion system with the potential to use motor fuels produced from low-GHG emissions feedstocks or from fossil feedstocks with carbon capture and sequestration. EPA recognizes that the use of EVs, PHEVs, and FCVs in the 2017–2025 timeframe, in conjunction with the incentives, will decrease the overall GHG emissions reductions associated with the program as the upstream emissions associated with the generation and distribution of electricity are higher than the upstream emissions associated with production and distribution of gasoline. EPA accounts for this difference in projections of the overall program's impacts and benefits (see Section III.F).[279]

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 Clean Air Act 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. 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, on a national average basis, than the corresponding upstream GHG emissions of gasoline or other petroleum based fuels.[280] 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 contribute to very large GHG reductions, and to transform the transportation sector's contribution to nationwide GHG emissions (as well as oil consumption). For a discussion of this issue in the 2012–2016 rule, see 75 FR at 25434–438.

EVs and FCVs also represent some of the most significant changes in automotive technology in the industry's history.[281] For example, EVs face major consumer barriers such as significantly

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[279] Also see the Regulatory Impact Analysis.

[280] There is significant regional variation with upstream GHG emissions associated with electricity production and distribution. Based on EPA's eGRID2010 database, comprised of 26 regions, the average powerplant GHG emissions rates per kilowatt-hour for those regions with the highest GHG emissions rates are about 3 times higher than those with the lowest GHG emissions rates. See *http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html.*

[281] A PHEV is not such a big change since, if the owner so chooses, it can operate on gasoline.

higher vehicle cost and lower range. However, EVs also have attributes that could be attractive to some consumers: Lower and more predictable fuel price, no need for oil changes or spark plugs, and reducing one's personal contribution to local air pollution, climate change, and oil dependence.[282]

Original equipment manufacturers currently offer two EVs and one PHEV in the U.S. market.[283] Deliveries of the Nissan Leaf EV, which has a list price of about $33,000 (before tax credits) and an EPA label range of 73 miles, began in December 2010 in selected areas, and total sales through October 2011 are about 8000. The luxury Tesla Roadster EV, with a list price of $109,000, has been on sale since March 2008 with cumulative sales of approximately 1500. The Chevrolet Volt PHEV, with a list price of about $41,000 and an EPA label all-electric range of 35 miles, has sold over 5000 vehicles since it entered the market in December 2010 in selected markets. At this time, no original equipment manufacturer offers FCVs to the general public except for some limited demonstration programs.[284] Currently, combined EV, PHEV, and FCV sales represent about 0.1% of overall light-duty vehicle sales. Additional models, such as the Ford Focus EV, the Mitsubishi i EV, and the Toyota Prius PHEV, are expected to enter the U.S. market in the next few months.

The agency remains optimistic about consumer acceptance of EVs, PHEVs, and FCVs in the long run, but we believe that near-term market acceptance is less certain. One of the most successful new automotive powertrain technologies—conventional hybrid electric vehicles like the Toyota Prius—illustrates the challenges involved with consumer acceptance of new technologies, even those that do not involve vehicle attribute tradeoffs. Even though conventional hybrids have now been on the U.S. market for over a decade, their market share hovers around 2 to 3 percent or so [285] even though they offer higher vehicle range than their traditional gasoline vehicle counterparts, involve no significant consumer tradeoffs (other than cost), and have reduced their incremental cost to a few thousand dollars. The cost and consumer tradeoffs associated with EVs, PHEVs, and FCVs are more significant than those associated with conventional hybrids. Given the long leadtimes associated with major transportation technology shifts, there is value in promoting these potential game-changing technologies today if we want to retain the possibility of achieving major environmental and energy benefits in the future.

In terms of the relative relationship between tailpipe and upstream fuel production and distribution GHG emissions, EVs, PHEVs, and FCVs are very different than conventional gasoline vehicles. Combining vehicle tailpipe and fuel production/distribution sources, gasoline vehicles emit about 80 percent of these GHG emissions at the vehicle tailpipe with the remaining 20 percent associated with ''upstream'' fuel production and distribution GHG emissions.[286] On the other hand, vehicles using electricity and hydrogen emit no GHG (or other emissions) at the vehicle tailpipe, and therefore all GHG emissions associated with powering the vehicle are due to fuel production and distribution.[287] Depending on how the electricity and hydrogen fuels are produced, these fuels can have very high fuel production/distribution GHG emissions (for example, if coal is used with no GHG emissions control) or very low GHG emissions (for example, if renewable processes with minimal fossil energy inputs are used, or if carbon capture and sequestration is used). For example, as shown in the Regulatory Impact Analysis, today's Nissan Leaf EV would have an upstream GHG emissions value of 161 grams per mile based on national average electricity, and a value of 89 grams per mile based on the average electricity in California, one of the initial markets for the Leaf.

Because these upstream GHG emissions values are generally higher than the upstream GHG emissions values associated with gasoline vehicles, and because there is currently no national program in place to reduce GHG emissions from electric powerplants, EPA believes it is appropriate to consider the incremental upstream GHG emissions associated with electricity production and distribution. But, we also think it is appropriate to encourage the initial commercialization of EV/PHEV/FCVs as well, in order to retain the potential for game-changing GHG emissions and oil savings in the long term.

Accordingly, EPA proposes to provide temporary regulatory incentives for EVs, PHEVs (when operated on electricity) and FCVs that will be discussed in detail below. EPA recognizes that the use of EVs, PHEVs, and FCVs in the 2017–2025 timeframe, in conjunction with the incentives, will decrease the overall GHG emissions reductions associated with the program as the upstream emissions associated with the generation and distribution of electricity are higher than the upstream emissions associated with production and distribution of gasoline. EPA accounts for this difference in projections of the overall program's impacts and benefits (see Section III.F). EPA believes that the relatively minor impact on GHG emissions reductions in the near term is justified by promoting technologies that have significant transportation GHG emissions and oil consumption game-changing potential in the longer run, and that also face major market barriers in entering a market that has been dominated by gasoline vehicle technology and infrastructure for over 100 years.

EPA will review all of the issues associated with upstream GHG emissions, including the status of EV/PHEV/FCV commercialization, the status of upstream GHG emissions control programs, and other relevant factors.

b. MYs 2012–2016 Light-Duty Vehicle Greenhouse Gas Emissions Standards

The light-duty vehicle greenhouse gas emissions standards for model years 2012–2016 provide a regulatory incentive for electric vehicles (EVs), fuel cell vehicles (FCVs), and for the electric portion of operation of plug-in hybrid

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[282] PHEVs and FCVs share many of these same challenges and opportunities.

[283] Smart has also leased approximately 100 Smart ED vehicles in the U.S.

[284] For example, Honda has leased up to 200 Clarity fuel cell vehicles in southern California (see Honda.com) and Toyota has announced plans for a limited fuel cell vehicle introduction in 2015 (see Toyota.com).

[285] Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2010, EPA–420–R–10–023, November 2010, *www.epa.gov/otaq/fetrends.htm.*

[286] Fuel production and distribution GHG emissions have received much attention because there is the potential for more widespread commercialization of transportation fuels that have very different GHG emissions characteristics in terms of the relative contribution of GHG emissions from the vehicle tailpipe and those associated with fuel production and distribution. Other GHG emissions source categories include vehicle production, including the raw materials used to manufacture vehicle components, and vehicle disposal. These categories have not been included in EPA motor vehicle emissions regulations for several reasons: These categories are less important from an emissions inventory perspective, they raise complex accounting questions that go well beyond vehicle testing and fuel-cycle analysis, and in general there are fewer differences across technologies.

[287] The Agency notes that many other fuels currently used in light-duty vehicles, such as diesel from conventional oil, ethanol from corn, and compressed natural gas from conventional natural gas, have tailpipe GHG and fuel production/distribution GHG emissions characteristics fairly similar to that of gasoline from conventional oil. See 75 FR at 25437. The Agency recognizes that future transportation fuels may be produced from renewable feedstocks with lower fuel production/distribution GHG emissions than gasoline from oil.

electric vehicles (PHEVs). See generally 75 FR at 25434–438. This is designed to promote advanced technologies that have the potential to provide ''game changing'' GHG emissions reductions in the future. This incentive is a 0 grams per mile compliance value (*i.e.,* a compliance value based on measured vehicle tailpipe GHG emissions) up to a cumulative EV/PHEV/FCV production cap threshold for individual manufacturers. There is a two-tier cumulative EV/PHEV/FCV production cap for MYs 2012–2016: The cap is 300,000 vehicles for those manufacturers that sell at least 25,000 EVs/PHEVs/FCVs in MY 2012, and the cap is 200,000 vehicles for all other manufacturers. For manufacturers that exceed the cumulative production cap over MYs 2012–2016, compliance values for those vehicles in excess of the cap will be based on a full accounting of the net fuel production and distribution GHG emissions associated with those vehicles relative to the fuel production and distribution GHG emissions associated with comparable gasoline vehicles. For an electric vehicle, this accounting is based on the vehicle electricity consumption over the EPA compliance tests, eGRID2007 national average powerplant GHG emissions factors, and multiplicative factors to account for electricity grid transmission losses and pre-powerplant feedstock GHG related emissions.[288] The accounting for a hydrogen fuel cell vehicle would be done in a comparable manner.

Although EPA also proposed a vehicle incentive multiplier for MYs 2012–2016, the agency did not finalize a multiplier. At that time, the Agency believed that combining the 0 gram per mile and multiplier incentives would be excessive.

The 0 grams per mile compliance value decreases the GHG emissions reductions associated with the 2012–2016 standards compared to the same standards and no 0 grams per mile compliance value. It is impossible to know the precise number of vehicles that will take advantage of this incentive in MYs 2012–2016. In the preamble to the final rule, EPA projected the decrease in GHG emissions reductions that would be associated with a scenario of 500,000 EVs certified with a compliance value of 0 grams per mile. This scenario would result in a projected decrease of 25 million metric tons of GHG emissions reductions, or less than 3 percent of the total projected GHG benefits of the program of 962 million metric tons. This GHG emissions impact could be smaller or larger, of course, based on the actual number of EVs that would certify at 0 grams per mile.

In the preamble to the final rule, EPA stated that it would reassess this issue for rulemakings beginning in MY 2017 based on the status of advanced vehicle technology commercialization, the status of upstream GHG control programs, and other relevant factors.

c. Supplemental Notice of Intent

In our most recent Supplemental Notice of Intent,[289] EPA stated that: ''EPA intends to propose an incentive multiplier for all electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs) sold in MYs 2017 through 2021. This multiplier approach means that each EV/PHEV/FCV would count as more than one vehicle in the manufacturer's compliance calculation. EPA intends to propose that EVs and FCVs start with a multiplier value of 2.0 in MY 2017, phasing down to a value of 1.5 in MY 2021. PHEVs would start at a multiplier value of 1.6 in MY 2017 and phase down to a value of 1.3 in MY 2021. These multipliers would be proposed for incorporation in EPA's GHG program * * *. As an additional incentive for EVs, PHEVs and FCVs, EPA intends to propose allowing a value of 0 g/mile for the tailpipe compliance value for EVs, PHEVs (electricity usage) and FCVs for MYs 2017–2021, with no limit on the quantity of vehicles eligible for 0 g/mi tailpipe emissions accounting. For MYs 2022–2025, 0 g/mi will only be allowed up to a per-company cumulative sales cap based on significant penetration of these advanced vehicles in the marketplace. EPA intends to propose an appropriate cap in the NPRM.''

d. Proposal for MYs 2017–2025

EPA is proposing the following temporary regulatory incentives for EVs, PHEVs, and FCVs consistent with the discussion in the August 2011 Supplemental Notice of Intent.

For MYs 2017 through 2021, EPA is proposing two incentives. The first proposed incentive is to allow all EVs, PHEVs (electric operation), and FCVs to use a GHG emissions compliance value of 0 grams per mile. There would be no cap on the number of vehicles eligible for the 0 grams per mile compliance value for MYs 2017 through 2021.

The second proposed incentive for MYs 2017 through 2021 is a multiplier for all EVs, PHEVs, and FCVs, which would allow each of these vehicles to ''count'' as more than one vehicle in the manufacturer's compliance calculation.[290] While the Agency rejected a multiplier incentive in the MYs 2012–2016 final rule, we are proposing a multiplier for MYs 2017–2021 because, while advanced technologies were not necessary for compliance in MYs 2012–2016, they are necessary, for some manufacturers, to comply with the GHG standards in the MYs 2022–2025 timeframe. A multiplier for MYs 2017–2021 can also promote the initial commercialization of these advanced technologies. In order for a PHEV to be eligible for the multiplier incentive, EPA proposes that PHEVs be required to be able to complete a full EPA highway test (10.2 miles), without using any conventional fuel, or alternatively, have a minimum equivalent all-electric range of 10.2 miles as measured on the EPA highway cycle. EPA seeks comment on whether this minimum range (all-electric or equivalent all-electric) should be lower or higher, or whether the multiplier should vary based on range or on another PHEV metric such as battery capacity or ratio of electric motor power to engine or total vehicle power. The specific proposed multipliers are shown in Table III–15.

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[288] See 40 CFR 600.113–12(m).

[289] 76 **Federal Register** 48758 (August 9, 2011).

[290] In the unlikely case where a PHEV with a low electric range might have an overall GHG emissions compliance value that is higher than its compliance target, EPA proposes that the automaker can choose not to use the multiplier.

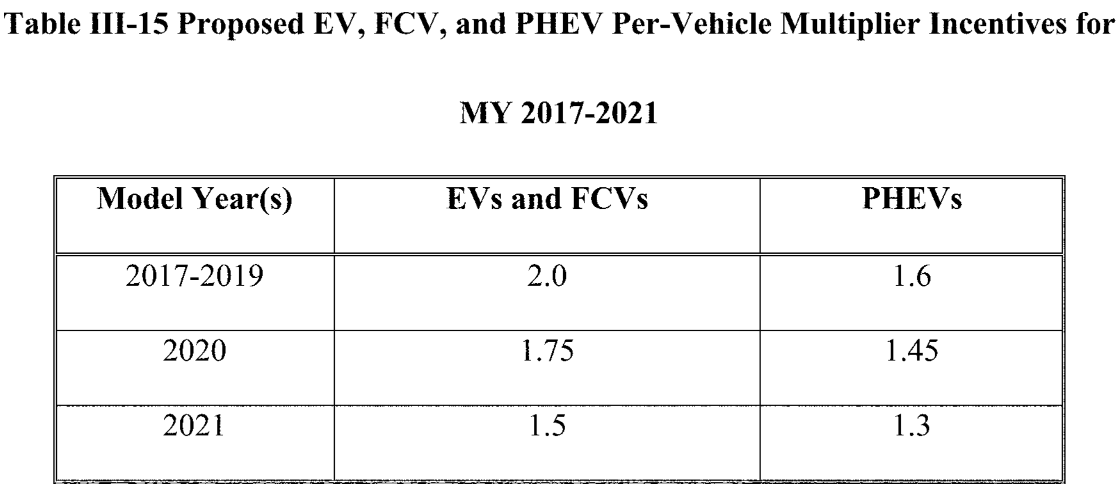

Table III-15 Proposed EV, FCV, and PHEV Per-Vehicle Multiplier Incentives for MY 2017-2021

Model Year(s)	EVs and FCVs	PHEVs
2017-2019	2.0	1.6
2020	1.75	1.45
2021	1.5	1.3

EPA also requests comments on the merits of providing similar multiplier incentives to dedicated and/or dual fuel compressed natural gas vehicles.

For MYs 2022 through 2025, EPA is proposing one incentive—the 0 grams per mile GHG emissions compliance incentive for EVs, PHEVs (electric operation), and FCVs up to a per-company cumulative production cap threshold for those model years. EPA is proposing a two-tier, per-company cap based on cumulative production in prior years, consistent with the general approach that was adopted in the rulemaking for MYs 2012–2016. For manufacturers that sell 300,000 or more EV/PHEV/FCVs combined in MYs 2019–2021, the proposed cumulative production cap would be 600,000 EV/PHEV/FCVs for MYs 2022–2025. Other automakers would have a proposed cumulative production cap of 200,000 EV/PHEV/FCVs in MYs 2022–2025.

This proposed cap design is appropriate as a way to encourage automaker investment in potential GHG emissions game-changing technologies that face very significant cost and consumer barriers. In addition, as with the rulemaking for MYs 2012–2016, EPA believes it is important to both recognize the benefit of early leadership in commercialization of these technologies, and encourage additional manufacturers to invest over time. Manufacturers are unlikely to do so if vehicles with these technologies are treated for compliance purposes to be no more advantageous than the best conventional hybrid vehicles. Finally, we believe that the proposed cap design provides a reasonable limit to the overall decrease in program GHG emissions reductions associated with the incentives, and EPA is being transparent about these GHG emissions impacts (see later in this section and also Section III.F).

EPA recognizes that a central tension in the design of a proposed cap relates to certainty and uncertainty with respect to both individual automaker caps and the overall number of vehicles that may fall under the cap, which determines the overall decrease in GHG emissions reductions. A per-company cap as described above would provide clear certainty for individual manufacturers at the time of the final rule, but would yield uncertainty about how many vehicles industry-wide would take advantage of the 0 grams per mile incentive and therefore the overall impact on GHG emissions. An alternative approach would be an industry-wide cap where EPA would establish a finite limit on the total number of vehicles eligible for the 0 grams per mile incentive, with a method for allocating this industry-wide cap to individual automakers. An industry-wide cap would provide certainty with respect to the maximum number of vehicles and GHG emissions impact and would reward those automakers who show early leadership. If EPA were to make a specific numerical allocation at the time of the final rule, automakers would have certainty, but EPA is concerned that we may not have sufficient information to make an equitable allocation for a timeframe that is over a decade away. If EPA were to adopt an allocation formula in the final rule that was dependent on future sales (as we are proposing above for the per-company cap), automakers would have much less certainty in compliance planning as they would not know their individual caps until some point in the future.

To further assess the merits of an industry-wide cap approach, EPA also seeks comment on the following alternative for an industry-wide cap. EPA would place an industry-wide cumulative production cap of 2 million EV/PHEV/FCVs eligible for the 0 grams per mile incentive in MYs 2022–2025. EPA has chosen 2 million vehicles because, as shown below, we project that this limits the maximum decrease in GHG emissions reductions to about 5 percent of total program GHG savings. EPA would allocate this 2 million vehicle cap to individual automakers in calendar year 2022 based on cumulative EV/PHEV/FCV sales in MYs 2019–2021, *i.e.,* if an automaker sold X percent of industry-wide EV/PHEV/FCV sales in MYs 2019–2021, that automaker would get X percent of the 2 million industry-wide cumulative production cap in MYs 2022–2025 (or possibly somewhat less than X percent, if EPA were to reserve some small volumes for those automakers that sold zero EV/PHEV/FCVs in MYs 2019–2021).

For both the proposed per-company cap and the alternative industry-wide cap, EPA proposes that, for production beyond the cumulative vehicle production cap for a given manufacturer in MY 2022 and later, compliance values would be calculated according to a methodology that accounts for the full net increase in upstream GHG emissions relative to that of a comparable gasoline vehicle. EPA also asks for comment on various approaches for phasing in from a 0 gram per mile value to a full net increase value, *e.g.,* an interim period when the compliance value might be one-half of the net increase.

EPA also seeks comments on whether any changes should be made for MYs 2012–2016, *i.e.,* whether the compliance value for production beyond the cap should be one-half of the net increase in upstream GHG emissions, or whether the current cap for MYs 2012–2016 should be removed.

EPA is not proposing any multiplier incentives for MYs 2022 through 2025. EPA believes that the 0 gram per mile compliance value, with cumulative vehicle production cap, is a sufficient incentive for MYs 2022–2025.

One key issue here is the appropriate electricity upstream GHG emissions factor or rate to use in future projections of EV/PHEV emissions based on the net upstream approach. In the following example, we use a 2025 nationwide average electricity upstream GHG emissions rate (powerplant plus feedstock extraction, transportation, and processing) of 0.574 grams GHG/watt-hour, based on simulations with the EPA Office of Atmospheric Program's Integrated Planning Model (IPM).[291] For the example below, EPA is using a projected national average value from the IPM model, but EPA recognizes that values appropriate for future vehicle use may be higher or lower than this value. EPA is considering running the IPM model with a more robust set of vehicle and vehicle charging-specific assumptions to generate a better electricity upstream GHG emissions factor for EVs and PHEVs for our final rulemaking, and, at minimum, intends to account for the likely regional sales variation for initial EV/PHEV/FCVs, and different scenarios for the relative frequency of daytime and nighttime charging. EPA seeks comment on whether there are additional factors that we should try to include in the IPM modeling for the final rulemaking.

EPA proposes a 4-step methodology for calculating the GHG emissions compliance value for vehicle production in excess of the cumulative production cap for an individual automaker. For example, for an EV in MY 2025, this methodology would include the following steps and calculations:

- Measuring the vehicle electricity consumption in watt-hours/mile over the EPA city and highway tests (for example, a midsize EV in 2025 might have a 2-cycle test electricity consumption of 230 watt-hours/mile)
- Adjusting this watt-hours/mile value upward to account for electricity losses during electricity transmission (dividing 230 watt-hours/mile by 0.93 to account for grid/transmission losses yields a value of 247 watt-hours/mile)
- Multiplying the adjusted watt-hours/mile value by a 2025 nationwide average electricity upstream GHG emissions rate of 0.574 grams/watt-hour at the powerplant (247 watt-hours/mile multiplied by 0.574 grams GHG/watt-hour yields 142 grams/mile)
- Subtracting the upstream GHG emissions of a comparable midsize gasoline vehicle of 39 grams/mile[292] to reflect a full net increase in upstream GHG emissions (142 grams/mile for the EV minus 39 grams/mile for the gasoline vehicle yields a net increase and EV compliance value of 103 grams/mile).[293]

The full accounting methodology for FCVs and the portion of PHEV operation on grid electricity would use this same approach. The proposed regulations contain EPA's proposed method to determine the compliance value for PHEVs, and EPA proposes to develop a similar methodology for FCVs if and when the need arises.[294] Given the uncertainty about how hydrogen would be produced, if and when it were used as a transportation fuel, EPA seeks comment on projections for the fuel production and distribution GHG emissions associated with hydrogen production for various feedstocks and processes.

EPA is fully accounting for the upstream GHG emissions associated with all electricity used by EVs and PHEVs (and any hydrogen used by FCVs), both in our regulatory projections of the impacts and benefits of the program, and in all GHG emissions inventory accounting.

EPA seeks public comment on the proposed incentives for EVs, PHEVs, and FCVs described above.

e. Projection of Impact on GHG Emissions Reductions Due to Incentives

EPA believes it is important to project the impact on GHG emissions that will be associated with the proposed incentives (both 0 grams per mile and the multiplier) for EV/PHEV/FCVs over the MYs 2017–2025 timeframe. Since it is impossible to know precisely how many EV/PHEV/FCVs will be sold in the MYs 2017–2025 timeframe that will utilize the proposed incentives, EPA presents projections for two scenarios: (1) The number of EV/PHEV/FCVs that EPA's OMEGA technology and cost model predicts based exclusively on its projections for the most cost-effective way for the industry to meet the proposed standards, and (2) a scenario with a greater number of EV/PHEV/FCVs, based not only on compliance with the proposed GHG and CAFE standards, but other factors such as the proposed cumulative production caps and manufacturer investments. For this analysis, EPA assumes that EVs and PHEVs each account for 50 percent of all EV/PHEV/FCVs. EPA seeks comment on whether there are other scenarios which should be evaluated for this purpose in the final rule.

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[291] Technical Support Document, Chapter 4.

[292] A midsize gasoline vehicle with a footprint of 46 square feet would have a MY 2025 GHG target of about 140 grams/mile; dividing 8887 grams CO_2/gallon of gasoline by 140 grams/mile yields an equivalent fuel economy level of 63.5 mpg; and dividing 2478 grams upstream GHG/gallon of gasoline by 63.5 mpg yields a midsize gasoline vehicle upstream GHG value of 39 grams/mile. The 2478 grams upstream GHG/gallon of gasoline is calculated from 21,546 grams upstream GHG/million Btu (EPA value for future gasoline based on DOE's GREET model modified by EPA standards and data; see docket memo to MY 2012–2016 rulemaking titled ''Calculation of Upstream Emissions for the GHG Vehicle Rule'') and multiplying by 0.115 million Btu/gallon of gasoline.

[293] Manufacturers can utilize alternate calculation methodologies if shown to yield equivalent or superior results and if approved in advance by the Administrator.

[294] 40 CFR 600.113–12(m).

Table III-16 Projected Impact of EV/PHEV/FCV Incentives on GHG Emissions Reductions

Scenario	Cumulative EV/PHEV/FCV Sales 2017-2025	Cumulative EV/PHEV/FCV Sales 2022-2025	Cumulative Decrease in GHG Emissions Reductions 2017-2025[295]	Percentage Decrease in GHG Emissions Reductions 2017-2025[296]
EPA OMEGA model projection	1.9 million	1.3 million	80 million metric tons	3.6%
EPA alternative projection	2.8 million	2.0 million	110 million metric tons	5.4%

EPA projects that the cumulative GHG emissions savings of the proposed MYs 2017–2025 standards, on a model year lifetime basis, is approximately 2 billion metric tons. Table III–16 projects that the likely decrease in cumulative GHG emissions reductions due to the EV/PHEV/FCV incentives for MYs 2017–2025 vehicles is in the range of 80 to 110 million metric tons, or about 4 to 5 percent.

It is important to note that the above projection of the impact of the EV/PHEV/FCV incentives on the overall program GHG emissions reductions assumes that there would be no change to the standard even if the EV 0 gram per mile incentive were not in effect, *i.e.,* that EPA would propose exactly the same standard if the 0 gram per mile compliance value were not allowed for any EV/PHEV/FCVs. While EPA has not analyzed such a scenario, it is clear that not allowing a 0 gram per mile compliance value would change the technology mix and cost projected for the proposed standard.

It is also important to note that the projected impact on GHG emissions reductions in the above table are based on the 2025 nationwide average electricity upstream GHG emissions rate (powerplant plus feedstock) of 0.574 grams GHG/watt-hour discussed above (based on simulations with the EPA's Integrated Planning Model (IPM) for powerplants in 2025, and a 1.06 factor to account for feedstock-related GHG emissions).

EPA recognizes two factors which could significantly reduce the electricity upstream GHG emissions factor by calendar year 2025. First, there is a likelihood that early EV/PHEV/FCV sales will be much more concentrated in parts of the country with lower electricity GHG emissions rates and much less concentrated in regions with higher electricity GHG emissions rates. This has been the case with sales of hybrid vehicles, and is likely to be more so with EVs in particular. Second, there is the possibility of a future comprehensive program addressing upstream emissions of GHGs from the generation of electricity. Other factors which could also help in this regard include technology innovation and lower prices for some powerplant fuels such as natural gas.

On the other hand, EPA also recognizes factors which could increase the appropriate electricity upstream GHG emissions factor in the future, such as a consideration of marginal electricity demand rather than average demand and use of high-power charging. The possibility that EVs won't displace gasoline vehicle use on a 1:1 basis (*i.e.,* multi-vehicle households may use EVs for more shorter trips and fewer longer trips, which could lead to lower overall travel for typical EVs and higher overall travel for gasoline vehicles) could also reduce the overall GHG emissions benefits of EVs.

EPA seeks comment on information relevant to these and other factors which could both decrease or increase the proper electricity upstream GHG emissions factor for calendar year 2025 modeling.

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[295] The number of metric tons represents the number of additional tons that would be reduced if the standards stayed the same and there was no 0 gram per mile compliance value.

[296] The percentage change represents the ratio of the cumulative decrease in GHG emissions reductions from the prior column to the total cumulative GHG emissions reductions associated with the proposed standards and the proposed 0 gram per mile compliance value.

3. Incentives for ''Game-Changing'' Technologies Including Use of Hybridization and Other Advanced Technologies for Full-Size Pickup Trucks

As explained in section II. C above, the agencies recognize that the standards under consideration for MY 2017–2025 will be challenging for large trucks, including full size pickup trucks that are often used for commercial purposes and have generally higher payload and towing capabilities, and cargo volumes than other light-duty vehicles. In Section II.C and Chapter 2 of the joint TSD, EPA and NHTSA describe how the slope of the truck curve has been adjusted compared to the 2012–2016 rule to reflect these disproportionate challenges. In Section III.B, EPA describes the progression of the truck standards. In this section, EPA describes a proposed incentive for full size pickup trucks, proposed by EPA under both section 202 (a) of the CAA and section 32904 (c) of EPCA, to incentivize advanced technologies on this class of vehicles. This incentive would be in the form of credits under the EPA GHG program, and fuel consumption improvement values (equivalent to EPA's credits) under the CAFE program.

The agencies' goal is to incentivize the penetration into the marketplace of ''game changing'' technologies for these pickups, including their hybridization. For that reason, EPA is proposing credits for manufacturers that hybridize a significant quantity of their full size pickup trucks, or use other technologies that significantly reduce CO_2 emissions and fuel consumption. This proposed credit would be available on a per-vehicle basis for mild and strong HEVs, as well as for use of other technologies that significantly improve the efficiency of the full sized pickup class. As described in section II.F. and III.B.10, EPA, in coordination with NHTSA, is also proposing that manufacturers be able to include ''fuel consumption improvement values'' equivalent to EPA CO_2 credits in the CAFE program. The gallon per mile values equivalent to EPA proposed CO_2 credits are also provided below, in addition to the proposed CO_2 credits.[297] These credits and fuel consumption improvement values provide the incentive to begin transforming this challenged category of vehicles toward use of the most advanced technologies.

Access to this credit is conditioned on a minimum penetration of the technologies in a manufacturer's full size pickup truck fleet. The proposed penetration rates can be found in Table 5–26 in the TSD. EPA is seeking comment on these penetration rates and how they should be applied to a manufacturer's truck fleet.

To ensure its use for only full sized pickup trucks, EPA is proposing a specific definition for a full sized pickup truck based on minimum bed size and minimum towing capability. The specifics of this proposed definition can be found in Chapter 5 of the draft joint TSD (see Section 5.3.1) and in the draft regulations at 86.1866–12(e). This proposed definition is meant to ensure that the larger pickup trucks which provide significant utility with respect to payload and towing capacity as well as open beds with large cargo capacity are captured by the definition, while smaller pickup trucks which have more limited hauling, payload and/or towing are not covered by the proposed definition. For this proposal, a full sized pickup truck would be defined as meeting requirements 1 and 2, below, as well as either requirement 3 or 4, below:

1. The vehicle must have an open cargo box with a minimum width between the wheelhouses of 48 inches measured as the minimum lateral distance between the limiting interferences (pass-through) of the wheelhouses. The measurement would exclude the transitional arc, local protrusions, and depressions or pockets, if present.[298] An open cargo box means a vehicle where the cargo bed does not have a permanent roof or cover. Vehicles sold with detachable covers are considered ''open'' for the purposes of these criteria.

2. Minimum open cargo box length of 60 inches defined by the lesser of the pickup bed length at the top of the body (defined as the longitudinal distance from the inside front of the pickup bed to the inside of the closed endgate; this would be measured at the height of the top of the open pickup bed along vehicle centerline and the pickup bed length at the floor) and the pickup bed length at the floor (defined as the longitudinal distance from the inside front of the pickup bed to the inside of the closed endgate; this would be measured at the cargo floor surface along vehicle centerline).[299]

3. Minimum Towing Capability—the vehicle must have a GCWR (gross combined weight rating) minus GVWR (gross vehicle weight rating) value of at least 5,000 pounds.[300]

4. Minimum Payload Capability—the vehicle must have a GVWR (gross vehicle weight rating) minus curb weight value of at least 1,700 pounds.

As discussed above, this proposed definition is intend to cover the larger pickup trucks sold in the U.S. today (and for 2017 and later) which have the unique attributes of an open bed, and larger towing and/or payload capacity. This proposed incentive will encourage the penetration of advanced, low CO_2 technologies into this market segment. The proposed definition would exclude a number of smaller-size pickup trucks sold in the U.S. today (examples are the Dodge Dakota, Nissan Frontier, Chevrolet Colorado, Toyota Tacoma and Ford Ranger). These vehicles generally have smaller boxes (and thus smaller cargo capacity), and lower payload and towing ratings. EPA is aware that some configurations of these smaller pickups trucks can offer towing capacity similar to the larger pickups. As discussed in the draft Joint TSD Section 5.3.1, EPA is seeking comment on expanding the scope of this credit to somewhat smaller pickups (with a minimum distance between the wheel wells of 42 inches, but still with a minimum box length of 60 inches), provided they have the towing capabilities of the larger full-size trucks (for example a minimum towing capacity of 6,000 pounds). EPA believes this could incentivize advanced technologies (such as HEVs) on pickups which offer some of the utility of the larger vehicles, but overall have lower CO_2 emissions due to the much lighter mass of the vehicle. Providing an advanced technology incentive credit for a vehicle which offers consumers much of the utility of a larger pickup truck but with overall lower CO_2 performance would promote the overall objective of the proposed standards.

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[297] Note that EPA's proposed calculation methodology in 40 CFR 600.510–12 does not use vehicle-specific fuel consumption adjustments to determine the CAFE increase due to the various incentives allowed under the proposed program. Instead, EPA would convert the total CO_2 credits due to each incentive program from metric tons of CO_2 to a fleetwide CAFE improvement value. The fuel consumption values are presented to give the reader some context and explain the relationship between CO_2 and fuel consumption improvements.

[298] This dimension is also known as dimension W202 as defined in Society of Automotive Engineers Procedure J1100.

[299] The pickup body length at the top of the body is also known as dimension L506 in Society of Automotive Engineers Procedure J1100. The pickup body length at the floor is also known as dimension L505 in Society of Automotive Engineers Procedure J1100.

[300] Gross combined weight rating means the value specified by the vehicle manufacturer as the maximum weight of a loaded vehicle and trailer, consistent with good engineering judgment. Gross vehicle weight rating means the value specified by the vehicle manufacturer as the maximum design loaded weight of a single vehicle, consistent with good engineering judgment. Curb weight is defined in 40 CFR 86.1803, consistent with the provisions of 40 CFR 1037.140.

EPA proposes that mild HEV pickup trucks would be eligible for a per-truck 10 g/mi CO_2 credit (equal to 0.0011 gal/mi for a 25 mpg truck) during MYs 2017–2021 if the mild HEV technology is used on a minimum percentage of a company's full sized pickups. That minimum percentage would be 30 percent of a company's full sized pickup production in MY 2017 with a ramp up to at least 80 percent of production in MY 2021.

EPA is also proposing that strong HEV pickup trucks would be eligible for a per-truck 20 g/mi CO_2 credit (equal to 0.0023 gal/mi for a 25 mpg truck) during MYs 2017–2025 if the strong HEV technology is used on a minimum percentage of a company's full sized pickups. That minimum percentage would be 10 percent of a company's full sized pickup production in each year over the model years 2017–2025.

To ensure that the hybridization technology used by manufacturers seeking one of these credits meets the intent behind the incentives, EPA is proposing very specific definitions of what qualifies as a mild and a strong HEV for these purposes. These definitions are described in detail in Chapter 5 of the draft joint TSD (see section 5.3.3).

Because there are other technologies besides mild and strong hybrids which can significantly reduce GHG emissions and fuel consumption in pickup trucks, EPA is also proposing performance-based incentive credits, and equivalent fuel consumption improvement values for CAFE, for full size pickup trucks that achieve an emission level significantly below the applicable CO_2 target.[301] EPA proposes that this credit be either 10 g/mi CO_2 (equivalent to 0.0011 gal/mi for the CAFE program) or 20 g/mi CO_2 (equivalent to 0.0023 gal/mi for the CAFE program) for pickups achieving 15 percent or 20 percent, respectively, better CO_2 than their footprint based target in a given model year. Because the footprint target curve has been adjusted to account for A/C related credits, the CO_2 level to be compared with the target would also include any A/C related credits generated by the vehicles. EPA provides further details on this performance-based incentive in Chapter 5 of the draft joint TSD (see Section 5.3). The 10 g/mi (equivalent to 0.0011 gal/mi) performance-based credit would be available for MYs 2017 to 2021 and a vehicle meeting the requirements would receive the credit until MY 2021 unless its CO_2 level or fuel consumption increases. The 10 g/mi credit is not available after 2021 because the post-2021 standards quickly overtake a 15% overcompliance. Earlier in the program, an overcompliance lasts for more years, making the credit/value appropriate for a longer period. The 20 g/mi CO_2 (equivalent to 0.0023 gal/mi) performance-based credit would be available for a maximum of 5 consecutive years within the model years of 2017 to 2025 after it is first eligible, provided its CO_2 level and fuel consumption does not increase. Subsequent redesigns can qualify for the credit again. The credits would begin in the model year of introduction, and (as noted) could not extend past MY 2021 for the 10 g/mi credit (equivalent to 0.0011 gal/mi) and MY 2025 for the 20 g/mi credit (equivalent to 0.0023 gal/mi).

As with the HEV-based credit, the performance-based credit/value requires that the technology be used on a minimum percentage of a manufacturer's full-size pickup trucks. That minimum percentage for the 10 g/mi GHG credit (equivalent to 0.0011 gal/mi fuel consumption improvement value) would be 15 percent of a company's full sized pickup production in MY 2017 with a ramp up to at least 40 percent of production in MY 2021. The minimum percentage for the 20 g/mi credit (equivalent to 0.0011 gal/mi fuel consumption improvement value) would be 10 percent of a company's full sized pickup production in each year over the model years 2017–2025. These minimum percentages are set to encourage significant penetration of these technologies, leading to long-term market acceptance.

Importantly, the same vehicle could not receive credits (or equivalent fuel consumption improvement values) under both the HEV and the performance-based approaches. EPA requests comment on all aspects of this proposed pickup truck incentive credit, including the proposed definitions for full sized pickup truck and mild and strong HEV.

4. Treatment of Plug-in Hybrid Electric Vehicles, Dual Fuel Compressed Natural Gas Vehicles, and Ethanol Flexible Fuel Vehicles for GHG Emissions Compliance

a. Greenhouse Gas Emissions

i. Introduction

This section addresses proposed approaches for determining the compliance values for greenhouse gas (GHG) emissions for those vehicles that can use two different fuels, typically referred to as dual fuel vehicles under the CAFE program. Three specific technologies are addressed: Plug-in hybrid electric vehicles (PHEVs), dual fuel compressed natural gas (CNG) vehicles, and ethanol flexible fuel vehicles (FFVs).[302] EPA's underlying principle is to base compliance values on demonstrated vehicle tailpipe CO_2 emissions performance. The key issue with vehicles that can use more than one fuel is how to weight the operation (and therefore GHG emissions performance) on the two different fuels. EPA proposes to do this on a technology-by-technology basis, and the sections below will explain the rationale for choosing a particular approach for each vehicle technology.

EPA is proposing no changes to the tailpipe GHG emissions compliance approach for dedicated vehicles, *i.e.,* those vehicles that can use only one fuel. As finalized for MY 2016 and later vehicles in the 2012–2016 rule, tailpipe CO_2 emissions compliance levels are those values measured over the EPA 2-cycle city/highway tests.[303] EPA is proposing provisions for how and when to also account for the upstream fuel production and distribution related GHG emissions associated with electric vehicles, fuel cell vehicles, and the electric portion of plug-in hybrid electric vehicles, and these provisions are discussed in Section III.C.2 above.

ii. Plug-In Hybrid Electric Vehicles

PHEVs can operate both on an on-board battery that can be charged by wall electricity from the grid, and on a conventional liquid fuel such as gasoline. Depending on how these vehicles are fueled and operated, PHEVs

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[301] The 15 and 20 percent thresholds would be based on CO_2 performance compared to the applicable CO_2 vehicle footprint target for both CO_2 credits and corresponding CAFE fuel consumption improvement values. As with A/C and off-cycle credits, EPA would convert the total CO_2 credits due to the pick-up incentive program from metric tons of CO_2 to a fleetwide equivalent CAFE improvement value.

[302] EPA recognizes that other vehicle technologies may be introduced in the future that can use two (or more) fuels. For example, the original FFVs were designed for up to 85% methanol/15% gasoline, rather than the 85% ethanol/15% gasoline for which current FFVs are designed. EPA has regulations that address methanol vehicles (both FFVs and dedicated vehicles), and, for GHG emissions compliance in MYs 2017–2025, EPA is proposing to treat methanol vehicles in the same way as ethanol vehicles.

[303] For dedicated alternative fuel vehicles. See 75 at FR 25434.

could operate exclusively on grid electricity, exclusively on the conventional fuel, or any combination of both fuels. EPA can determine the CO_2 emissions performance when operated on the battery and on the conventional fuel. But, in order to generate a single CO_2 emissions compliance value, EPA must adopt an approach for determining the appropriate weighting of the CO_2 emissions performance on grid electricity and the CO_2 emissions performance on gasoline.

EPA is proposing no changes to the Society of Automotive Engineers (SAE) cycle-specific utility factor approach for PHEV compliance and label emissions calculations first adopted by EPA in the joint EPA/DOT final rulemaking establishing new fuel economy and environment label requirements for MY 2013 and later vehicles.[304] This utility factor approach is based on several key assumptions. One, PHEVs are designed such that the first mode of operation is all-electric drive or electric assist. Every PHEV design with which EPA is familiar is consistent with this assumption. Two, PHEVs will be charged once per day. While this critical assumption is unlikely to be met by every PHEV driver every day, EPA believes that a large majority of PHEV owners will be highly motivated to re-charge as frequently as possible, both because the owner has paid a considerably higher initial vehicle cost to be able to operate on grid electricity, and because electricity is considerably cheaper, on a per mile basis, than gasoline. Three, it is reasonable to assume that future PHEV drivers will retain driving profiles similar to those of past drivers on which the utility factors were based. More detailed information on the development of this utility factor approach can be obtained from the Society of Automotive Engineers.[305] EPA will continue to reevaluate the appropriateness of these assumptions over time.

Based on this approach, and PHEV-specific specifications such as all-electric drive or equivalent all-electric range, the cycle-specific utility factor methodology yields PHEV-specific values for projected average percent of operation on grid electricity and average percent of operation on gasoline over both the city and highway test cycles. For example, the Chevrolet Volt PHEV, the only original equipment manufacturer (OEM) PHEV in the U.S. market today, which has an all-electric range of 35 miles on EPA's fuel economy label, has city and highway cycle utility factors of about 0.65, meaning that the average Volt driver is projected to drive about 65 percent of the miles on grid electricity and about 35 percent of the miles on gasoline. Each PHEV will have its own utility factor.

Based on this utility factor approach, EPA calculates the GHG emissions compliance value for an individual PHEV as the sum of (1) the GHG emissions value for electric operation (either 0 grams per mile or a non-zero value reflecting the net upstream GHG emissions accounting depending on whether automaker EV/PHEV/FCV production is below or above its cumulative production cap as discussed in Section III.C.2 above) multiplied by the utility factor, and (2) the tailpipe CO_2 emissions value on gasoline multiplied by (1 minus the utility factor).

iii. Dual Fuel Compressed Natural Gas Vehicles

Dual fuel CNG vehicles operate on either compressed natural gas or gasoline, but not both at the same time, and have separate tanks for the two fuels.[306] There are no OEM dual fuel CNG vehicles in the U.S. market today, but some manufacturers have expressed interest in bringing them to market during the rulemaking time frame. Under current EPA regulations through MY 2015, GHG emissions compliance values for dual fuel CNG vehicles are based on a methodology that provides significant GHG emissions incentives equivalent to the ''CAFE credit'' approach for dual and flexible fuel vehicles. For MY 2016, current EPA regulations utilize a methodology based on demonstrated vehicle emissions performance and real world fuels usage, similar to that for ethanol flexible fuel vehicles discussed below.

EPA proposes to develop a new approach for dual fuel CNG vehicle GHG emissions compliance that is very similar to the utility factor approach developed and described above for PHEVs, and for this new approach to take effect with MY 2016. As with PHEVs, EPA believes that owners of dual fuel CNG vehicles will preferentially seek to refuel and operate on CNG fuel as much as possible, both because the owner paid a much higher price for the dual fuel capability, and because CNG fuel is considerably cheaper than gasoline on a per mile basis. EPA notes that there are some relevant differences between dual fuel CNG vehicles and PHEVs, and some of these differences might weaken the case for using utility factors for dual fuel CNG vehicles. For example, a dual fuel CNG vehicle might be able to run on gasoline when both fuels are available on board (depending on how the vehicle is designed), it may be much more inconvenient for some private dual fuel CNG vehicle owners to fuel every day relative to PHEVs, and there are many fewer CNG refueling stations than electrical charging facilities.[307] On the other hand, there are differences that could strengthen the case as well, *e.g.,* many dual fuel CNG vehicles will likely have smaller gasoline tanks given the expectation that gasoline will be used only as an ''emergency'' fuel, and it may be easier for a dual fuel CNG vehicle to be refueled during the day than a PHEV (which is most conveniently refueled at night with a home charging unit).

Taking all these considerations into account, EPA believes that the merit of using a utility factor-based approach for dual fuel CNG vehicles is similar to that of doing so for PHEVs, and we propose to develop a similar methodology for dual fuel CNG vehicles. For example, applying the current SAE fleet utility factor approach developed for PHEVs to a dual fuel CNG vehicle with a 150-mile CNG range would result in a compliance assumption of about 95 percent operation on CNG and about 5 percent operation on gasoline.[308] EPA is proposing to directly extend the PHEV utility factor methodology to dual fuel CNG vehicles, using the same assumptions about daily refueling. EPA invites comment on this proposal, including the appropriateness of the assumptions described above for dual fuel CNG vehicles.

Further, for MYs 2012–2015, EPA is also proposing to allow the option, at the manufacturer's discretion, to use the proposed utility factor-based methodology for MYs 2016–2025 discussed above. The rationale for providing this option is that some manufacturers are likely to reach the maximum allowable GHG emissions credits (based on the statutory CAFE credits) through their production of

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[304] 76 FR 39504–39505 (July 6, 2011) and 40 CFR 600.116–12(b).

[305] *http://www.SAE.org*, specifically SAE J2841 ''Utility Factor Definitions for Plug-In Hybrid Electric Vehicles Using Travel Survey Data,'' September 2010.

[306] EPA considers ''bi-fuel'' CNG vehicles to be those vehicles that can operate on a mixture of CNG and gasoline. Bi-fuel vehicles would not be eligible for this treatment, since they are not designed to allow the use of CNG only.

[307] EPA assumes that most PHEV owners will charge at home with electrical charging equipment that they purchase and install for their own use.

[308] See SAE J2841 ''Utility Factor Definitions for Plug-In Hybrid Electric Vehicles Using Travel Survey Data,'' September 2010, available at *http://www.SAE.org*, which we are proposing to use for dual fuel CNG vehicles as well.

ethanol FFVs, and therefore would not be able to gain any GHG emissions compliance benefit even if they produced dual fuel CNG vehicles that demonstrated superior GHG emissions performance.

In determining eligibility for the utility factor approach, EPA may consider placing additional constraints on the designs of dual fuel CNG vehicles to maximize the likelihood that consumers will routinely seek to use CNG fuel. Options include, but are not limited to, placing a minimum value on CNG tank size or CNG range, a maximum value on gasoline tank size or gasoline range, a minimum ratio of CNG-to-gasoline range, and requiring an onboard control system so that a dual fuel CNG vehicle is only able to access the gasoline fuel tank if the CNG tank is empty. EPA seeks comments on the merits of these additional eligibility constraints for dual fuel CNG vehicles.

iv. Ethanol Flexible Fuel Vehicles

Ethanol FFVs can operate on E85 (a blend of 15 percent gasoline and 85 percent ethanol, by volume), gasoline, or any blend of the two. There are many ethanol FFVs in the market today.

In the final rulemaking for MY 2012–2016, EPA promulgated regulations for MYs 2012–2015 ethanol FFVs that provided significant GHG emissions incentives equivalent to the long-standing ''CAFE credits'' for ethanol FFVs under EPCA, since many manufacturers had relied on the availability of these credits in developing their compliance strategies.[309] Beginning in MY 2016, EPA ended the GHG emissions compliance incentives and adopted a methodology based on demonstrated vehicle emissions performance. This methodology established a default value assumption where ethanol FFVs are operated 100 percent of the time on gasoline, but allows manufacturers to use a relative E85 and gasoline vehicle emissions performance weighting based either on national average E85 and gasoline sales data, or manufacturer-specific data showing the percentage of miles that are driven on E85 vis-à-vis gasoline for that manufacturer's ethanol FFVs.[310] EPA is not proposing any changes to this methodology for MYs 2017–2025.

EPA believes there is a compelling rationale for not adopting a utility factor-based approach, as discussed above for PHEVs and dual fuel CNG vehicles, for ethanol FFVs. Unlike with PHEVs and dual fuel CNG vehicles, owners of ethanol FFVs do not pay any more for the E85 fueling capability. Unlike with PHEVs and dual fuel CNG vehicles, operation on E85 is not cheaper than gasoline on a per mile basis, it is typically the same or somewhat more expensive to operate on E85. Accordingly, there is no direct economic motivation for the owner of ethanol FFVs to seek E85 refueling, and in some cases there is an economic disincentive. Because E85 has a lower energy content per gallon than gasoline, an ethanol FFV will have a lower range on E85 than on gasoline, which provides an additional disincentive. The data confirm that, on a national average basis in 2008, less than one percent of ethanol FFVs used E85 fuel.[311]

If, in the future, this situation were to change (*e.g.,* if E85 were less expensive, on a per mile basis), then EPA could reconsider its approach to this issue.

b. Procedures for CAFE Calculations for MY 2020 and Later

49 U.S.C. 32905 specifies how the fuel economy of dual fuel vehicles is to be calculated for the purposes of CAFE through the 2019 model year. The basic calculation is a 50/50 harmonic average of the fuel economy for the alternative fuel and the conventional fuel, irrespective of the actual usage of each fuel. In addition, the fuel economy value for the alternative fuel is significantly increased by dividing by 0.15 in the case of CNG and ethanol and by using a petroleum equivalency factor methodology that yields a similar overall increase in the CAFE mpg value for electricity.[312] In a related provision, 49 U.S.C. 32906, the amount by which a manufacturer's CAFE value (for domestic passenger cars, import passenger cars, or light-duty trucks) can be improved by the statutory incentive for dual fuel vehicles is limited by EPCA to 1.2 mpg through 2014, and then gradually reduced until it is phased out entirely starting in model year 2020.[313] With the expiration of the special calculation procedures in 49 U.S.C. 32905 for dual fueled vehicles, the CAFE calculation procedures for model years 2020 and later vehicles need to be set under the general provisions authorizing EPA to establish testing and calculation procedures.[314]

With the expiration of the specific procedures for dual fueled vehicles, there is less need to base the procedures on whether a vehicle meets the specific definition of a dual fueled vehicle in EPCA. Instead, EPA's focus is on establishing appropriate procedures for the broad range of vehicles that can use both alternative and conventional fuels. For convenience, this discussion uses the term dual fuel to refer to vehicles that can operate on an alternative fuel and on a conventional fuel.

EPA sees two potential approaches for dual fuel vehicle CAFE calculations for model years 2020 and later. EPA requests comment on the two options discussed here, and we welcome comments on other potential options as well.

Determining the fuel economy of the vehicle for purposes of CAFE requires a determination on how to weight the fuel economy performance on the alternative fuel and the fuel economy performance on the conventional fuel. For PHEVs, dual-fuel CNG vehicles, and FFVs, EPA proposes to apply the same weighting for CAFE purposes as for purposes of GHG emissions compliance values. EPA proposes that, for PHEVs and dual-fuel CNG vehicles, the fuel economy weightings will be determined using the SAE utility factor methodology, while for ethanol FFVs, manufacturers can choose to use a default based on 100% gasoline operation, or can choose to base the fuel economy weightings on national average E85 and gasoline use, or on manufacturer-specific data showing the percentage of miles that are driven on E85 vis-à-vis gasoline for that manufacturer's ethanol FFVs. Where the two options differ is whether the 0.15 divisor or similar adjustment factor is retained or not. EPA believes that there are legitimate arguments both for and against retaining the adjustment factors.

EPA proposes to continue to use the 0.15 divisor for CNG and ethanol, and the petroleum equivalency factor for electricity, both of which the statute requires to be used through 2019, for model years 2020 and later. EPA believes there are two primary arguments for retaining the 0.15 divisor and petroleum equivalency factor. One, this approach is directionally consistent with the overall petroleum reduction goals of EPCA and the CAFE program, because it continues to encourage manufacturers to build vehicles capable of operating on fuels other than petroleum. Two, the 0.15 divisor and petroleum equivalency factor are used under EPCA to calculate CAFE compliance values for dedicated alternative fuel vehicles, and retaining this approach for dual fuel vehicles would maintain consistency, for MY 2020 and later, between the approaches for dedicated alternative fuel vehicles and for the alternative fuel portion of

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[309] 75 FR at 25432–433.

[310] 75 FR at 25433–434.

[311] 75 FR 14762 (March 26, 2010).

[312] 49 U.S.C. 32905.

[313] 49 U.S.C. 32906. NHTSA interprets section 32906(a) as not limiting the impact of duel fueled vehicles on CAFE calculations after MY2019.

[314] 49 U.S.C. 32904(a), (c).

dual fuel vehicle operation. Opting not to provide the 0.15 divisor or PEF for the alternative fuel portion of these vehicles' operation may discourage manufacturers from building vehicles capable of operating on both gasoline/diesel and alternative fuels, and thus potentially discourage important "bridge" technologies that may help consumers overcome current concerns about advanced technology vehicles.

EPA recognizes that this proposed calculation procedure would continue to provide, directionally, an increase in fuel economy values for the vehicles previously covered by the special calculation procedures in 49 U.S.C. 32905, and that Congress chose both to end the specific calculation procedures in that section and over time to reduce the benefit for CAFE purposes of the increase in fuel economy mandated by those special calculation procedures. However, the proposed provisions differ significantly in important ways from the special calculation provisions mandated by EPCA. Most importantly, they are changed to reflect actual usage rates of the alternative fuel and do not use the artificial 50/50 weighting previously mandated by 49 U.S.C. 32905. In practice this means the primary vehicles to benefit from the proposed provision will be PHEVs and dual-fuel CNG vehicles, and not FFVs, while the primary source of benefit to manufacturers under the statutory provisions came from FFVs. Changing the weighting to better reflect real world usage is a major change from that mandated by 49 U.S.C. 32905, and it orients the calculation procedure more to the real world impact on petroleum usage, consistent with the statute's overarching purpose of energy conservation. In addition, as noted above, Congress clearly continued the calculation procedures for dedicated alternative fuel vehicles that result in increased fuel economy values. This proposed approach is consistent with this, as it uses the same approach for calculating fuel economy on the alternative fuel when there is real world usage of the alternative fuel. Since the proposed provisions are quite different in effect from the specified provisions in 49 U.S.C. 32905, and are consistent with the calculation procures for dedicated vehicles that use the same alternative fuel, EPA believes this proposal would be an appropriate exercise of discretion under the general authority provided in 49 U.S.C. 32904.

An alternative option to the above proposal, and about which EPA seeks comment, is to not adopt the 0.15 divisor and petroleum equivalency factor for model years 2020 and later. The fuel economy for the CNG portion of a dual fuel CNG vehicle, E85 portion of FFVs, and the electric portion of a PHEV would be determined strictly on an energy-equivalent basis, without any adjustment based on the 0.15 divisor or petroleum equivalency factor. For E85 FFVs, the manufacturer would almost certainly use the gasoline fuel economy value only because gasoline has higher energy content and fuel economy than E85.[315] This approach would place less emphasis on conservation of petroleum and more on conservation of energy for dual fuel vehicles. It would also place more emphasis on Congress' decision to reduce over time the impact on CAFE from the increased fuel economy values derived from the specified calculation procedures in 49 U.S.C. 32905, and less emphasis on aligning the incentives for dual fuel alternative fuel vehicles with the incentives for dedicated alternative fuel vehicles.[316] EPA invites comment on both approaches.

5. Off-Cycle Technology Credits

For MYs 2012–2016, EPA provided an option for manufacturers to generate credits for employing new and innovative technologies that achieve CO_2 reductions which are not reflected on current 2-cycle test procedures. For this proposal, EPA, in coordination with NHTSA, is proposing to apply the off-cycle credits and equivalent fuel consumption improvement values to both the GHG and CAFE programs. This proposed expansion is a change from the 2012–16 final rule where EPA only provided the off-cycle credits for the GHG program. For MY 2017 and later, EPA is proposing that manufacturers may continue to use off-cycle credits for GHG compliance and begin to use fuel consumption improvement values (essentially equivalent to EPA credits) for CAFE compliance. In addition, EPA is proposing a set of defined (*e.g.* default) values for identified off-cycle technologies that would apply unless the manufacturer demonstrates to EPA that a different value for its technologies is appropriate. The proposed changes to incorporate off-cycle technologies for the GHG program are described in Section III.C.5.a–b below, and for the CAFE program are described in Section III.C.5.c below.

a. Off-Cycle Credit Program Adopted in MY 2012–2016 Rule

In the MY 2012–2016 Final Rule, EPA adopted an optional credit opportunity for 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").[317] EPA indicated that eligible innovative technologies are those that may be relatively newly introduced in one or more vehicle models, but that are not yet implemented in widespread use in the light-duty fleet, and which provide novel approaches to reducing greenhouse gas emissions. The technologies must have verifiable and demonstrable real-world GHG reductions.[318] EPA adopted the off-cycle credit option to provide an incentive to encourage the introduction of these types of technologies, believing 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 is currently available through the 2016 model year.

EPA finalized a two-tiered process for OEMs to demonstrate that CO_2 reductions of an innovative and novel technology are verifiable and measureable but are not captured by the 2-cycle 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 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 manufacture must follow the 5-cycle procedures.

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. This case-by-case, non-5-cycle credits approach includes an opportunity for public comment as part of the approval

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[315] Manufacturers can also choose to base the fuel economy weightings on national average E85 and gasoline use, or on manufacturer-specific data showing the percentage of miles that are driven on E85 vis-à-vis gasoline for that manufacturer's ethanol FFVs, but since E85 fuel economy ratings are based on miles per gallon of E85, not adjusted for energy equivalency with gasoline, E85 mpg values are lower than gasoline mpg values, which makes this a non-option.

[316] Incentives for dedicated alternative fuel vehicles would not be affected by changes to incentives for dual fueled vehicles. Dedicated alternative fuel vehicles would continue to use the 0.15 divisor or petroleum equivalency factor.

[317] 75 FR 25438–440,

[318] See 40 CFR 1866.12 (d); 75 FR at 25438.

process. The demonstration program must be robust, verifiable, and capable of demonstrating the real-world emissions benefit of the technology with strong statistical significance. Whether the approach involves on-road testing, modeling, or some other analytical approach, the manufacturer is 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. Data must be on a vehicle model-specific basis unless a manufacturer demonstrated model specific data was not necessary. See generally 75 FR at 25438–40.

b. Proposed Changes to the Off-cycle Credits Program

EPA has been encouraged by automakers' interest in off-cycle credits since the program was finalized. Though it is early in the program, several manufacturers have shown interest in introducing off-cycle technologies which are in various stages of development and testing. EPA believes that continuing the option for off-cycle credits would further encourage innovative strategies for reducing CO_2 emissions beyond those measured by the 2-cycle test procedures. Continuing the program provides manufacturers with additional flexibility in reducing CO_2 to meet increasingly stringent CO_2 standards and to encourage early penetration of off-cycle technologies into the light duty fleet. Furthermore, extending the program may encourage automakers to invest in off-cycle technologies that could have the benefit of realizing additional reductions in the light-duty fleet over the longer-term. Therefore, EPA is proposing to extend the off-cycle credits program to 2017 and later model years.

In implementing the program, some manufacturers have expressed concern that a drawback to using the program is uncertainty over which technologies may be eligible for off-cycle credits plus uncertainties resulting from a case-by-case approval process. Current EPA eligibility criteria require technologies to be new, innovative, and not in widespread use in order to qualify for credits. Also, the MY 2012–2016 Final Rule specified that technologies must not be significantly measurable on the 2-cycle test procedures. As discussed below, EPA proposes to significantly modify the eligibility criteria, as the current criteria are not well defined and have been a source of uncertainty for manufacturers, thereby interfering with the goal of providing an incentive for the development and use of additional technologies to achieve real world reductions in CO_2 emissions. The focus will be on whether or not add-on technologies can be demonstrated to provide off-cycle CO_2 emissions reductions that are not sufficiently reflected on the 2-cycle tests.

In addition, as described below in section III.C.5.b.i, EPA is proposing that manufacturers would be able to generate credits by applying technologies listed on an EPA pre-defined and pre-approved technology list starting with MY 2017. These credits would be verified and approved as part of certification with no prior approval process needed. We believe this new option would significantly streamline and simplify the program for manufacturers choosing to use it and would provide manufacturers with certainty that credits may be generated through the use of pre-approved technologies. For credits not based on the pre-defined list, EPA is proposing to streamline and better define a step-by-step process for demonstrating emissions reductions and applying for credits. EPA is proposing that these procedural changes to the case-by-case approach would be effective for new credit applications for both the remaining years of the MY 2012–2016 program as well as for MY 2017 and later credits that are not based on the pre-defined list.

As discussed in section II.F and III.B.10, EPA, in coordination with NHTSA, is also proposing that manufacturers be able to include fuel consumption reductions resulting from the use of off-cycle technologies in their CAFE compliance calculations. Manufacturers would generate ''fuel consumption improvement values'' essentially equivalent to EPA credits, for use in the CAFE program. The proposed changes to the CAFE program to incorporate off-cycle technologies are discussed below in section III.5.c.

i. Pre-Defined Credit List for MY 2017 and Later

As noted above, EPA proposes to establish a list of off-cycle technologies from which manufacturers could select to earn a pre-defined level of CO_2 credits in MY 2017 and later. Both technologies and credit values based on the list would be pre-approved. The manufacturer would demonstrate in the certification process that their technology meets the definition of the technology in the list. Table III–17 provides an initial proposed list of the technologies and per vehicle credit levels for cars and light trucks. EPA has used a combination of available activity data from the MOVES model, vehicle and test data, and EPA's vehicle simulation tool to estimate a proposed credit value EPA believes to be appropriate. In particular, this vehicle simulation tool was used to determine the credit amount for electrical load reduction technologies (*e.g.* high efficiency exterior lighting, engine heat reconvery, and solar roof panels) and active aerodynamic improvements. Chapter 5 of the joint TSD provides a detailed description of how these technologies are defined and how the proposed credits levels were derived.

Table III-17 Off-cycle Technologies and Proposed Credits for Cars and Light Trucks

Technology	Credit for Cars	Credit for Light Trucks	Minimum Penetration Requirement
	g/mi	g/mi	percent
High Efficiency Exterior Lighting	1.1	1.1	10%
Engine Heat Recovery	0.7	0.7	--
Solar Roof Panels	3.0	3.0	--
Active Aerodynamic Improvements	0.6	1.0	10%
Engine Start-Stop	2.9	4.5	10%
Electric Heater Circulation Pump	1.0	1.5	--
Active Transmission Warm-Up	1.8	1.8	10%
Active Engine Warm-Up	1.8	1.8	10%
Solar Control	Up to 3.0	Up to 4.3	10%

Two technologies on the list—active aerodynamic improvements and stop start—are in a different category than the other technologies on the list. Both of these technologies are included in the agencies' modeling analysis of technologies projected to be available for use in achieving the reductions needed for the standards. We have information on their effectiveness, cost, and availability for purposes of considering them along with the various other technologies we consider in determining the appropriate CO_2 emissions standard. These technologies are among those listed in Chapter 3 of the joint TSD and have measureable benefit on the 2-cycle test. However in the context of off-cycle credits, stop start is any technology which enables a vehicle to automatically turn off the engine when the vehicle comes to a rest and restart the engine when the driver applies pressure to the accelerator or releases the brake. This includes HEVs and PHEVs (but not EVs). In addition, active grill shutters is just one of various technologies that can be used as part of aerodynamic design improvements (as part of the "aero2" technology). The modeling and other analysis developed for determining the appropriate emissions standard includes these technologies, using the effectiveness values on the 2-cycle test. This is consistent with our consideration of all of the other technologies included in these analyses. Including them on the list for off-cycle credit generation, for purposes of compliance with the standard, would recognize that these technologies have a higher degree of effectiveness in reducing real-world CO_2 emissions than is reflected in their 2-cycle effectiveness. EPA has taken into account the generation of off-cycle credits by these two technologies in determining the appropriateness of the proposed GHG standards, considering the amount of credit, the projected degree of penetration of these technologies, and other factors. Section III.D has a more detailed discussion on the feasibility of the standards within the context of the flexibilities (such as off-cycle credits) proposed in this rule. As discussed in section III.D, EPA plans to incorporate the off-cycle credits for these two technologies in the cost analysis for the final rule (which EPA anticipates would slightly reduce costs with no change to benefits). EPA requests comments on this approach for stop start and active aerodynamic improvements.

Although EPA believes that there is sufficient information to estimate performance of other listed technologies for purposes of a credit program, EPA does not believe it appropriate to reflect these technologies in setting the level of standards at this point. There remains significant uncertainty as to the extent listed technologies other than stop start and active aerodynamic improvements may be used across the light duty fleet and (in some instances) costs of the technologies. Including them in the standard setting, as is done with A/C control technology, calls for a reasonable projection of the penetration of these technologies across the fleet and over time, along with reasonable estimates of their cost. EPA does not have adequate data at this point in time to make such fleet wide projections for other technologies on the list, or for other technologies addressed by the case-by-case approach. As in the 2012–2016 rule, the use of these technologies continues to be not nearly so well developed and understood for purposes of consideration in setting the standards. See 75 FR at 25438. Technologies that are considered by EPA in setting the standard, as discussed in section III.D and in Chapter 3 of the TSD, may not generate off-cycle credits under this approach, except for active aerodynamic improvements and stop start.[319] This would amount to the double counting discussed at 75 FR 25438, as EPA has already considered these technologies and assigned them an emission reduction effectiveness for purposes of standard setting, and has enough information on effectiveness, cost, and applicability to project their use for purposes of standard setting. EPA will reassess the list above for the Final Rule, based on additional information that becomes available during the comment period. It may also be appropriate to reconsider this approach as part of the mid-term evaluation as information on these technologies' applicability, costs, and performance becomes more robust.

EPA proposes to cap the amount of credits a manufacturer could generate using the above list to 10 g/mile per year on a combined car and truck fleet-wide average basis. The cap would not apply on a vehicle model basis, allowing manufacturers the flexibility to focus off-cycle technologies on certain vehicle models and generate credits for that vehicle model in excess of 10 g/mile. EPA is proposing a fleet-wide cap because the proposed credits are based on limited data, and also EPA recognizes that some uncertainty is introduced when credits are provided based on a general assessment of off-cycle performance as opposed to testing on the individual vehicle models. Also, as discussed in Chapter 5 of the draft TSD, EPA believes the credits proposed are based on conservative estimates, providing additional assurance that the list would not result in an overall loss of CO_2 benefits. EPA proposes that manufacturers wanting to generate credits in excess of the 10 g/mile limit for these listed technologies could do so by generating necessary data and going through the credit approval process described below in Section III.C.5.b.iii and iv.

As noted above, EPA proposes to make the list available for credit generation starting in MY 2017. Prior to MY 2017, manufacturers would need to demonstrate off-cycle emissions reductions in order to generate credits for off-cycle technologies, including those on the list. Requirements for demonstrating off-cycle credits not based on the list are described below. Manufacturers may also opt to generate data for listed technologies in MY 2017 and later where they are able to demonstrate a credit value greater than that provided on the list.

Prior to MY 2017, EPA would continue to evaluate off-cycle technologies. Based on data provided by manufacturers for non-listed technologies, and other available data, EPA would consider adding technologies to the list through rulemaking. EPA could also issue guidance in the future for additional off-cycle technologies, indicating the level of credits that EPA expects could be approved for any manufacturer through the case-by-case approach, helping to streamline the case-by-case approach until a rulemaking was conducted to update the list. If the CO_2 reduction benefits of a technology have been established through manufacturer data and testing, EPA believes that it would be appropriate to list the technology and a conservative associated credit value.

Since one purpose of the off-cycle credits is to encourage market penetration of the technologies (see 75 FR at 25438), EPA also proposes to require minimum penetration rates for several of the listed technologies as a condition for generating credit from the list as a way to further encourage their widespread adoption by MY 2017 and later. The proposed minimum penetration rates for the various technologies are provided in Table III–17. At the end of the model year for which the off-cycle credit is claimed, manufacturers would need to demonstrate that production of vehicles equipped with the technologies for that model year exceeded the percentage thresholds in order to receive the listed credit. EPA proposes to set the threshold at 10 percent of a manufacturer's overall combined car and light truck production except for technologies specific to HEVs/PHEVs/EVs and exhaust heat recovery. EPA believes 10 percent is an appropriate threshold as it would encourage manufacturers to develop technologies for use on larger volume models and bring the technologies into the mainstream. On the other hand, EPA is not proposing a larger value because EPA does not want to discourage the use of technologies. For solar roof panels (solar control) and electric heater circulation pumps, which are HEV/PHEV/EV-specific, EPA is not proposing a minimum penetration rate threshold for credit generation. Hybrids and EVs may be a small subset of a manufacturer's fleet, less than 10 percent in some cases, and EPA does not believe establishing a threshold for hybrid-based technologies would be useful and could unnecessarily impede the introduction of these technologies. EPA is also not proposing to apply a minimum penetration threshold to exhaust heat recovery because the threshold could impede rather than encourage the development of the technology due to its relatively early stage of development and potentially high cost. EPA requests comments on applying this type of threshold, the appropriateness of 10 percent as the threshold for several of the listed technologies, and the proposed treatment of HEV/PHEV/EV specific technologies and exhaust heat recovery.

ii. Proposed Technology Eligibility Criteria

EPA proposes to remove the criteria in the 2012–2016 rule that off-cycle technologies must be 'new, innovative, and not widespread' because these terms are imprecise and have created implementation issues and uncertainty in the program. For example, it is unclear if technologies developed in the past but not used extensively would be considered new, if only the first one or two manufacturers using the technology would be eligible or if all manufacturers could use a technology to generate credits, or if credits for a technology would sunset after a period of time. It has also been unclear if a technology such as active aerodynamics would be eligible since it provides a small measurable reduction on the 2-cycle test but provides additional reductions off-cycle, especially during high speed driving. These criteria have interfered with the goal of providing an incentive for the development and use of off-cycle technology that reduces CO_2 emissions. EPA proposes this approach for new MY 2012–2016 credits as well as for MY 2017–2025.

EPA believes it is appropriate to provide credit opportunities for technologies that achieve real world

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[319] Section III.D provides EPA projected technology penetration rates. Technologies projected to be used to meet the standards would not be eligible for off-cycle credits, with the exception of stop start and active aerodynamic improvements.

reductions beyond those measured under the two-cycle test without further making (somewhat subjective) judgments regarding the newness and innovativeness of the technology. Instead, EPA proposes to provide off-cycle credits for any technologies that are added to a vehicle model that are demonstrated to provide significant incremental off-cycle CO_2 reductions, like those on the list. The proposed technology demonstration and step-by-step application process is described in detail below in section III.C.5.b.ii. EPA is proposing to clarify that technologies providing small reductions on the 2-cycle tests but additional significant reductions off-cycle could be eligible to generate off-cycle credits. EPA thus proposes to remove the ''not significantly measurable over the 2-cycle test'' criteria. EPA proposes that, instead, manufacturers must be able to make a demonstration through testing with and without the off-cycle technology.

As noted above, EPA proposes that technologies included in EPA's assessment in this rulemaking of technology for purposes of developing the standard would not be allowed to generate off-cycle credits, as their cost and effectiveness and expected use are already included in the assessment of the standard. (As explained above, the agencies have done so with respect to stop start and active aerodynamic improvements by including the projected level of credits in determining the appropriateness of the proposed standards.) EPA proposes that technologies integral or inherent to the basic vehicle design including engine, transmission, mass reduction, passive aerodynamic design, and base tires would not be eligible for credits. For example, manufacturers would not be able to generate off-cycle credits by moving to an eight-speed transmission. EPA believes that it would be difficult to clearly establish an appropriate A/B test (with and without technologies) for technologies so integral to the basic vehicle design. EPA proposes to limit the off-cycle program to technologies that can be clearly identified as add-on technologies conducive to A/B testing. Further, EPA would not provide credits for a technology required to be used by Federal law, such as tire pressure monitoring systems, as EPA would consider such credits to be windfall credits (*i.e.* not generated as a result of the rule). The base versions of such technologies would be considered part of the base vehicle. However, if a manufacturer demonstrates that an improvement to such technologies provides additional off-cycle benefits above and beyond a system meeting minimum Federal requirements, those incremental improvements could be eligible for off-cycle credits, assuming an appropriate quantification of credits is demonstrated.

By proposing to remove the ''new, innovative, not widespread use'' criteria in the present rule, EPA is also making clear that once approved, EPA does not intend to sunset a technology's credit eligibility or deny credits to other vehicle applications using the technology, as may have been implied by those criteria under the MY 2012–2016 program. EPA believes, at this time, that it should encourage the wider use of technologies with legitimate off-cycle emissions benefits. Manufacturers demonstrating through the EPA approval process that the technology is effective on additional vehicle models would be eligible for credits. Limiting the application of a technology or sunsetting the availability of credits during the 2017–2025 time frame would be counterproductive because it would remove part of the incentive for manufacturers to invest in developing and deploying off-cycle technologies, some of which may be promising but have considerable development costs associated with them. Also, approving a technology only to later disallow it could lead to a manufacturer discontinuing the use of the technology even if it remained a cost effective way to reduce emissions. EPA also believes that this approach provides an incentive for manufacturers to continue to improve technologies without concern that they will become ineligible for credits at some future time. EPA requests comments on all aspects of the above approach for the off-cycle credits program criteria.

iii. Demonstrating Off-Cycle Emissions Reductions

5-Cycle Testing

EPA is retaining a two-tiered process for demonstrating the CO_2 reductions of off-cycle technologies (in those instances when a manufacturer is not using the default value provided by the rule), but is clarifying several of the requirements. The process described below would be used for all credits not based on the pre-defined list described in Section III.C.5.i, above. As noted above, the proposed approach would replace the requirement in the 2012–2016 rule that technology must not be ''significantly measurable'' over the 2-cycle test. See section 86. 1866–12 (d)(ii). This criterion has been problematic because several technologies provide some benefit on the 2-cycle test but much greater benefits off-cycle. Under today's proposal, technologies would need to be demonstrated to provide significant incremental off-cycle benefits above and beyond those provided over the 2-cycle test (examples are shown below). EPA proposes this approach for new MY 2012–2016 credits as well as for MY 2017–2025.

The 5-cycle test procedures would remain the starting point for demonstrating off-cycle emissions reductions. The MY 2012–2016 rulemaking established general 5-cycle testing requirements and EPA is proposing several provisions to delineate what EPA would expect as part of a 5-cycle based demonstration. Manufacturers requested clarification on the amount of 5-cycle testing that would be needed to demonstrate off-cycle credits, and EPA is proposing the following as part of the step-by-step methodology manufacturers would follow to generate credits. In addition to the general 5-cycle demonstration requirements of the MY 2012–2016 program, EPA proposes to specifically require model-based verification of 5-cycle results where off-cycle reductions are small and could be a product of testing variability. EPA is also proposing to specifically require that all applications include an engineering analysis for why the technology provides off-cycle emissions reductions. EPA proposes to specify that manufacturers would run an initial set of three 5-cycle tests with and without the technology providing the off-cycle CO_2 reduction. Testing must be conducted on a representative vehicle, selected using good engineering judgment, for each vehicle model. EPA proposes that manufacturers could bundle off-cycle technologies together for testing in order to reduce testing costs and improve their ability to demonstrate consistently measurable reductions over the tests. If these A/B 5-cycle tests demonstrate an off-cycle benefit of 3 percent or greater, comparing average test results with and without the off-cycle technology, the manufacturer would be able to use the data as the basis for credits. EPA has long used 3 percent as a threshold in fuel economy confirmatory testing for determining if a manufacturer's fuel economy test results are comparable to those run by EPA.[320]

If the initial three sets of 5-cycle results demonstrate a reduction of less than a 3 percent difference in the 5-cycle results with and without the off-cycle technology, the manufacturer

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[320] 40 CFR 600.008 (b)(3).

would have to run two additional 5-cycle tests with and without the off-cycle technologies and verify the emission reduction using the EPA Light-duty Simulation Tool described below. If the simulation tool supports credits that are less than 3 percent of the baseline 2-cycle emissions, then EPA would approve the credits based on the test results. As outlined below, credits based on this methodology would be subject to a 60 day EPA review period starting when EPA receives a complete application, which would not include a public review.

EPA believes that small off-cycle credit claims (*i.e.,* less than 3 percent of the vehicle model 2-cycle CO_2 level) should be supported with modeling and engineering analysis. EPA is proposing the approach above for a number of reasons. Emissions reductions of only a few grams may not be statistically significant and could be the product of gaming. Also, manufacturers have raised test-to-test variability as an issue for demonstrating technologies through 5-cycle testing. Modeling and engineering analyses can help resolve these questions. EPA also requests comments on allowing manufacturers to use the EPA simulation tool and engineering analysis in lieu of additional 5-cycle testing. For some technologies providing very small incremental benefits, it may not be possible to accurately measure their benefit with vehicle testing.

Demonstrations Not Based on 5-Cycle Testing

In cases where the benefit of a technological approach to reducing CO_2 emissions cannot be adequately represented using 5-cycle testing, manufacturers will need to develop test procedures and analytical approaches to estimate the effectiveness of the technology for the purpose of generating credits. See 75 FR at 25440. EPA is not proposing to make significant changes to this aspect of the program. If 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 by the manufacturer 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 methodology developed and submitted to EPA would be subject to public review as explained at 75 FR 25440 and in 86.1866(d)(2)(ii).

EPA has identified two general situations where manufacturers would need to develop their own demonstration methodology. The first is a situation where the technology is active only during certain operating conditions that are not represented by any of the 5-cycle tests. To determine the overall emissions reductions, manufacturers must determine not only the emissions impacts during operation but also real-world activity data to determine how often the technology is utilized during actual, in-use driving on average across the fleet. EPA has identified some of these types of technologies and has calculated a default credit for them, including items such as high efficiency (*e.g.,* LED) lights and solar panels on hybrids. See Table III–17 above. In their demonstrations, manufacturers may be able to apply the same type of methodologies used by EPA as a basis for these default values (see TSD Chapter 5).

The second type of situation where manufacturers would need to develop their own demonstration data would be for technologies that involve action by the driver to make the technology effective in reducing CO_2 emissions. EPA believes that driver interactive technologies face the highest demonstration hurdle because manufacturers would need to provide actual real-world usage data on driver response rates. Such technologies would include ''eco buttons'' where the driver has the option of selecting more fuel efficient operating modes, traffic avoidance systems, and more advanced tire pressure monitor systems (*i.e.,* technologies that go beyond the minimum Federal requirements) notifying the driver to fill their tires more often.[321] EPA proposes that data would need to be from instrumented vehicle studies and not through driver surveys where results may be influenced by drivers failure to accurately recall their response behavior. Systems such as On-star could be one promising way to collect driver response data if they are designed to do so. 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. EPA proposes this approach for new MY 2012–2016 credits as well as for MY 2017–2025.

EPA Light-Duty Vehicle Simulation Tool

As explained above and, EPA has developed full vehicle simulation capabilities in order to support regulations and vehicle compliance by quantifying the effectiveness of different technologies over a wide range of engine and vehicle operating conditions. This in-house simulation tool has been developed for modeling a wide variety of light, medium, and heavy duty vehicle applications over various driving cycles. In order to ensure transparency of the models and free public access, EPA has developed the tool in MATLAB/Simulink environment with a completely open source code. EPA's first application of the vehicle simulation tool was for purposes of heavy-duty vehicle compliance and certification. For the model years 2014 to 2017 final rule for medium and heavy duty trucks, EPA created the ''Greenhouse gas Emissions Model'' (GEM), which is used both to assess Class 2b–8 vocational vehicle and Class 7/8 combination tractor GHG emissions and fuel efficiency and to demonstrate compliance with the vocational vehicle and combination tractor standards. See 76 FR at 57146–147.[322] EPA will submit the simulation tool for peer review for the final rule. Chapter 2 of the Draft RIA has more details of this simulation tool.

As mentioned previously, the tool is based on MATLAB/Simulink and is a forward-looking full vehicle model that uses the same physical principles as other commercially available vehicle simulation tools (*e.g.* Autonomie, AVL–CRUISE, GT–Drive, etc.) to derive the governing equations. These governing equations describe steady-state and transient behaviors of each of electrical, engine, transmission, driveline, and vehicle systems, and they are integrated together to provide overall system behavior during transient conditions as well as steady-state operations. In the light-duty vehicle simulation tool, there are four key system elements that describe the overall vehicle dynamics behavior and the corresponding fuel efficiency: Electrical, engine, transmission, and vehicle. The electrical system model consists of parasitic electrical load and A/C blower fan, both of which were assumed to be constant. The engine system model is comprised

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[321] A tire pressure monitor system that also automatically fills the tire without driver interaction would obviously not involve driver response data for the automatic system, but the demonstration may involve the driver response rates for the baseline system to determine an incremental credit.

[322] See also US EPA, ''Final Rule Making to Establish Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles,'' Heavy-Duty Regulatory Impact Analysis.give cite to where GEM is written up in the heavy duty RIA.

of engine torque and fueling maps. For the vehicle system, four vehicles were modeled: Small, mid, large size passenger vehicles, and a light-duty pick-up truck. The engine maps, transmission gear ratios and shifting schedules were appropriately sized and adjusted according to the vehicle type represented by the simulation. This tool is capable of simulating a wide range of conventional and advanced engines, transmissions, and vehicle technologies over various driving cycles. It evaluates technology package effectiveness while taking into account synergy (and dis-synergy) effects among vehicle components and estimates GHG emissions for various combinations of technologies. Chapter 2 of the Draft Regulatory Impact Analysis provides more details on this light-duty vehicle simulation tool.

As discussed in section III.C.1, EPA has used the light-duty vehicle simulation tool to estimate indirect A/C CO_2 emissions from conventional (non-hybrid) vehicles, helping to quantify the indirect A/C credit. In addition to A/C related CO_2 reductions, EPA believes this same simulation tool may be useful in estimating CO_2 reductions from off-cycle technologies. Currently, the model provides A/B relative comparisons with and without technologies that can help inform credits estimates. EPA has used it to estimate credits for some of the technologies in the proposed pre-defined list, including active aerodynamic improvements. As discussed above, EPA is proposing to require this simulation tool be used as an additional way to estimate emissions reductions in cases where the 5-cycle test results indicate the potential reductions to be small, and EPA is also requesting comments on using the simulation tool as a basis for estimating off-cycle credits in lieu of 5-cycle testing.

There are a number of technologies that could bring additional GHG reductions over the 5-cycle drive test (or in the real world) compared to the combined FTP/Highway (or two) cycle test. These are called off-cycle technologies and are described in chapter 5 of the Joint TSD in detail. Among them are technologies related to reducing vehicle's electrical loads, such as High Efficiency Exterior Lights, Engine Heat Recovery, and Solar Roof Panels. In an effort to streamline the process for approving off-cycle credits, we have set a relatively conservative estimate of the credit based on our efficacy analysis. EPA seeks comment on utilizing the model in order to quantify the credits more accurately, for example, if actual data of electrical load reduction and/or on-board electricity generation by one or more of these technologies is available through data submission from manufacturers. Similarly, there are technologies that would provide additional GHG reduction benefits in the 5-cycle test by actively reducing the vehicle's aerodynamic drag forces. These are referred to as active aerodynamic technologies, which include but are not limited to Active Grill Shutters and Active Suspension Lowering. Like the electrical load reduction technologies, the vehicle simulation tool can be used to more accurately estimate the additional GHG reductions (therefore the credits) provided by these active aerodynamic technologies over the 5-cycle drive test. EPA seeks comment on using the simulation tool in order to quantify these credits. In order to do this properly, manufacturers would be expected to submit two sets of coast-down coefficients (with and without the active aerodynamic technologies).

There are other technologies that would result in additional GHG reduction benefits that cannot be fully captured on the combined FTP/Highway cycle test. These technologies typically reduce engine loads by utilizing advanced engine controls, and they range from enabling the vehicle to turn off the engine at idle, to reducing cabin temperature and thus A/C compressor loading when the vehicle is restarted. Examples include Engine Start-Stop, Electric Heater Circulation Pump, Active Engine/Transmission Warm-Up, and Solar Control. For these types of technologies, the overall GHG reduction largely depends on the control and calibration strategies of individual manufacturers and vehicle types. Also, the current vehicle simulation tool does not yet have the capability to properly simulate the vehicle behaviors that depend on thermal conditions of the vehicle and its surroundings, such as Active Engine/Transmission Warm-Up and Solar Control. Therefore, the vehicle simulation may not provide full benefits of the technologies on the GHG reductions. For this reason, the agency is not proposing to use the simulation tool to generate the GHG credits for these technologies at this time, though future versions of the model may be more capable of quantifying the efficacy of these off-cycle technologies as well.

iv. In-Use Emissions Requirements

EPA requires off-cycle components to be durable in-use and continues to believe that this is an important aspect of the program. See 86.1866–12 (d)(1)(iii). The technologies upon which the credits are based are 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. In-use requirements would apply to technologies generating credits based on the pre-defined list as well as to those based on a manufacturer's demonstration.

Manufacturers have requested clarification of these provisions and guidance on how to demonstrate in-use performance. EPA is proposing to clarify that off-cycle technologies are considered emissions related components and all in-use requirements apply including defect reporting, warranty, and recall. OBD requirements do not apply under the MY 2012–2016 program and EPA is not proposing any OBD requirements at this time for off-cycle technologies. Manufacturers may establish maintenance intervals for these components in the same way they would for other emissions related components. The performance of these components would be considered in determining compliance with the applicable in-use CO_2 standards. Manufacturers may demonstrate in-use emissions durability at time of certification by submitting an engineering analysis describing why the technology is durable and expected to last for the full useful life of the vehicle. This demonstration may also include component durability testing or through whole vehicle aging if the manufacturer has such data. The demonstration would be subject to EPA approval prior to credits being awarded.[323] EPA believes these provisions are important to ensure that promised emissions reductions and fuel economy benefit to the consumer are delivered in-use. EPA requests comments on the above approach for in-use emissions durability.

v. Step-by-Step EPA Review Process

EPA proposes to provide a step-by-step process and timeline for reviewing credit applications and providing a decision to manufacturers. EPA requests comments on the process described below including comments on how to further improve or streamline it while maintaining its effectiveness. EPA

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[323] Listed technologies are pre-approved assuming the manufacturer demonstrates durability.

proposes these clarifications and further detailed step-by-step instructions for new MY 2012–2016 credits as well as for MY 2017–2025. EPA believes these additional details are consistent with the general off-cycle requirements adopted in the MY 2012–2016 rule. Starting in MY 2017, EPA is proposing that manufacturers may generate credits using technologies on a pre-defined list, and these technologies would not be required to go through the approval process described below.

Step 1: Manufacturer Conducts Testing and Prepares Application

- 5-cycle—Manufacturers would conduct the testing and/or simulation described above
- Non 5-cycle—Manufacturers would develop a methodology for non 5-cycle based demonstration and carry-out necessary testing and analysis
  - ○ Manufacturers may opt to meet with EPA to discuss their plans for demonstrating technologies and seek EPA input prior to conducting testing or analysis
- Manufacturers conduct engineering analysis and/or testing to demonstrate in-use durability

Step 2: Manufacturer Submits Application

The manufacturer application must contain the following:

- Description of the off-cycle technologies and how they function to reduce off-cycle emissions
- The vehicle models on which the technology will be applied
- Test vehicles selection and supporting engineering analysis for their selection
- 5-cycle test data, and/or including simulation results using EPA Light-duty Simulation Tool, as applicable
- For credits not based on 5-cycle testing, a complete description of methodology used to estimate credits and supporting data (vehicle test data and activity data)
  - ○ Manufacturer may seek EPA input on methodology prior to conducting testing or analysis
- An estimate of off-cycle credits by vehicle model, and fleetwide based on projected vehicle sales
- Engineering analysis and/or component durability testing or whole vehicle test data (as necessary) demonstrating in-use durability of components

Step 3: EPA Review

Once EPA receives an application, EPA would do the following:

- EPA will review the application for completeness and within 30 days will notify the manufacturer if additional information is needed
- EPA will review the data and information provided to determine if the application supports the level of credits estimated by manufacturers
- EPA will consult with NHTSA on the application and the data received in cases where the manufacturer intends to generate fuel consumption improvement values for CAFE in MY 2017 and later
- For applications where the rule specifies public participation in the review process, EPA will make the applications available to the public within 60 days of receiving a complete application
  - ○ The public review period will be 30 day review of the methodology used by the manufacturer to estimate credits, during which time the public may submit comments.
  - ○ Manufacturers may submit a written rebuttal of comments for EPA consideration or may revise their application in response to comments following the end of the public review period.

Step 4: EPA Decision

- For applications where the rule does not specify public participation and review, EPA, after consultation with NHTSA in cases where the manufacturer intends to generate fuel consumption improvement values for CAFE in MY 2017 and later, will notify the manufacturer of its decision within 60 days of receiving a complete application.
- For applications where the rule does specify public participation and review, EPA will notify the manufacturer of its decision on the application after reviewing public comments.
- EPA will notify manufacturers in writing of its decision to approve or deny the credits application, and provide a written explanation for its action (supported by the administrative record for the application proceeding).

c. Off-Cycle Technology Fuel Consumption Improvement Values in the CAFE Program

EPA proposes, in coordination with NHTSA, that manufacturers would be able to generate fuel consumption improvement values equivalent to CO_2 off-cycle credits for use in the CAFE program. EPA is proposing that a CAFE improvement value for off-cycle improvements be determined at the fleet level by converting the CO_2 credits determined under the EPA program (in metric tons of CO_2) for each fleet (car and truck) to a fleet fuel consumption improvement value. This improvement value would then be used to adjust the fleet's CAFE level upward. See the proposed regulations at 40 CFR 600.510–12. Note that while the following table presents fuel consumption values equivalent to a given CO_2 credit value, these consumption values are presented for informational purposes and are not meant to imply that these values will be used to determine the fuel economy for individual vehicles. For off-cycle CO_2 credits not based on the list, manufacturers would go though the steps described above in Section III.C.5.b. Again, all off-cycle CO_2 credits would be converted to a gallons per mile fuel consumption improvement value at a fleet level for purposes of the CAFE program. EPA would approve credit generation, and corresponding equivalent fuel consumption improvement values, in consultation with NHTSA.

III-18 Fuel Consumption Improvement Values Equivalent to Proposed CO_2 Off-cycle Credits

Technology	Cars	Light Trucks
	gallons/mi	gallons/mi
High Efficiency Exterior Lighting	0.000124	0.000124
Engine Heat Recovery	0.000778	0.000778
Solar Roof Panels	0.000338	0.000338
Active Aerodynamic Improvements	0.0000675	0.000113
Engine Start-Stop	0.000326	0.000506
Electric Heater Circulation Pump	0.000123	0.000169
Active Transmission Warm-Up	0.000203	0.000203
Active Engine Warm-Up	0.000203	0.000203
Solar Control	Up to 0.000338	Up to 0.000484

D. Technical Assessment of the Proposed CO_2 Standards

This proposed 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 available in this timeframe to achieve such reductions for MY 2017–2025 light duty 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 as that taken in the MYs 2012–2016 rulemaking. EPA is evaluating emissions control technologies which reduce CO_2 and other greenhouse gases. CO_2 emissions from automobiles are largely the product of fuel combustion. 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 as in the MYs 2012–2016 rule, the proposed 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' utility.[324] 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 (and, in our assessment of the costs of the rule, included the costs to manufacturers of preserving vehicle utility). Manufacturers may decide to alter the utility of the vehicles which they sell, but this would not be a

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[324] EPA recognizes that electric vehicles, a technology considered in this analysis, have unique attributes and discusses these considerations in Section III.H.1.b. There is also a fuller discussion of the utility of Atkinson engine hybrid vehicles in EPA DRIA Chapter 1.

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 vehicle design. As discussed below, there are many technologies that are currently available which can reduce vehicle energy consumption. Several of these are ''game-changing'' technologies and are already being commercially utilized to a limited degree in the current light-duty fleet. Examples include hybrid technologies that use high efficiency batteries and electric motors as the power source in combination with or instead of internal combustion engines, plug-in hybrid electric vehicles, and battery-electric vehicles. While already commercialized, these technologies continue to be developed and offer the potential for even more significant efficiency improvements. There are also other advanced technologies under development and not yet on production vehicles, such as high BMEP engines with cooled EGR, which offer the potential of improved energy generation taking the gasoline combustion process nearly to its thermodynamic limit. In addition, the available technologies are not limited to powertrain improvements but also include a number of technologies that are expected to continually improve incrementally, such as engine friction reduction, rolling resistance reduction, 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, product development and manufacturing process plays a major role in developing the proposed standards. Vehicle manufacturers typically develop many different models by basing them on a limited number of vehicle platforms. The platform typically consists of a common set of vehicle architecture and structural components.[325] 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.[326] 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 to comply with emissions, fuel economy, and safety regulations.[327] This redesign 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.

This proposal affects nine years of vehicle production, model years 2017–2025. Given the now-typical five year redesign cycle, many vehicles will be redesigned three times between MY 2012 and MY 2025 and are expected to be redesigned twice during the 2017–2025 timeframe. Due to the relatively long lead time before 2017, there are fewer lead time concerns with regard to product redesign in this proposal than with the MYs 2012–2016 rule (or the MY 2014–2018 rule for heavy duty vehicles and engines). However, there are still some technologies that require significant lead time, and are not projected to be heavily utilized in the first years of this proposal. An example is the advanced high BMEP, cooled EGR engines. As these engines are not yet in vehicles today, a research and development period is required, even if there are a number of demonstration projects complete (as discussed in Chapter 3 of the joint TSD).

In developing the proposed MY 2021 and 2025 car and truck curves (discussed in Section III.B), EPA used the OMEGA model to evaluate technologies that manufacturers could use to comply with the targets which those curves would establish. These curves correspond to sales-weighted fleetwide CO_2 average targets of 200 g/mile in MY 2021 and 163 g/mile in MY 2025. As discussed later in this section, we believe that this level of technology application to the light-duty vehicle fleet can be achieved in this time frame, the standards will produce significant reductions in GHG emissions, and the costs for both the industry and the costs to the consumer are reasonable and that consumer savings due to improved fuel economy will more than pay for the increased vehicle cost over the life of the vehicles. EPA also estimated costs for the intermediate model years 2017 through 2020 based on the OMEGA analyses in MYs 2016 and 2021 as well as the intermediate model years 2022–2024 based on the OMEGA analyses in MYs 2021 and 2025.

EPA's technical assessment of the proposed MY2017–2025 standards is described below. EPA has also evaluated a set of alternative standards for these model years, two of which are more stringent and two of which are less stringent than the standards proposed. The technical assessment of these alternative standards in relation to the ones proposed is discussed at the end of this section.

Evaluating the appropriateness of these standards includes a core focus on 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 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 within the constraints of the redesign cycles, 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 involving dozens of technologies and hundreds of vehicle platforms. In order to assist in this task, EPA is again using a computerized program called the Optimization Model for reducing Emissions of Greenhouse gases from Automobiles (OMEGA). Broadly, OMEGA starts with a description of the future vehicle fleet (*i.e.* the 'reference fleet'; see section II.B above), 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, EPA uses OMEGA to analyze over 200 vehicle platforms comprising approximately 1300 vehicle models in order o capture the important differences in vehicle and engine design and utility of future vehicle sales of roughly 16–18 million

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[325] Examples of shared vehicle platforms include the Ford Taurus and Ford Explorer or the Chrysler Sebring and Dodge Journey.

[326] See TSD Chapter 3.

[327] TSD 3 discusses redesign schedules in greater detail.

units annually in the 2017–2025 timeframe. The model is then provided with a list of technologies which are applicable to various types of vehicles, along with the technologies' 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 increasing 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 efficiency related emissions and refrigerant leakage emissions associated with air conditioner use, this task is currently handled outside of the OMEGA model. A/C improvements are relatively cost-effective, and would always be added to vehicles by the model, thus they are simply added into the results at the projected penetration levels. The model can also be set to account for the various proposed compliance flexibilities (and to accommodate compliance flexibilities in general.

The remainder of this section describes the technical feasibility analysis in greater detail. Section III.D.1 describes the development of our reference and control case projections of the MY 2017–2025 fleet. Section III.D.2 describes our estimates of the effectiveness and cost of the control technologies available for application in the 2017–2025 timeframe. Section III.D.3 describes how these technologies are combined 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 adopted individually is described. Section III.D.4 describes EPA's OMEGA model and its approach to estimating how manufacturers will add technology to their vehicles in order to comply with potential CO_2 emission standards. Section III.D.5 presents the results of the OMEGA modeling, namely the level of technology added to manufacturers' vehicles and the cost of adding that technology. Section III.D.6 discusses the appropriateness (or lack of appropriateness) of the alternative standards in relation to those proposed. Further technical detail on all of these issues can be found in the Draft Joint Technical Support Document as well as EPA's Regulatory Impact Analysis.

1. How did EPA develop a reference and control fleet for evaluating standards?

In order to calculate the impacts of this proposal, it is necessary to project the GHG emissions characteristics of the future vehicle fleet absent the proposed regulation. EPA and NHTSA develop this projection using a three step process. (1) Develop a set of detailed vehicle characteristics and sales for a specific model year (in this case, 2008).[328] This is called the baseline fleet. (2) Adjust the sales of this baseline fleet using projections made by the Energy Information Administration (EIA) and CSM to account for projected sales volumes in future MYs absent future regulation.[329] (3) Apply fuel saving and emission control technology to these vehicles to the extent necessary for manufacturers to comply with the existing 2016 standards and the proposed standards.

Thus, the analyzed 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. A similar method is used to analyze both reference and control cases, with the major distinction being the stringency of the standards.

EPA and NHTSA perform steps one and two above in an identical manner. The development of the characteristics of the baseline 2008 fleet and the sales adjustment to match AEO and CSM forecasts is described in Section II.B above and in greater detail in Chapter 1 of the joint TSD. 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 reference and proposed standards. Further, each agency evaluates its own proposed and MY 2016 standards; neither NHTSA nor EPA evaluated the other agency's standard in this proposal.[330]

The use of MY 2008 vehicles in our fleet projections 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. However, we believe that the use of MY 2008 vehicle designs is still the most appropriate approach available for this proposal.[331] First, as discussed in Section II.B above, the designs of these MYs 2017–2025 vehicles at the level of detail required for emission and cost modeling are not publically available, and in many cases, do not yet exist. Even manufacturers' 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 case 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 MY 2016 standards, we account for the vast majority of ways in which these new vehicles will differ from their older counterparts.

a. Reference Fleet Scenario Modeled

EPA projects that in the absence of the proposed GHG and CAFE standards, the reference case fleet in MY 2017–2025 would have fleetwide GHG emissions performance no better than that projected to be necessary to meet the MY 2016 standards. While it is not possible to know with certainty the future fleetwide GHG emissions performance in the absence of more stringent standards, EPA believes that this approach is the most reasonable projection for developing the reference case fleet for MYs 2017–2025. One important element supporting the proposed approach is that AEO2011 projects relatively stable gasoline prices over the next 15 years. The average actual price in the U.S. for the first nine months of 2011 for gasoline was \$3.57 per gallon (\$3.38 in 2009 dollars).[332] However, the AEO2011 reference case projects a price of \$2.80 per gallon (in 2009 dollars) AEO2011 projects prices to be \$3.25 in 2017, rising slightly to \$3.54 per gallon in 2025 (which is less than a 4 cent per year increase on average). Based on these fuel price projections, the reference fleet for MYs 2017–2025 should correspond to a time period where there is a stable, unchanging GHG standard, and essentially stable gasoline prices.

EPA reviewed the historical record for similar periods when we had stable fuel economy standards and stable gasoline

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[328] As discussed in TSD Chapter 1, and in Section II.B.2, the agencies will consider using Model Year 2010 for the final rule, based on availability and an analysis of the data representativeness.

[329] See generally Chapter 1 of the Joint TSD for details on development of the baseline fleet, and Section III.H.1 for a discussion of the potential sales impacts of this proposal.

[330] While the MY 2012–2016 standards are largely similar, some important differences remain. See 75 FR at 25342.

[331] See section II.B.2 concerning the selection of MY 2008 as the appropriate baseline.

[332] The Energy Information Administration estimated the average regular unleaded gasoline price in the U.S. for the first nine months of 2011 was \$3.57.

prices. EPA maintains, and publishes every year, the seminal reference on new light-duty vehicle CO_2 emissions and fuel economy.[333] This report contains very detailed data from MYs 1975–2010. There was an extended 18-year period from 1986 through 2003 during which CAFE standards were essentially unchanged,[334] and gasoline prices were relatively stable and remained below $1.50 per gallon for almost the entire period. The 1975–1985 and 2004–2010 timeframes are not relevant in this regard due to either rising gasoline prices, rising CAFE standards, or both. Thus, the 1986–2003 time frame is an excellent analogue to the period out to MY 2025 during which AEO projects relatively stable gasoline prices. EPA staff have analyzed the fuel economy trends data from the 1986–2003 timeframe (during which CAFE standards did not vary by footprint) and have drawn three conclusions: (1) there was a small, industry-wide, average over-compliance with CAFE on the order of 1–2 mpg or 3–4%, (2) almost all of this industry-wide over-compliance was from 3 companies (Toyota, Honda, and Nissan) that routinely over-complied with the universal CAFE standards simply because they produced smaller and lighter vehicles relative to the industry average, and (3) full line car and truck manufacturers, such as General Motors, Ford, and Chrysler, which produced larger and heavier vehicles relative to the industry average and which were constrained by the universal CAFE standards, rarely over-complied during the entire 18-year period.[335]

Since the MY 2012–2016 standards are footprint-based, every major manufacturer is expected to be constrained by the new standards in 2016 and manufacturers of small vehicles will not routinely over-comply as they had with the past universal standards.[336] Thus, the historical evidence and the footprint-based design of the 2016 GHG emissions and CAFE standards strongly support the use of a reference case fleet where there are no further fuel economy improvements beyond those required by the MY 2016 standards. There are additional factors that reinforce the historical evidence. While it is possible that one or two companies may over-comply, any voluntary over-compliance by one company would generate credits that could be sold to other companies to substitute for their more expensive compliance technologies; this ability to buy and sell credits could eliminate any over-compliance for the overall fleet.[337] NHTSA also evaluated EIA assumptions and inputs employed in the version of NEMS used to support AEO 2011 and found, based on this analysis, that when fuel economy standards were held constant after MY 2016, EIA appears to forecast market-driven levels of over- and under-compliance generally consistent with a CAFE model analysis using a flat, 2016-based reference case fleet. From a consumer market driven perspective, while there is considerable evidence that many consumers now care more about fuel economy than in past decades, the 2016 compliance level is projected to be several mpg higher than that being demanded in the market today.[338] On the other hand, some manufacturers have already announced plans to introduce technology well beyond that required by the 2016 MY GHG standards.[339] However, it is difficult, if not impossible, to separate future fuel economy improvements made for marketing purposes from those designed to efficiently plan for compliance with anticipated future CAFE or CO_2 emission standards, *i.e.,* some manufacturers may have made public statements about higher mpg levels in the future in part because of the expectation of higher future standards.

All estimates of actual GHG emissions and fuel economy performance in 2016 or other future years are projections, and it is plausible that actual GHG emissions and fuel economy performance in 2016 and later years, absent more stringent standards, could be worse than projected if there are shifts from car market share to truck market share, or to higher footprint levels. For example, average fuel economy performance levels decreased over the period from 1986–2003 even as car CAFE standards were stable and truck CAFE levels rose slightly.[340] On the other hand, it is also possible that future GHG emissions and fuel economy performance could be better than MY2016 levels if there are shifts from trucks to cars, or to lower footprint levels. While EPA has not performed a quantified sensitivity assessment for this proposal, EPA believes that a reasonable range for a sensitivity analysis would evaluate over or under compliance on the order of a few percent which EPA projects would have, at most, a small impact on projected program costs and benefits.

Based on this assessment, the EPA reference case fleet is estimated through the target curves defined in the MY 2016 rulemaking applied to the projected MYs 2017–2025 fleet.[341] As in the previous rulemaking, EPA assumes that manufacturers make use of 10.2 grams of air conditioning credits on cars and 11.5 on light trucks, or an average of approximately 11 grams on the U.S. fleet and the technology for doing so is included in the reference case (Section III.C).

b. Control Scenarios Modeled

For the control scenario, EPA modeled the proposed standard curves discussed in Section III.B, as well as the alternative scenarios discussed in III.D.6. Other flexibilities are accounted for in the analysis. The air conditioning credits modeled are discussed in III.D.2. Air conditioning credits (both leakage and efficiency) are included in the cost and technology analysis described below. The compliance value of 0 g/mi for PHEVs and EVs are also included. However, off-cycle credits, PH/EV multipliers through MY 2021, pickup truck credits, flexible fuel, and carry forward/back credits are not included explicitly in the cost analysis. These flexibilities will offer the manufacturers more compliance options. Moreover, the overall cost analysis includes small volume manufacturers in the fleet, which would have company specific standards assuming this part of the proposal is finalized (see section III.C). As we expect all of these flexibilities together to only have a small impact on the fleet compliance costs on average, we will re-evaluate including them in the final rule analysis.

c. Vehicle Groupings Used

In order to create future technology projections and enable compliance with the modeled standards, EPA aggregates vehicle sales by a combination of manufacturer, vehicle platform, and engine design for the OMEGA model. As

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[333] Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 through 2010, November 2010, available at *http://www.epa.gov/otaq/fetrends.htm*.

[334] There are no EPA LD GHG emissions regulations prior to MY 2012.

[335] See Regulatory Impact Analysis, Chapter 3.

[336] With the notable exception of manufacturers who only market electric vehicles or other limited product lines.

[337] Oates, Wallace E., Paul R. Portney, and Albert M. McGartland. ''The Net Benefits of Incentive-Based Regulation: A Case Study of Environmental Standard Setting.'' American Economic Review 79(5) (December 1989): 1233–1242.

[338] The average, fleetwide ''laboratory'' or ''unadjusted'' fuel economy value for MY 2010 is 28.3 mpg (see Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2010, November 2010, available at *http://www.epa.gov/otaq/fetrends.htm*), 6–7 mpg less than the 34–35 mpg levels necessary to meet the EPA GHG and NHTSA CAFE levels in MY 2016.

[339] For example, Hyundai has made a public commitment to achieve 50 mpg by 2025.

[340] See Regulatory Impact Analysis, Chapter 3.

[341] 75 FR at 25686.

discussed above, manufacturers implement major design changes at vehicle redesign and tend to implement these changes across a vehicle platform (such as large SUV, mid-size SUV, large automobile, etc) at a given manufacturing plant. 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–19.

Table III-19 Vehicle Groupings[a]

Vehicle Description	Vehicle Type	Vehicle Description	Vehicle Type
Large SUV (Car) V8+ OHV	13	Large Pickup V8+ DOHC	19
Large SUV (Car) V6 4v	16	Large Pickup V8+ SOHC 3v	14
Large SUV (Car) V6 OHV	12	Large Pickup V8+ OHV	13
Large SUV (Car) V6 2v SOHC	9	Large Pickup V8+ SOHC	10
Large SUV (Car) I4 and I5	7	Large Pickup V6 DOHC	18
Large SUV V8+ DOHC	17	Large Pickup V6 OHV	12
Large SUV V8+ SOHC 3v	14	Large Pickup V6 SOHC 2v	11
Large SUV V8+ OHV	13	Large Pickup I4 S/DOHC	7
Large SUV V8+ SOHC	10	Small Pickup V6 OHV	12
Large SUV V6 S/DOHC 4v	16	Small Pickup V6 2v SOHC	8
Large SUV V6 OHV	12	Small Pickup I4	7
Large SUV V6 SOHC 2v	9	Cargo Van V8+ OHV	13
Large SUV I4/	7	Cargo Van V8+ SOHC	10
Midsize SUV (Car) V6 2v SOHC	8	Cargo Van V6 OHV	12
Midsize SUV (Car) V6 S/DOHC 4v	5	Minivan V6 S/DOHC	16
Midsize SUV (Car) I4	7	Minivan V6 OHV	12
Midsize SUV V6 OHV	12	Minivan I4	7
Midsize SUV V6 2v SOHC	8		
Midsize SUV V6 S/DOHC 4v	5		
Midsize SUV I4 S/DOHC	7		
Small SUV (Car) V6 OHV	12		
Small SUV (Car) V6 S/DOHC	4		
Small SUV (Car) I4	3		
Small SUV V6 OHV	12		

Large Auto V8+ OHV	15	Compact Auto V7+ S/DOHC	6
Large Auto V8+ SOHC	10	Compact Auto V6 OHV	12
Large Auto V8+ DOHC, 4v SOHC	6	Compact Auto V6 S/DOHC 4v	4
Large Auto V6 OHV	12	Compact Auto I5	7
Large Auto V6 SOHC 2/3v	5	Compact Auto I4	2
Midsize Auto V8+ OHV	15	Subcompact Auto V8+ OHV	15
Midsize Auto V8+ SOHC	10	Subcompact Auto V8+ S/DOHC	6
Midsize Auto V7+ DOHC, 4v SOHC	6	Subcompact Auto V6 2v SOHC	8
Midsize Auto V6 OHV	12	Subcompact Auto I5/V6 S/DOHC 4v	4
Midsize Auto V6 2v SOHC	8	Subcompact Auto I4	1
Midsize Auto V6 S/DOHC 4v	5		
Midsize Auto I4	3		

[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.

2. What are the Effectiveness and Costs of CO_2-Reducing Technologies?

EPA and NHTSA worked together to develop information on the effectiveness and cost of most CO_2-reducing and fuel economy-improving technologies. This joint work is reflected in Chapter 3 of the draft Joint TSD and in Section II.D of this preamble. The work on technology cost and effectiveness also includes maximum penetration rates, or ''caps'' for the OMEGA model. These caps are an important input to OMEGA that capture the agencies' analysis concerning the rate at which technologies can be added to the fleet (see Chapter 3.5 of the draft joint TSD for more detail). This preamble section, rather than repeating those details, focuses upon EPA-only technology assumptions, specifically, those relating to air conditioning refrigerant.

EPA expects all manufacturers will choose to use AC improvement credit opportunities as a strategy for complying with the CO_2 standards, and has set the stringency of the proposed standards accordingly (see section II.F above). EPA estimates that the level of the credits earned will increase from 2017 (13 grams/mile) to 2021 (21 grams/mile) as more vehicles in the fleet convert to use of the new alternative refrigerant.[342] By 2021, we project that 100% of the MY 2021 fleet will be using alternative refrigerants, and that credits will remain constant on a car and truck basis until 2025. Note from the table below that costs then decrease from 2021 to 2025 due to manufacturer learning as discussed in Section II of this preamble and in Chapter 3 of the draft joint TSD. A more in-depth discussion of feasibility and availability of low GWP alternative refrigerants, can be found in Section III.C of the Preamble.

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[342] See table in III.B.

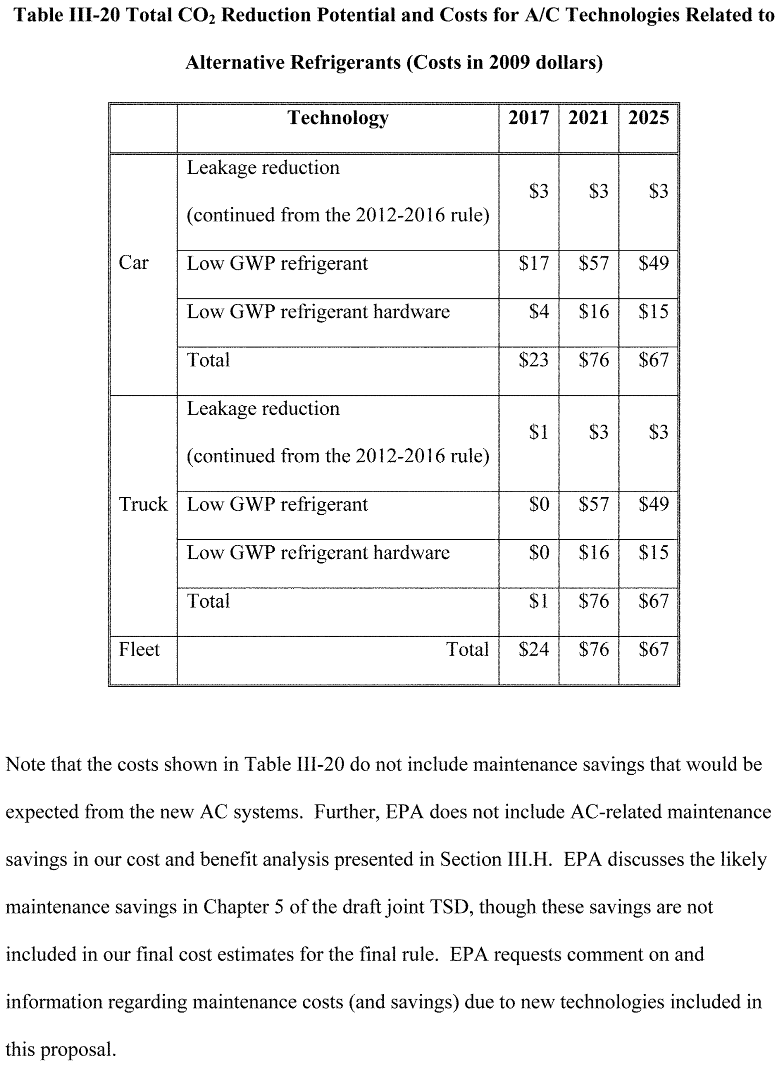

Table III-20 Total CO_2 Reduction Potential and Costs for A/C Technologies Related to Alternative Refrigerants (Costs in 2009 dollars)

	Technology	2017	2021	2025
Car	Leakage reduction (continued from the 2012-2016 rule)	$3	$3	$3
	Low GWP refrigerant	$17	$57	$49
	Low GWP refrigerant hardware	$4	$16	$15
	Total	$23	$76	$67
Truck	Leakage reduction (continued from the 2012-2016 rule)	$1	$3	$3
	Low GWP refrigerant	$0	$57	$49
	Low GWP refrigerant hardware	$0	$16	$15
	Total	$1	$76	$67
Fleet	Total	$24	$76	$67

Note that the costs shown in Table III-20 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 5 of the draft joint TSD, though these savings are not included in our final cost estimates for the final rule. EPA requests comment on and information regarding maintenance costs (and savings) due to new technologies included in this proposal.

Additionally, by MY 2019, EPA estimates that 100% of the A/C efficiency improvements will by fully phased-in. However 85% of these costs are already in the reference fleet, as this is the level of penetration assumed in the 2012–2016 final rule. The penetration of A/C costs for this proposal can be found in Chapter 5 of the draft joint TSD.

3. How were technologies 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 discussed extensively in the MYs 2012–2016 Rule, 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 this manner, and consistent with the concept of a redesign cycle, manufacturers can optimize their available resources, including engineering, development, manufacturing and marketing activities to create a product with multiple new features. Therefore, the approach taken here is to group technologies into packages of increasing cost and effectiveness.

EPA built unique technology packages for each of 19 ''vehicle types,'' which, as in the MYs 2012–2016 rule and the Interim Joint TAR, provides sufficient resolution to represent the technology of 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) then by valvetrain configuration (DOHC, SOHC, OHV), and finally by the number of valves per cylinder. For purposes of calculating some technology costs and effectiveness values, each of these 19 vehicle types is mapped into one of seven classes of vehicles: Subcompact, Small car, Large car, Minivan, Minivan with towing, Small truck, and Large truck.[343] We believe that these seven vehicle classes, along with engine cylinder count, provide adequate representation for the cost basis associated with most technology application. Note also that these 19 vehicle types span the range of vehicle footprints—smaller footprints for smaller vehicles and larger footprints for larger vehicles—which served as the basis for the 2012–2016 GHG standards and the standards in this proposal. A detailed table showing the 19 vehicle types, their baseline engines and their

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[343] Note that, for the current assessment and representing an update since the 2010 TAR, EPA has created a new vehicle class called ''minivan with towing'' which allows for greater differentiation of costs for this popular class of vehicles (such as the Ford Edge, Honda Odyssey, Jeep Grand Cherokee).

descriptions is contained in Table III–19 and in Chapter 1 of EPA's draft RIA.

Within each of the 19 vehicle types, multiple technology packages were created in increasing technology content resulting in increasing effectiveness. As stated earlier, with few exceptions, each package is meant to provide equivalent driver-perceived performance to the baseline package. Note that we refer throughout this discussion of package building to a ''baseline'' vehicle or a ''baseline'' package. This should not be confused with the baseline fleet, which is the fleet of roughly 16 million 2008MY individual vehicles comprised of over 1,100 vehicle models. In this discussion, when we refer to ''baseline'' vehicle we refer to the ''baseline'' configuration of the given vehicle type. So, we have 19 baseline vehicles in the context of building packages. Each of those 19 baseline vehicles is equipped with a port fuel injected engine and a 4 speed automatic transmission. The valvetrain configuration and the number of cylinders changes for each vehicle type in an effort to encompass the diversity in the 2008 baseline fleet as discussed above. In short, while the baseline vehicle that defines the vehicle type is relevant when discussing the package building process, the baseline and reference case fleets of real vehicles are not relevant to the discussion here. We describe this in more detail in Chapter 1 of EPA's draft RIA.

To develop a set of packages as OMEGA inputs, EPA builds packages consisting of every legitimate permutation of technology available, subject to constraints.[344] This ''preliminary-set'' of packages consists of roughly 2,000 possible packages of technologies for each of 19 vehicle types, or nearly 40,000 packages in all. The cost of each package is determined by adding the cost of each individual technology contained in the package for the given year of interest. The effectiveness of each package is determined in a more deliberate manner; one cannot simply add the effectiveness of individual technologies to arrive at a package-level effectiveness because of the synergistic effects of technologies when grouped with other technologies that seek to improve the same or similar efficiency loss mechanism. As an example, the benefits of the engine and transmission technologies can usually be combined multiplicatively,[345] but in some cases, the benefit of the transmission-related technologies overlaps with the engine technologies. This occurs because the transmission technologies shift operation of the engine to more efficient locations on the engine map 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 uses an engineering approach known as the lumped-parameter technique. The results from this approach were then applied directly to the vehicle packages. The lumped-parameter technique is well documented in the literature, and the specific approach developed by EPA is detailed in Chapter 3 (Section 3.3.2) of the draft joint TSD as well as Chapter 1 of EPA's draft RIA.

Table III–21 presents technology costs for a subset of the more prominent technologies in our analysis (note that all technology costs are presented in Chapter 3 of the draft Joint TSD and in Chapter 1.2 of EPA's draft RIA). Table III–21 includes technology costs for a V6 dual overhead cam midsize or large car and a V8 overhead valve large pickup truck. This table is meant to illustrate how technology costs are similar and/or different for these two large selling vehicle classes and how the technology costs change over time due to learning and indirect cost changes as described in section II.D of this preamble and at length in Chapter 3.2 of the draft Joint TSD. Note that these costs are not package costs but, rather, individual technology costs. We present package costs for the V6 midsize or large car in Table III–22, below.

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[344] Example constraints include the requirement for stoichiometric gasoline direct injection on every turbocharged and downsized engine and/or any 27 bar BMEP turbocharged and downsized engine must also include cooled EGR. Some constraints are the result of engineering judgment while others are the result of effectiveness value estimates which are tied to specific combinations of technologies.

[345] 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%)).

Table III-21 Total Costs of Select Technologies for V6 Midsize or Large Car and V8 Large Pickup Truck (2009 dollars)

Vehicle Class & Base Engine	Technology	2017 MY	2021 MY	2025 MY
Midsize/Large car V6 DOHC 4 valves/cylinder Port fuel injected 4 speed auto trans	Dual cam phasing on V6	$201	$175	$165
	Dual cam phasing on I4 (used when downsized)	$94	$81	$77
	Stoichiometric gasoline direct injection on V6	$413	$359	$338
	Stoichiometric gasoline direct injection on I4 (used when downsized)	$274	$238	$224
	18-bar BMEP with downsize from V6 DOHC to I4 DOHC	$248	$163	$170
	24-bar BMEP with downsize from V6 DOHC to I4 DOHC	$509	$448	$382
	Cooled EGR on I-configuration (used when downsized)	$303	$285	$247
	Advanced diesel	$3,595	$3,120	$2,936
	8 speed dual clutch transmission (wet)	$47	$44	$38
	High efficiency gearbox	$248	$225	$200
	Aerodynamic treatments (active, Aero2)	$210	$195	$173
	Stop-start (12 Volt)	$446	$376	$343
	P2 hybrid electric technology[a]	$4,196	$3,521	$3,121
	Plug-in hybrid technology with 20 mile range[a]	$15,448	$11,719	$9,657
	Electric vehicle technology with 75 mile range[a]	$20,727	$15,458	$11,430
Large pickup truck V8 OHV 2 valves/cylinder Port fuel injected	Dual cam phasing on V6 (used when downsized)	$201	$175	$165
	Stoichiometric gasoline direct injection on V8	$497	$431	$406
	Stoichiometric gasoline direct injection on V6 (used when downsized)	$413	$359	$338

4 speed auto trans	18-bar BMEP with downsize from V8 OHV to V6 DOHC	$1,323	$1,138	$1,067
	24-bar BMEP with downsize from V8 OHV to V6 DOHC	$1,762	$1,618	$1,426
	Cooled EGR on V-configuration	$303	$285	$247
	Advanced diesel	$4,114	$3,570	$3,359
	8 speed automatic transmission	$61	$53	$50
	High efficiency gearbox	$248	$225	$200
	Aerodynamic treatments (active, Aero2)	$210	$195	$173
	Stop-start (12 Volt)	$490	$413	$376
	P2 hybrid electric technology[a]	$4,417	$3,717	$3,282

[a] Assumes application of weight reduction technology resulting in 10% weight reduction before adding back the weight of batteries and motors resulting in a net weight reduction less than 10% (see Chapter 3.4.3.8 of the draft Joint TSD for more details).

Table III–22 presents the cost and effectiveness values from a 2025MY master-set of packages used in the OMEGA model for EPA's vehicle type 5, a midsize or large car class equipped with a V6 engine. 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 1 of EPA's draft RIA.

As detailed in Chapter 1 of EPA's draft RIA, this preliminary-set of packages is then ranked according to technology application ranking factors (TARFs) to eliminate packages that are not as cost-effective as others.[346] The result of this TARF ranking process is a ''ranked-set'' of roughly 500 packages for use as OMEGA inputs, or roughly 25 per vehicle type. EPA prepares a ranked set of packages for any MY in which OMEGA is run,[347] the initial packages represent what we believe a manufacturer will most likely implement on all vehicles, including lower rolling resistance tires, low friction lubricants, engine friction reduction, aggressive shift logic, early torque converter lock-up, improved electrical accessories, and low drag brakes (to the extent not reflected in the baseline vehicle).[348] Subsequent packages include gasoline direct injection, turbocharging and downsizing, and more advanced transmission technologies such as six and eight speed dual-clutch transmissions and 6 and 8 speed automatic transmissions. The most technologically advanced packages within a vehicle type include the hybrids, plug-in hybrids and electric vehicles. Note that plug-in hybrid and electric vehicle packages are only modeled for the non-towing vehicle types, in order to better maintain utility. We request comment on this decision and whether or not we should perhaps consider plug-in hybrids for towing vehicle types.

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[346] The Technology Application Ranking Factor (TARF) is discussed further in III.D.5.

[347] Note that a ranked-set of package is generated for any year for which OMEGA is run due to the changes in costs and maximum penetration rates. EPA's draft RIA chapter 3 contains more details on the OMEGA modeling and draft Joint TSD Chapter 3 has more detail on both costs changes over time and the maximum penetration limits of certain technologies.

[348] When making reference to low friction lubricants, the technology being referred to is the engine changes and possible durability testing that would be done to accommodate the low friction lubricants, not the lubricants themselves.

Table III-22 CO$_2$ Reducing Technology Vehicle Packages for a V6 Midsize or Large Car Effectiveness and Costs in the 2025MY (Costs in 2009 dollars)

Pkg#	Engine & Vehicle technologies	Trans	Electrical	Mass Rdxn	Cost	Effectiveness
500	3.3L 4V DOHC V6	4sp AT	12V	base	$0	0.0%
501	4V DOHC V6 +EFR2 +LDB +ASL2 +IACC +EPS +Aero1 +LRRT1 +HEG	6sp DCT-wet	12V	5%	$646	27.3%
502	4V DOHC V6 +EFR2 +LDB +ASL2 +IACC +EPS +Aero1 +LRRT1 +HEG	8sp DCT-wet	12V	5%	$760	30.2%
503	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC +EPS +Aero1 +LRRT1 +HEG +DCP +GDI +TDS18	6sp DCT-wet	12V	5%	$1,058	37.4%
504	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC +EPS +Aero1 +LRRT1 +HEG +DCP +GDI +TDS18	8sp DCT-wet	12V	5%	$1,172	39.4%
505	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS18	8sp DCT-wet	12V	5%	$1,386	42.6%
506	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS18	8sp DCT-wet	12V	10%	$1,507	44.2%
509	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS18	8sp DCT-wet	12V	15%	$1,741	45.8%
507	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS24	8sp DCT-wet	12V	10%	$1,719	46.1%
511	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS18	8sp DCT-wet	12V	20%	$2,048	47.4%
513	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +SAX +TDS18	8sp DCT-wet	12V	20%	$2,128	47.7%
508	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS24 +EGR	8sp DCT-wet	12V	10%	$1,966	48.0%
515	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +SAX +TDS18	8sp DCT-wet	12V	20%	$2,259	48.2%
516	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +SS +SAX +TDS18	8sp DCT-wet	12V S-S	20%	$2,602	48.7%

519	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +DSL-Adv +SAX	8sp DCT-wet	12V	20%	$4,673	49.4%
510	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS24 +EGR	8sp DCT-wet	12V	15%	$2,200	49.5%
512	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS24 +EGR	8sp DCT-wet	12V	20%	$2,507	51.0%
514	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +SAX +TDS24 +EGR	8sp DCT-wet	12V	20%	$2,588	51.3%
517	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +SS +SAX +TDS24 +EGR	8sp DCT-wet	12V S-S	20%	$2,931	51.8%
518	4V DOHC I4 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +SS +SAX +TDS27 +EGR	8sp DCT-wet	12V S-S	20%	$3,356	52.2%
520	4V DOHC V6 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +ATKCS +HEV	8sp DCT-wet	HEV	20%	$5,353	59.3%
521	4V DOHC V6 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +ATKCS +HEV +SAX	8sp DCT-wet	HEV	20%	$5,433	59.6%
522	4V DOHC V6 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +ATKCS +REEV20	8sp DCT-wet	EV	20%	$12,485	75.2%
523	4V DOHC V6 +EFR2 +LDB +ASL2 +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +ATKCS +REEV40	8sp DCT-wet	EV	20%	$15,670	84.7%
524	EV75 mile +IACC2 +Aero2 +LRRT2 +EPS	N/A	EV	20%	$12,908	100%
525	EV100 mile +IACC2 +Aero2 +LRRT2 +EPS	N/A	EV	20%	$14,643	100%
526	EV150 mile +IACC2 +Aero2 +LRRT2 +EPS	N/A	EV	20%	$20,280	100%

Aero=aerodynamic treatments;ASL=aggressive shift logic; AT=auto trans; ATKCS=Atkinson-cycle; DCP=dual cam phasing; DCT=dual clutch trans; DSL-Adv=advanced diesel; DOHC=dual overhead cam; EFR=engine friction reduction; EGR=exhaust gas recirculation; EPS=electric power steering; EV=electric vehicle; GDI=stoich gasoline direct injection; HEG=high efficiency gearbox; HEV=hybrid EV; IACC=improved accessories; LDB=low drag brakes; LRRT=lower rolling resistance tires; REEV=range extended EV or plug-in HEV; SAX=secondary axle disconnect; S-S=stop-start; TDS18/24/27=turbocharged & downsized 18 bar BMEP/24 bar BMEP/27 bar BMEP.

"1" and "2" suffixes to certain technologies indicate the first level versus the second level of the technology as described in Chapter 3 of the draft joint TSD.

4. How does EPA project how a manufacturer would decide between options to improve CO_2 performance to meet a fleet average standard?

As discussed, 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 a desired CO_2 reduction. As noted earlier, EPA used the same model used in the MYs 2012–2016 Rule, 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 previously in the model documentation,[349] makes the model publically available on its Web site,[350] and has recently peer reviewed the model.[351]

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, see Section III.D.3 above.) In addition, the degree to which each baseline 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. This information was described above as well as in Chapter 3 of the draft Joint TSD and Chapter 1 of EPA's draft RIA. 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. The third type of input data describes vehicle operational data, such as annual vehicle scrappage rates and mileage accumulation rates, and economic data, such as fuel prices and discount rates. These estimates are described in Section II.E 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 MY 2016 standards, proposed MY 2021 and proposed MY 2025 standards. 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 an example, on an industry wide basis, EPA projects that manufacturers will generate 11 g/mi of A/C credit in 2016. Thus, the 2016 CO_2 target in OMEGA was approximately eleven grams less stringent for each manufacturer than predicted by the curves. Similar adjustments were made for the control cases (*i.e.*, the A/C credits allowed by the rule are accounted for in the standards), but for a larger amount of A/C credit (approximately 25 grams).

As mentioned above for the market data input file utilized by OMEGA, which characterizes the vehicle fleet, our modeling accounts 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 because 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.

Thus, EPA developed a method to account for the presence of the combinations of applied technologies in terms of their proportion of the technology packages. This analysis can be broken down into four steps

The first step in the updated process is to break down the available GHG control technologies into five groups: (1) Engine-related, (2) transmission-related, (3) hybridization, (4) weight reduction and (5) other. Within each group, each individual technology was given a ranking which generally followed the degree of complexity, cost and effectiveness of the technologies within each group. More specifically, the ranking is based on the premise that a technology on a 2008 baseline vehicle with a lower ranking would be replaced by one with a higher ranking which was contained in one of the technology packages which we included in our OMEGA modeling. The corollary of this premise is that a technology on a 2008 baseline vehicle with a higher ranking would be not be replaced by one with an equal or lower ranking which was contained in one of the technology packages which we chose to include in our OMEGA modeling. This ranking scheme can be seen in an OMEGA pre-processor (the TEB/CEB calculation macro), available in the docket.

In the second step of the process, these rankings were used to estimate the complete list of technologies which would be present on each baseline vehicle after the application of a technology package. In other words, this step indicates the specific technology on each baseline vehicle after a package has been applied to it. EPA then used the lumped parameter model to estimate the total percentage CO_2 emission reduction associated with the technology present on the baseline vehicle (termed package 0), as well as the total percentage reduction after application of each package. A similar approach was used to determine the total cost of all of the technology present on the baseline vehicle and after the application of each applicable technology package.

The third step in this process is to account for the degree of each technology package's incremental effectiveness and incremental cost is affected by the technology already present on the baseline vehicle. In this step, we calculate the degree to which a technology package's effectiveness is already present on the baseline vehicle, and produce a value for each package termed the technology effectiveness basis, or TEB. The degree to which a technology package's incremental cost is reduced by technology already present on the baseline vehicle is termed the cost effectiveness basis, or CEB, in the OMEGA model. The equations for calculating these values can be seen in RIA chapter 3.

As described in Section III.D.3 above, technology packages are applied to groups of vehicles which generally represent a single vehicle platform and which are equipped with a single engine size (*e.g.,* compact cars with four cylinder engine produced by Ford). These groupings are described in Table

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[349] Previous OMEGA documentation for versions used in MYs 2012–2016 Final Rule (EPA–420–B–09–035), Interim Joint TAR (EPA–420–B–10–042).

[350] *http://www.epa.gov/oms/climate/models.htm.*

[351] EPA–420–R–09–016, September 2009.

III–19. Thus, the fourth step is to combine the fractions of the CEB and TEB of each technology package already present on the individual MY 2008 vehicle 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 modeled 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 proposal 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 (*i.e.*, the respective car and truck curves) in the inputs, and creates a combined car-truck standard. This combined standard considers the difference in lifetime VMT of cars and trucks, as indicated in the proposed regulations which govern credit trading between these two vehicle classes (which reflect the final 2012–2016 rules on this point).[352]

As noted above, EPA estimated separately the cost of the improved A/C systems required to generate the credit. In the reference case fleet that complies with the MY 2016 standards, 85% of vehicles are modeled with improved A/C efficiency and leakage prevention technology.

The model then works with one manufacturer at a time to add technologies until that manufacturer meets its applicable proposed 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).[353] 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.

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:

$$CostEffManuf_t = \frac{\Delta TechCost - \Delta FS}{\Delta CO_2 x\ VMT_{regulatory}}$$

Where:

CostEffManuf$_t$ = Manufacturer-Based Cost Effectiveness (in dollars per kilogram CO_2),
TechCost = Marked up cost of the technology (dollars),
FS = Difference in fuel consumption due to the addition of technology times fuel price and discounted over the 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
dCO_2 = Difference in CO_2 emissions (g/mile) due to the addition of technology
$VMT_{regulatory}$ = the statutorily defined VMT

EPA describes the technology ranking methodology and manufacturer-based cost effectiveness metric in greater detail in the OMEGA documentation.[354]

When calculating the fuel savings in the TARF equation, 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 proposed 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.[355]

The values of manufacturer-based net cost-effectiveness for specific

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[352] The analysis for the control cases in this proposal was run with slightly different lifetime VMT estimates than those proposed in the regulation. The impact on the cost estimates is small and varies by manufacturer.

[353] While our costs and benefits are discounted at 3% or 7%, the decision algorithm (TARF) used in OMEGA was run at a discount rate of 3%. Given that manufacturers must comply with the standard regardless of the discount rate used in the TARF, this has little impact on the technology projections shown here.

[354] OMEGA model documentation. EPA–420–B–10–042.

[355] 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. 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 proposal, this factor was not included in our determination of manufacturer-based net cost-effectiveness in the analyses.

technologies will vary from vehicle to vehicle, often substantially. This occurs for three reasons. First, both the cost and fuel-saving component cost, ownership fuel-savings, and lifetime CO_2 effectiveness of a specific technology all vary by the type of vehicle or engine to which it is being applied (*e.g.,* small car versus large truck, or 4-cylinder versus 8-cylinder engine). Second, the effectiveness of a specific technology often depends on the presence of other technologies already being used on the vehicle (*i.e.,* the dis-synergies). Third, the absolute fuel savings and CO_2 reduction of a percentage an incremental reduction in fuel consumption depends on the CO_2 level of the vehicle prior to adding the technology. Chapter 1 of EPA's draft RIA contains further detail on the values of manufacturer-based net cost-effectiveness for the various technology packages.

5. Projected Compliance Costs and Technology Penetrations

The following tables present the projected incremental costs and technology penetrations for the proposed program. Overall projected cost increases are $734 in MY 2021 and $1946 in MY 2025. Relative to the reference fleet complying with of MY 2016 standards, we see significant increases in advanced transmission technologies such as the high efficiency gear box and 8 speed transmissions, as well as more moderate increase in turbo downsized, cooled EGR 24 bar BMEP engines. In the control case, 15 percent of the MY 2025 fleet is projected to be a strong P2 hybrid as compared to 5% in the 2016 reference case. Similarly, 3 percent of the MY 2025 fleet are projected to be electric vehicles while less than 1 percent are projected to be electric vehicles in the reference case. EPA notes that we have projected one potential compliance path for each company and the industry as a whole—this does not mean other potential technology penetrations are not possible, in fact, it is likely that each firm will of course plot their own future course on how to comply. For example, while we show relatively low levels of EV and PHEV technologies may be used to meet the proposed standards, several firms have announced plans to aggressively pursue EV and PHEV technologies and thus the actual penetration of those technologies may turn out to be much higher than the prediction we present here.

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Table III-23 Total Costs per Vehicle by Company, Incremental to the 2016 Standards (2009$)

Company	2021			2025		
	Cars	Trucks	Fleet	Cars	Trucks	Fleet
BMW	$945	$915	$937	$2,251	$1,959	$2,174
Chrysler/Fiat	$569	$853	$698	$1,914	$2,212	$2,043
Daimler	$1,949	$956	$1,702	$2,931	$1,952	$2,707
Ferrari[356]	$6,351	$0	$6,351	$7,109	$0	$7,109
Ford	$655	$776	$696	$2,051	$2,463	$2,178
Geely-Volvo	$2,035	$1,086	$1,741	$3,228	$2,040	$2,876
GM	$502	$680	$590	$2,209	$1,834	$2,030
Honda	$467	$756	$556	$1,452	$1,937	$1,595
Hyundai	$614	$884	$669	$1,677	$1,988	$1,739
Kia	$483	$927	$582	$1,442	$1,675	$1,491
Mazda	$924	$897	$919	$2,196	$1,806	$2,131
Mitsubishi	$813	$998	$877	$2,114	$2,171	$2,133
Nissan	$759	$662	$729	$1,997	$2,212	$2,060
Porsche	$5,455	$1,328	$4,482	$5,827	$2,054	$5,012
Spyker-Saab	$3,335	$898	$2,986	$4,001	$1,468	$3,670
Subaru	$1,017	$922	$994	$2,236	$2,087	$2,202
Suzuki	$1,160	$1,000	$1,132	$2,307	$1,832	$2,225
Tata-JLR	$2,220	$1,648	$1,935	$3,255	$2,653	$2,976
Toyota	$332	$713	$481	$1,399	$1,631	$1,483
VW	$1,624	$797	$1,457	$2,618	$2,048	$2,506
Fleet	$718	$764	$734	$1,942	$1,954	$1,946

Costs for Aston Martin, Lotus and Tesla are not included here but can be found in EPA's draft RIA.

Costs include stranded capital and A/C-related costs.

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[356] Note that Ferrari is shown as a separate entity in the table above but could be combined with other Fiat-owned companies for purposes of GHG compliance at the manufacturer's discretion. Also, in Section III.B., EPA is requesting comment on the concept of allowing companies that are able to demonstrate "operational independence" to be eligible for SVM alternative standards. However, the costs shown above are based on Ferrari meeting the primary program standards.

Table III-24 Technology Penetrations for the 2021 MY Reference Case – Combined Fleet

	Mass	TDS18	TDS24	TDS27	AT6	AT8	DCT6	DCT8	MT	HEG	EGR	HEV	EV	PHEV	SS	LRRT2	IACC2	EFR2	GDI	DSL
BMW	-8%	51%	15%	0%	28%	8%	36%	19%	9%	0%	15%	15%	0%	0%	57%	0%	30%	0%	77%	13%
Chrysler/ Fiat	-7%	45%	11%	0%	27%	12%	31%	17%	3%	0%	4%	0%	0%	0%	0%	0%	18%	0%	56%	0%
Daimler	-8%	48%	14%	0%	16%	19%	39%	21%	5%	0%	14%	15%	0%	0%	57%	0%	30%	0%	69%	16%
Ferrari	-8%	42%	15%	0%	14%	0%	52%	28%	5%	0%	15%	15%	0%	0%	57%	0%	30%	0%	72%	13%
Ford	-7%	52%	12%	0%	30%	12%	29%	16%	6%	0%	10%	2%	0%	0%	0%	0%	21%	0%	63%	0%
Geely-Volvo	-8%	54%	15%	0%	37%	12%	32%	17%	2%	0%	15%	15%	0%	0%	57%	0%	30%	0%	72%	13%
GM	-7%	37%	8%	0%	38%	18%	20%	11%	3%	0%	6%	0%	0%	0%	0%	0%	21%	0%	46%	0%
Honda	-3%	6%	0%	0%	24%	6%	41%	19%	8%	0%	0%	2%	0%	0%	0%	0%	8%	0%	6%	0%
Hyundai	-3%	28%	0%	0%	24%	11%	32%	17%	6%	0%	0%	0%	0%	0%	0%	0%	4%	0%	28%	0%
Kia	-3%	9%	0%	0%	22%	9%	35%	19%	7%	0%	0%	0%	0%	0%	0%	0%	8%	0%	9%	0%
Mazda	-5%	26%	11%	0%	22%	7%	34%	19%	14%	0%	4%	0%	0%	0%	0%	0%	24%	0%	37%	0%
Mitsubishi	-7%	68%	15%	0%	17%	7%	39%	22%	6%	0%	15%	2%	0%	0%	0%	0%	27%	0%	85%	0%
Nissan	-5%	33%	8%	0%	20%	8%	39%	21%	4%	0%	3%	1%	0%	0%	0%	0%	21%	0%	41%	0%
Porsche	-5%	48%	15%	0%	20%	7%	19%	10%	43%	0%	15%	15%	0%	0%	57%	0%	30%	0%	78%	13%
Spyker-Saab	-8%	57%	15%	0%	19%	4%	41%	23%	11%	0%	15%	15%	0%	0%	57%	0%	30%	0%	72%	13%
Subaru	-7%	46%	5%	0%	6%	2%	39%	22%	22%	0%	3%	0%	0%	0%	0%	0%	17%	0%	50%	0%
Suzuki	-1%	67%	15%	0%	11%	4%	42%	23%	9%	0%	15%	3%	0%	0%	0%	0%	26%	0%	85%	0%
Tata-JLR	-8%	48%	15%	0%	33%	10%	37%	20%	0%	0%	15%	15%	0%	0%	57%	0%	30%	0%	72%	13%
Toyota	-2%	5%	0%	0%	26%	10%	28%	15%	5%	0%	0%	12%	0%	0%	0%	0%	12%	0%	12%	0%
VW	-7%	50%	15%	0%	22%	6%	40%	21%	11%	0%	15%	15%	0%	0%	57%	0%	30%	0%	86%	13%

Fleet	-5%	30%	7%	0%	27%	11%	31%	16%	6%	0%	5%	5%	0%	0%	7%	0%	18%	0%	40%	2%

Mass=true mass reduction; TDS18/24/27=turbocharged & downsized at 18/24/27 bar BMEP; AT=automatic transmission; DCT=dual clutch transmission; MT=manual transmission; HEG=high efficiency gearbox; EGR=cooled exhaust gas recirculation; HEV=hybrid electric vehicle; EV=full electric vehicle; PHEV=plug-in HEV; SS=12V stop-start; LRRT2=lower rolling resistance tires level 2; IACC2=Improved accessories level 2; EFR2=engine friction reduction level 2; GDI=stoichiometric gasoline direct injection; DSL=advanced diesel

Note that technology penetrations for Aston Martin, Lotus and Tesla are not included here but can be found in EPA's draft RIA.

Negative values for Mass Reduction represent percentage of mass removed.

Table III-25 Technology Penetrations for the 2025 MY Reference Case – Combined Fleet

	Mass	TDS18	TDS24	TDS27	AT6	AT8	DCT6	DCT8	MT	HEG	EGR	HEV	EV	PHEV	SS	LRRT2	IACC2	EFR2	GDI	DSL
BMW	-8%	51%	15%	0%	28%	8%	36%	19%	9%	0%	15%	15%	0%	0%	57%	0%	30%	0%	77%	13%
Chrysler/ Fiat	-7%	38%	11%	0%	26%	12%	33%	18%	3%	0%	4%	0%	0%	0%	0%	0%	20%	0%	49%	0%
Daimler	-8%	48%	14%	0%	15%	18%	40%	22%	5%	0%	14%	15%	0%	0%	57%	0%	30%	0%	70%	16%
Ferrari	-8%	42%	15%	0%	14%	0%	52%	28%	5%	0%	15%	15%	0%	0%	57%	0%	30%	0%	72%	13%
Ford	-7%	53%	12%	0%	29%	12%	29%	16%	6%	0%	10%	2%	0%	0%	0%	0%	21%	0%	64%	0%
Geely- Volvo	-8%	53%	15%	0%	36%	12%	33%	18%	2%	0%	15%	15%	0%	0%	57%	0%	30%	0%	72%	13%
GM	-7%	40%	9%	0%	37%	18%	21%	11%	3%	0%	6%	0%	0%	0%	0%	0%	21%	0%	49%	0%
Honda	-3%	4%	0%	0%	23%	5%	42%	19%	8%	0%	0%	2%	0%	0%	0%	0%	8%	0%	4%	0%
Hyundai	-3%	27%	0%	0%	24%	11%	32%	18%	6%	0%	0%	0%	0%	0%	0%	0%	4%	0%	27%	0%
Kia	-3%	6%	0%	0%	21%	8%	36%	20%	7%	0%	0%	0%	0%	0%	0%	0%	9%	0%	6%	0%
Mazda	-5%	25%	11%	0%	22%	7%	34%	19%	15%	0%	4%	0%	0%	0%	0%	0%	25%	0%	36%	0%
Mitsubis hi	-7%	68%	15%	0%	16%	6%	40%	22%	6%	0%	15%	2%	0%	0%	0%	0%	27%	0%	85%	0%

Nissan	-5%	33%	7%	0%	20%	8%	39%	21%	4%	0%	3%	1%	0%	0%	0%	0%	21%	0%	40%	0%
Porsche	-5%	48%	15%	0%	19%	6%	20%	11%	44%	0%	15%	15%	0%	0%	57%	0%	30%	0%	78%	13%
Spyker-Saab	-8%	57%	15%	0%	18%	4%	42%	23%	11%	0%	15%	15%	0%	0%	57%	0%	30%	0%	72%	13%
Subaru	-7%	52%	5%	0%	6%	2%	39%	21%	23%	0%	3%	0%	0%	0%	0%	0%	15%	0%	55%	0%
Suzuki	-1%	67%	15%	0%	11%	4%	42%	23%	9%	0%	15%	3%	0%	0%	0%	0%	26%	0%	85%	0%
Tata-JLR	-8%	48%	15%	0%	32%	9%	38%	21%	0%	0%	15%	15%	0%	0%	57%	0%	30%	0%	72%	13%
Toyota	-2%	3%	0%	0%	25%	9%	36%	9%	5%	0%	0%	12%	0%	0%	0%	0%	12%	0%	11%	0%
VW	-7%	50%	15%	0%	21%	6%	40%	21%	11%	0%	15%	15%	0%	0%	57%	0%	30%	0%	86%	13%
Fleet	-5%	30%	6%	0%	26%	11%	33%	15%	6%	0%	5%	5%	0%	0%	7%	0%	18%	0%	39%	2%

Mass=true mass reduction; TDS18/24/27=turbocharged & downsized at 18/24/27 bar BMEP; AT=automatic transmission; DCT=dual clutch transmission; MT=manual transmission; HEG=high efficiency gearbox; EGR=cooled exhaust gas recirculation; HEV=hybrid electric vehicle; EV=full electric vehicle; PHEV=plug-in HEV; SS=12V stop-start; LRRT2=lower rolling resistance tires level 2; IACC2 = improved accessories level 2; EFR2=engine friction reduction level 2; GDI=stoichiometric gasoline direct injection; DSL=advanced diesel

Note that technology penetrations for Aston Martin, Lotus and Tesla are not included here but can be found in EPA's draft RIA.

Negative values for Mass Reduction represent percentage of mass removed.

Table III-26 Technology Penetrations for the 2021 MY Control Case – Combined Fleet

	Mass	TDS18	TDS24	TDS27	AT6	AT8	DCT6	DCT8	MT	HEG	EGR	HEV	EV	PHEV	SS	LRRT2	IACC2	EFR2	GDI	DSL
BMW	-9%	49%	25%	2%	5%	21%	13%	52%	8%	59%	28%	30%	1%	0%	0%	75%	80%	59%	99%	0%
Chrysler/ Fiat	-7%	64%	15%	2%	8%	32%	11%	45%	3%	60%	14%	0%	0%	0%	0%	75%	80%	60%	81%	0%
Daimler	-10%	48%	20%	4%	5%	20%	13%	52%	4%	57%	24%	30%	6%	0%	0%	75%	80%	57%	91%	3%
Ferrari	-7%	0%	0%	15%	0%	0%	16%	65%	2%	50%	15%	30%	16%	15%	15%	75%	80%	50%	60%	24%
Ford	-8%	75%	16%	3%	8%	32%	10%	42%	6%	59%	18%	2%	0%	0%	0%	74%	79%	59%	94%	0%
Geely- Volvo	-10%	52%	18%	6%	8%	32%	10%	42%	1%	57%	24%	30%	6%	0%	11%	75%	80%	57%	94%	0%
GM	-8%	41%	14%	3%	12%	49%	7%	29%	3%	60%	14%	0%	0%	0%	0%	75%	80%	60%	58%	0%
Honda	-5%	33%	0%	0%	4%	15%	14%	56%	8%	59%	0%	2%	0%	0%	0%	73%	78%	59%	33%	0%
Hyundai	-6%	45%	6%	0%	7%	29%	12%	46%	6%	60%	6%	0%	0%	0%	0%	75%	80%	60%	51%	0%
Kia	-4%	37%	0%	0%	6%	23%	13%	51%	7%	60%	0%	0%	0%	0%	0%	41%	44%	60%	37%	0%
Mazda	-6%	78%	22%	0%	5%	19%	12%	50%	14%	60%	11%	0%	0%	0%	0%	75%	80%	60%	100%	0%
Mitsubishi	-10%	64%	30%	0%	5%	18%	14%	58%	5%	60%	30%	6%	0%	0%	0%	75%	80%	60%	100%	0%
Nissan	-5%	68%	14%	1%	5%	21%	14%	56%	4%	60%	15%	1%	0%	0%	0%	75%	80%	60%	83%	0%
Porsche	-5%	24%	25%	4%	5%	19%	9%	36%	21%	54%	29%	30%	11%	11%	16%	75%	80%	54%	86%	3%
Spyker- Saab	-8%	34%	24%	3%	3%	11%	14%	55%	7%	54%	27%	30%	10%	3%	10%	75%	80%	54%	90%	0%
Subaru	-9%	69%	30%	0%	1%	5%	14%	58%	22%	60%	30%	1%	0%	0%	0%	75%	80%	60%	100%	0%
Suzuki	-2%	49%	30%	0%	3%	11%	16%	63%	7%	60%	30%	21%	0%	0%	0%	75%	80%	60%	100%	0%
Tata-JLR	-9%	54%	9%	11%	7%	26%	12%	48%	0%	56%	19%	30%	7%	0%	4%	75%	80%	56%	93%	0%

Toyota	-3%	40%	0%	1%	7%	26%	10%	41%	5%	53%	1%	12%	0%	0%	0%	38%	40%	53%	41%	0%
VW	-8%	42%	27%	1%	4%	16%	13%	54%	8%	57%	29%	30%	5%	0%	0%	75%	80%	57%	95%	0%
Fleet	-6%	50%	11%	2%	7%	28%	11%	44%	6%	58%	12%	7%	1%	0%	0%	66%	71%	58%	65%	0%

Mass=true mass reduction; TDS18/24/27=turbocharged & downsized at 18/24/27 bar BMEP; AT=automatic transmission; DCT=dual clutch transmission; MT=manual transmission; HEG=high efficiency gearbox; EGR=cooled exhaust gas recirculation; HEV=hybrid electric vehicle; EV=full electric vehicle; PHEV=plug-in HEV; SS=12V stop-start; LRRT2=lower rolling resistance tires level 2; IACC2=Improved accessories level 2; EFR2=engine friction reduction level 2; GDI=stoichiometric gasoline direct injection; DSL=advanced diesel

Note that technology penetrations for Aston Martin, Lotus and Tesla are not included here but can be found in EPA's draft RIA.

Negative values for Mass Reduction represent percentage of mass removed.

Table III-27 Technology Penetrations for the 2025 MY Control Case – Combined Fleet

	Mass	TDS18	TDS24	TDS27	AT6	AT8	DCT6	DCT8	MT	HEG	EGR	HEV	EV	PHEV	SS	LRRT2	IACC2	EFR2	GDI	DSL
BMW	-10%	8%	58%	6%	0%	26%	0%	59%	7%	92%	64%	34%	8%	0%	0%	100%	100%	92%	92%	0%
Chrysler/ Fiat	-11%	16%	66%	5%	0%	38%	0%	58%	2%	99%	71%	15%	1%	0%	0%	100%	100%	99%	99%	0%
Daimler	-11%	11%	41%	11%	0%	23%	0%	62%	4%	88%	53%	36%	12%	0%	0%	100%	100%	88%	86%	2%
Ferrari	-6%	0%	0%	5%	0%	0%	0%	77%	0%	77%	5%	50%	23%	22%	5%	100%	100%	77%	77%	0%
Ford	-11%	18%	56%	9%	0%	39%	0%	51%	4%	95%	65%	19%	4%	0%	0%	99%	99%	95%	95%	0%
Geely-Volvo	-10%	11%	42%	13%	0%	39%	0%	50%	1%	89%	54%	44%	11%	0%	0%	100%	100%	89%	89%	0%
GM	-11%	21%	60%	8%	0%	59%	0%	37%	2%	98%	68%	10%	2%	0%	0%	100%	100%	98%	98%	0%
Honda	-8%	24%	73%	0%	0%	18%	0%	71%	8%	98%	73%	3%	0%	0%	0%	98%	98%	98%	98%	0%
Hyundai	-10%	25%	75%	0%	0%	35%	0%	58%	6%	100%	75%	0%	0%	0%	0%	100%	100%	100%	100%	0%
Kia	-7%	39%	61%	0%	0%	27%	0%	66%	7%	100%	42%	0%	0%	0%	0%	100%	100%	100%	100%	0%
Mazda	-8%	6%	73%	0%	0%	23%	0%	65%	11%	98%	73%	19%	2%	0%	0%	100%	100%	98%	98%	0%

Mitsubishi	-12%	8%	70%	0%	0%	21%	0%	69%	4%	95%	70%	17%	5%	0%	0%	100%	100%	95%	95%	0%
Nissan	-7%	13%	69%	3%	0%	25%	0%	69%	3%	98%	72%	20%	2%	0%	0%	100%	100%	98%	98%	0%
Porsche	-5%	8%	35%	7%	0%	21%	0%	42%	19%	83%	41%	34%	17%	10%	1%	100%	100%	83%	83%	0%
Spyker-Saab	-10%	5%	47%	3%	0%	13%	0%	66%	6%	84%	50%	32%	16%	5%	2%	100%	100%	84%	84%	0%
Subaru	-10%	6%	71%	0%	0%	6%	0%	72%	19%	96%	71%	19%	4%	0%	0%	100%	100%	96%	96%	0%
Suzuki	-3%	3%	67%	0%	0%	14%	0%	72%	6%	92%	67%	22%	8%	0%	0%	100%	100%	92%	92%	0%
Tata-JLR	-9%	15%	16%	29%	0%	31%	0%	58%	0%	88%	45%	43%	12%	0%	0%	100%	100%	88%	88%	0%
Toyota	-7%	23%	60%	4%	0%	30%	0%	53%	5%	88%	64%	13%	0%	0%	0%	88%	88%	88%	88%	0%
VW	-8%	6%	60%	3%	0%	20%	0%	63%	8%	90%	62%	31%	10%	1%	0%	100%	100%	90%	90%	0%
Fleet	-9%	19%	62%	5%	0%	34%	0%	55%	5%	94%	66%	15%	3%	0%	0%	97%	97%	94%	94%	0%

Mass=true mass reduction; TDS18/24/27=turbocharged & downsized at 18/24/27 bar BMEP; AT=automatic transmission; DCT=dual clutch transmission; MT=manual transmission; HEG=high efficiency gearbox; EGR=cooled exhaust gas recirculation; HEV=hybrid electric vehicle; EV=full electric vehicle; PHEV=plug-in HEV; SS=12V stop-start; LRRT2=lower rolling resistance tires level 2; IACC2=Improved accessories level 2; EFR2=engine friction reduction level 2; GDI=stoichiometric gasoline direct injection; DSL=advanced diesel

Note that technology penetrations for Aston Martin, Lotus and Tata are not included here but can be found in EPA's draft RIA.

Negative values for Mass Reduction represent percentage of mass removed.

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6. How does the technical assessment support the proposed CO_2 standards as compared to the alternatives has EPA considered?

a. What are the targets and achieved levels for the fleet in this proposal?

In this section EPA analyzes the proposed standards alongside several potential alternative GHG standards.

Table III–28 includes a summary of the proposed standards and the four alternatives considered by EPA for this notice. In this table and for the majority of the data presented in this section, EPA focuses on two specific model years in the 2017–2025 time frame addressed by this proposal. For the purposes of considering alternatives, EPA assessed these two specific years as being reasonably separated in time in order to evaluate a range of meaningfully different standards, rather than analyzing alternatives for each individual model year. After discussing the reasons for selecting the proposed standards rather than any of the alternatives, EPA will describe the specific standard phase-in schedule for the proposal. Table III–28 presents the projected reference case targets for the fleet in 2021 and 2025, that is the estimated industry wide targets that would be required for the projected fleet in those years by the MY 2016 standards.[357] The alternatives, like the proposed standards, account for projected use of A/C related credits. They represent the average targets for cars and trucks projected for the proposed standards and four alternative standards. They do not represent the manner in which manufacturers are projected to achieve compliance with these targets, which includes the ability to transfer credits to and from the car and truck fleets. That is discussed later.

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[357] The reference case targets for 2021 and 2025 may be different even though the footprint based standards are identical (the 2016 curves). This is because the fleet distribution of cars and trucks may change in the intervening years thus changing the targets in 2021 and 2025.

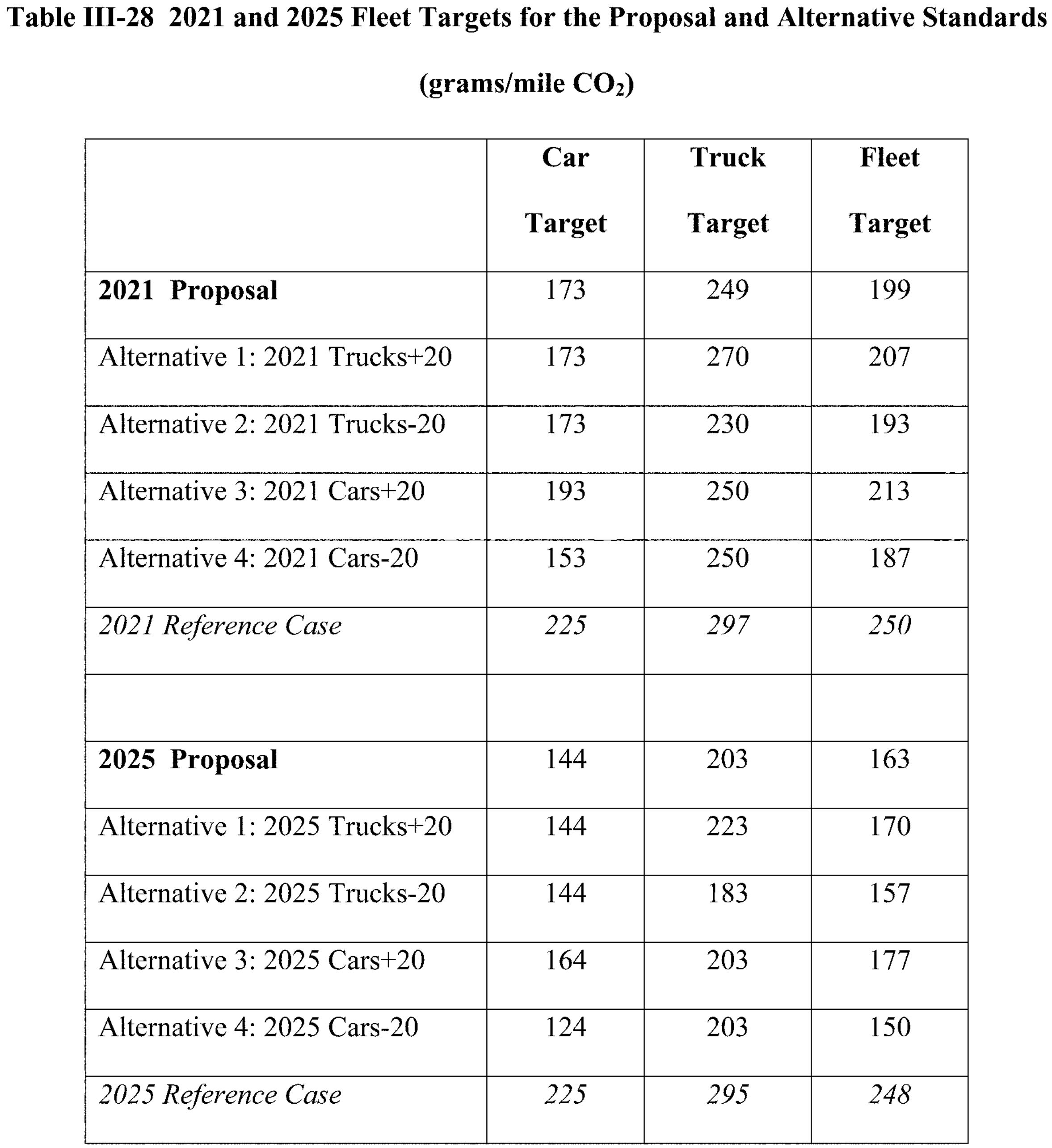

Table III-28 2021 and 2025 Fleet Targets for the Proposal and Alternative Standards

(grams/mile CO_2)

	Car Target	**Truck Target**	**Fleet Target**
2021 Proposal	173	249	199
Alternative 1: 2021 Trucks+20	173	270	207
Alternative 2: 2021 Trucks-20	173	230	193
Alternative 3: 2021 Cars+20	193	250	213
Alternative 4: 2021 Cars-20	153	250	187
2021 Reference Case	*225*	*297*	*250*
2025 Proposal	144	203	163
Alternative 1: 2025 Trucks+20	144	223	170
Alternative 2: 2025 Trucks-20	144	183	157
Alternative 3: 2025 Cars+20	164	203	177
Alternative 4: 2025 Cars-20	124	203	150
2025 Reference Case	*225*	*295*	*248*

Alternative 1 and 2 are focused on changes in the level of stringency for just light-duty trucks: Alternative 1 is 20 grams/mile CO_2 less stringent (higher) in 2021 and 2025, and Alternative 2 is 20 grams/mile CO_2 more stringent (lower) in 2021 and 2025. Alternative 3 and 4 are focused on changes in the level of stringency for just passenger cars: Alternative 3 is 20 grams/mile CO_2 less stringent (higher) in 2021 and 2025, and Alternative 4 is 20 grams/mile CO_2 more stringent (lower) in 2021 and 2025. When combined with the sales projections for 2021 and 2025, these alternatives span fleet wide targets with a range of 187–213 g/mi CO_2 in 2021 (equivalent to a range of 42–48 mpge if all improvements were made with fuel economy technologies) and a range of 150–177 g/mi CO_2 in 2025 in 2025 (equivalent to a range of 50–59 mpg if all improvements were made with fuel economy technologies).

Using the OMEGA model, EPA evaluated the proposed standards and each of the alternatives in 2021 and in 2025. It is worth noting that although Alternatives 1 and 2 consider different truck footprint curves compared to the proposal and Alternatives 3 and 4 evaluate different car footprint curves compared to the proposal, in all cases EPA evaluated the alternatives by modeling both the car and truck footprint curves together (which achieve the fleet targets shown in Table III–28) as this is how manufacturers would view the future standards given the opportunity to transfer credits between cars and trucks under the GHG program.[358] A manufacturer's ability to transfer GHG credits between its car and truck fleets without limit does have the effect of muting the ‘‘truck'' focused and ‘‘car'' focused nature of the alternatives EPA is evaluating. For example, while Alternative 1 has truck standards

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[358] The curves for the alternatives were developed using the same methods as the proposed curves, however with different targets. Thus, just as in the proposed curves, the car and truck curves described in TSD 2 were ‘‘fanned'' up or down to determine the curves of the alternatives.

projected in 2021 and 2025 to be 20 grams/mile less stringent than the proposed truck standards and the same car standards as the proposed car standards, individual firms may over comply on trucks and under-comply on cars (or vice versa) in order to meet Alternative 1 in a cost effective manner from each company's perspective. EPA's modeling of single manufacturer fleets reflects this flexibility, and appropriately so given that it reflects manufacturers' expected response.

Table III–29 shows the projected target and projected achieved levels in 2025 for the proposed standards. This accounts for a manufacturer's ability to transfer credits to and from cars and trucks to meet a manufacturer's car and truck targets.

Table III-29 2025 Projected Target and Achieved Levels for the Proposal for Individual Firms (grams/mile CO2)

	Target			Achieved			Car Target-Achieved	Truck Target-Achieved
Company	Cars	Trucks	Fleet	Cars	Trucks	Fleet		
BMW	146	194	159	145	196	158	1	-2
Chrysler/Fiat	146	201	170	148	199	170	-2	2
Daimler	153	208	166	146	230	165	8	-22
Ferrari	150	n/a	150	159	n/a	159	-9	n/a
Ford	147	213	167	153	200	167	-6	13
Geely-Volvo	148	189	160	141	204	159	8	-15
GM	146	213	178	146	212	178	0	1
Honda	142	191	156	143	186	156	-2	5
Hyundai	142	188	151	145	178	152	-3	11
Kia	143	199	155	146	189	155	-3	10
Mazda	142	186	149	145	172	150	-3	14
Mitsubishi	139	180	153	144	171	153	-5	8
Nissan	145	202	162	143	204	161	1	-2
Porsche	131	195	144	119	231	143	12	-36
Spyker-Saab	141	188	148	133	231	146	8	-43
Subaru	137	177	146	147	149	147	-10	28
Suzuki	132	181	140	132	179	140	-1	3
Tata-JLR	161	182	171	134	208	168	27	-26
Toyota	141	200	163	140	201	162	1	-1
VW	139	203	152	133	225	151	6	-22
Fleet	144	203	163	144	202	163	-0.1	1.6

Note: This table and the remainder in this section do not include projections for Aston Martin and Lotus. These two firms would qualify for consideration of the unique Small Volume Manufacturer alternative standards discussed in Section III.B, and thus while we have included modeling for these companies in the Draft RIA, we do not present the results in this section. In addition, we do not present in this section results for the firm Tesla, as our forecast assumes they only make all electric vehicles, and thus under any standard we analyzed the firm always complies without the addition of any technology.

Similar tables for each of the alternatives for 2025 and for the alternatives and the proposal for 2021 are contained in Chapter 3 of EPA's draft RIA. With the proposed standards and for Alternatives 1 and 2, all companies are projected to be able to comply both in 2021 and 2025, with the with the exception of Ferrari, which in each case falls 9 g/mi short of its projected fleet wide obligation in 2025.[359] In Alternatives 3 and 4, where the car stringency varies, all companies are again projected to comply with the exception of Ferrari, which complies under Alternative 3, but has a 30 gram shortfall under Alternative 4. This level of compliance was not the case for the 2016 standards from the previous rule. The primary reason for this result is the penetration of more efficient technologies beyond 2016. As described earlier, many technologies projected as not to be available by MY 2016 or whose penetration was limited due to lead time issues are projected to be available or available at greater penetration rates in the 2017–2025 timeframe, especially given two more redesign cycles for the industry on average.

b. Why is the Relative Rate of Car Truck Stringency Appropriate?

Table III–29 illustrates the importance of car-truck credit transfer for individual firms. For example, the OMEGA model projects for the proposed standards that in 2025, Daimler would under comply for trucks by 22 g/mile but over comply in their car fleet by 8 g/mi in order to meet their overall compliance obligation, while for Kia the OMEGA model projects that under the proposed standards Kia's truck fleet would over comply by 10 g/mi and under comply in their car fleet by 3 g/mi in order to meet their compliance obligations. However, for the fleet as a whole, we project only a relatively small degree of net credit transfers from the truck fleet to the car fleet.

Table III–23 shows that the average costs for cars and trucks are also nearly equivalent for 2021 and 2025. For MY 2021, the average cost to comply with the car standards is $718, while it is $764 for trucks. For MY 2025, the average cost to comply with the car standards is $1,942, while it is $1,954 for trucks. These results are highly consistent with the small degree of net projected credit transfer between cars and trucks.

The average cost for complying with the truck and car standards are similar, even though the level of stringency for trucks is increasing at a slower rate than for cars. As described in Section I.B.2 of the preamble, the proposed car standards are decreasing (in CO_2) at a rate of 5% per year from MYs 2017–2025, while the proposed truck standards are decreasing at a rate of 3.5% per year on average from MYs 2017–2021, then 5% per year thereafter till 2025. Given this difference in percentage rates, the close similarity in average cost stems from the fact that it is more costly to add the technologies to trucks (in general) than to cars as described in Chapter 1 of the draft RIA. Moreover, some technologies are not even available for towing trucks. These include EVs, PHEVs, Atkinson Cycle engines (matched with HEVs), and DCTs—the latter two are relatively cost effective. Together these result in a decrease in effectiveness potential for the heavier towing trucks compared to non-towing trucks and cars. In addition,, there is more mass reduction projected for these vehicles, but this comes at higher cost as well, as the cost per pound for mass reduction goes up with higher levels of mass reduction (that is, the cost increase curves upward rather than being linear). As described in greater detail in Chapter 2 of the joint TSD, these factors help explain the reason EPA and NHTSA are proposing to make the truck curve steeper relative to the 2016 curve, thus resulting in a truck curve that is ''more parallel'' to cars than the 2016 truck curve.

Taken together, our analysis shows that under the proposed standards, there is relatively little net trading between car and trucks; average costs for compliance with cars is similar to that of trucks in MY 2021 as well as MY 2025; and it is more costly to add technologies to trucks than to cars. These facts corroborate the reasonableness for increasing the slope of the truck curve. These observations also lead us to the conclusion that (at a fleet level) starting from MYs 2017–2021, the slower rate of increase for trucks compared to cars (3.5% compared to 5% per year), and the same rate of increase (5% per year) for both cars and trucks for MY 2022–2025 results in car and truck standards that reflect increases in stringency over time that are comparable and consistent. There are no indications that either the truck or car standards are leading manufacturers to choose technology paths that lead to significant over or under compliance for cars or trucks, on an industry wide level. *E.g.,* there is no indication that on average the proposed car standards would lead manufacturers to consistently under or over comply with the car standard in light of the truck standard, or vice versa. A consistent pattern across the industry of manufacturers choosing to under or over comply with a car or trucks standard could indicate that the car or truck standard should be evaluated further to determine if one was more or less stringent than might be appropriate in light of the technology choices available to manufacturers and their costs. As shown above, that is not the case for the proposed car and truck standards. However, EPA did evaluate a set of alternative standards that reflect separately increasing or decreasing the stringency of the car and truck standards, as discussed below.

c. What are the costs and advanced technology penetration rates for the alternative standards in relation to the proposed standards?

Below we discuss results for the proposed car and truck standards compared to the truck alternatives evaluated (Alternatives 1 and 2), and then discuss the proposed car and truck standards compared to the car alternatives (Alternatives 3 and 4).

Table III–30 presents our projected per-vehicle cost for the average car, truck and for the fleet in model year 2021 and 2025 for the proposal and for Alternatives 1 and 2. All costs are relative to the reference case (*i.e.* the fleet with technology added to meet the 2016 MY standards). As can be seen, even though only the truck standards vary among these three scenarios, in each case the projected average car and truck costs vary as a result of car-truck credit transfer by individual companies. Table III–30 shows that compared to the proposal, Alternative 1 (with a 2021 and 2025 truck target 20 g/mile less stringent, or 20 g/mile greater, than the proposal) is $281 per vehicle less than the proposal in 2021 and $430 per vehicle less than the proposal in 2025. Alternative 2 (with a 2021 and 2025 truck target 20g/mile more stringent, or 20 g/mile less, than the proposal) is $343 per vehicle more than the proposal in 2021 and $516 per vehicle more than the proposal in 2025.

Note that while the car and truck costs are nearly equivalent for Alternative 2 in 2021 and 2025, cars are over complying on average by 7 g/mi, while trucks are under complying by 11 g/mi, thus indicating significant flow of credits from cars to trucks.[360] The situation is reversed in Alternative 1, where cars are under complying on average by 9 g/mi and trucks are over

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[359] Note that Ferrari is shown as a separate entity in the table above but could be combined with other Fiat-owned companies for purposes of GHG compliance at the manufacturer's discretion. Also, in Section III.B., EPA is requesting comment on the concept of allowing companies that are able to demonstrate ''operational independence'' to be eligible for SVM alternative standards. However, the costs shown above are based on Ferrari meeting the primary program standards.

[360] These detailed tables are in Chapter 3 of EPA's draft RIA.

complying by 16 g/mi, implying significant flow of credits from truck to cars.

significant flow of credits from truck to cars.

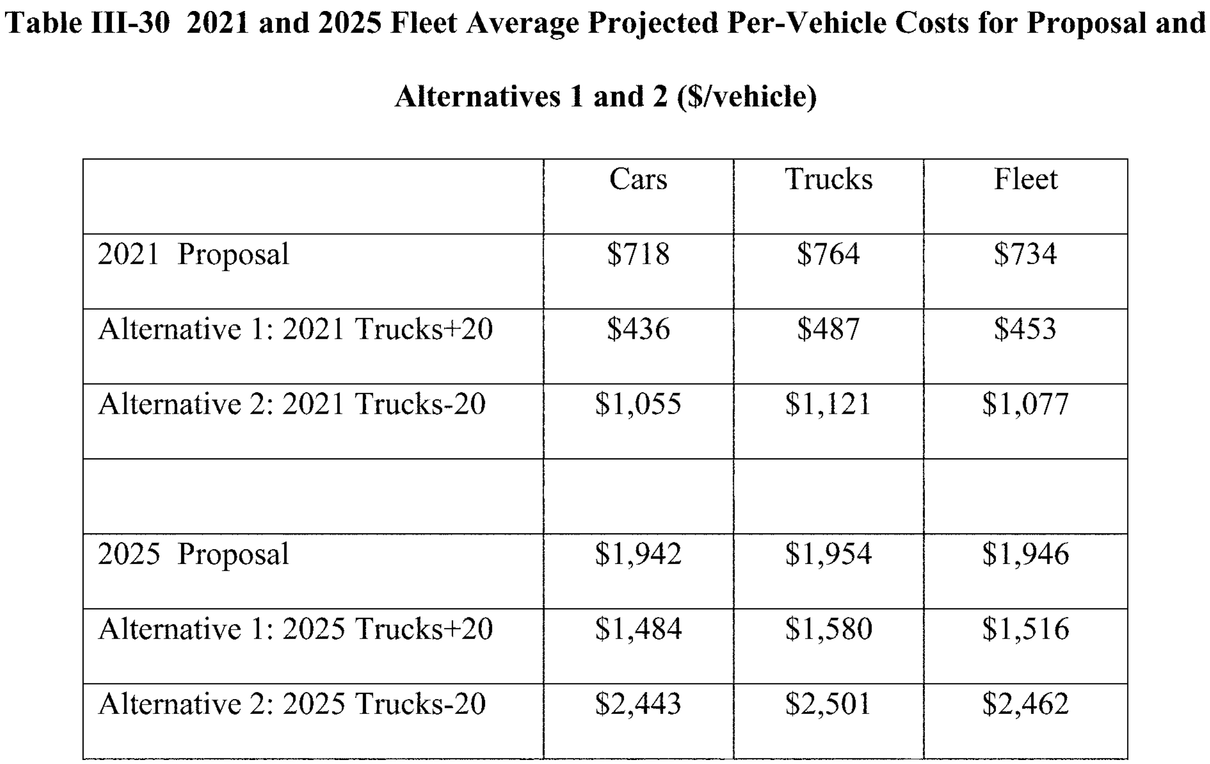

Table III-30 2021 and 2025 Fleet Average Projected Per-Vehicle Costs for Proposal and Alternatives 1 and 2 ($/vehicle)

	Cars	Trucks	Fleet
2021 Proposal	$718	$764	$734
Alternative 1: 2021 Trucks+20	$436	$487	$453
Alternative 2: 2021 Trucks-20	$1,055	$1,121	$1,077
2025 Proposal	$1,942	$1,954	$1,946
Alternative 1: 2025 Trucks+20	$1,484	$1,580	$1,516
Alternative 2: 2025 Trucks-20	$2,443	$2,501	$2,462

Table III–31 presents the per-vehicle cost estimates in MY 2021 by company for the proposal, Alternative 1 and Alternative 2. In general, for most of the companies our projected results show the same trends as for the industry as a whole.

Table III-31 2021 Projected Per-Vehicle Costs for the Proposal and Alternatives 1 and 2 by Company (cars & trucks, $/vehicle)

	Proposal	Alternative 1 (trucks+20)	Alternative 2 (trucks-20)
BMW	$937	$427	$1,354
Chrysler/Fiat	$698	$280	$1,125
Daimler	$1,702	$1,255	$2,208
Ferrari	$6,351	$6,351	$6,351
Ford	$696	$368	$1,131
Geely-Volvo	$1,741	$1,190	$2,437
GM	$590	$202	$1,123
Honda	$556	$411	$758
Hyundai	$669	$559	$829
Kia	$582	$479	$704
Mazda	$919	$763	$1,113
Mitsubishi	$877	$507	$1,384
Nissan	$729	$462	$985
Porsche	$4,482	$4,070	$5,148
Spyker-Saab	$2,986	$2,696	$3,342
Subaru	$994	$766	$1,319
Suzuki	$1,132	$890	$1,370
Tata-JLR	$1,935	$1,097	$2,821
Toyota	$481	$320	$678
VW	$1,457	$1,034	$1,812
Fleet	$734	$453	$1,077

Table III–32 presents the per-vehicle cost estimates in MY 2025 by company for the proposal, Alternative 1 and Alternative 2. In general, for most of the companies our projected results show the same trends as for the industry as a whole, with Alternative 1 on the order of $200 to $600 per vehicle less expensive then the proposal, and Alternative 2 on the order of $200 to $800 per vehicle more expensive. For the fleet as a whole, the average cost for Alternative 1 is $430 less costly, while Alternative 2 is $516 more costly. Thus the incremental average cost is higher for the more stringent alternative than for an equally less stringent alternative standard. This is not a surprise as more technologies must be added to vehicles to meet tighter standards, and these technologies increase in cost in a non-linear fashion.

Table III-32 2025 Projected Per-Vehicle Costs for Proposal and Alternatives 1 and 2 by Company

(cars & trucks, $/vehicle)

	Proposal	Alternative 1 (trucks+20)	Alternative 2 (trucks-20)
BMW	$2,174	$1,780	$2,607
Chrysler/Fiat	$2,043	$1,455	$2,673
Daimler	$2,707	$2,345	$3,127
Ferrari	$7,109	$7,109	$7,109
Ford	$2,178	$1,671	$2,670
Geely-Volvo	$2,876	$2,374	$3,546
GM	$2,030	$1,355	$2,877
Honda	$1,595	$1,327	$1,987
Hyundai	$1,739	$1,509	$2,004
Kia	$1,491	$1,282	$1,715
Mazda	$2,131	$1,895	$2,347
Mitsubishi	$2,133	$1,758	$2,574
Nissan	$2,060	$1,616	$2,487
Porsche	$5,012	$4,555	$5,477
Spyker-Saab	$3,670	$3,338	$3,887
Subaru	$2,202	$1,925	$2,452
Suzuki	$2,225	$2,051	$2,436
Tata-JLR	$2,976	$2,337	$3,787
Toyota	$1,483	$1,133	$2,014
VW	$2,506	$2,168	$2,871
Fleet	$1,946	$1,516	$2,462

The previous tables present the costs for the proposal and alternatives 1 and 2 at both the industry and company level. In addition to costs, another key is the technology required to meet potential future standards. The EPA assessment of the proposal, as well as Alternatives 1 and 2 predict the penetration into the fleet of a large number of technologies at various rates of penetration. A subset of these technologies are discussed below, while EPA's draft RIA Chapter 3 includes the details on this much longer list for the passenger car fleet, light-duty truck fleet, and the overall fleet at both the industry and individual company level. Table III–33 and Table III–34 present only a sub-set of the technologies EPA estimates could be used to meet the proposed standards as well as alternative 1 and 2 in MY 2021. Table III–35 and Table III–36 show the same for 2025. The technologies listed in these tables are those for which there is a large difference in penetration rates between the proposal and the alternatives. We have not included here, for example, the penetration rates for improved high efficiency gear boxes because in 2021 our modeling estimates a 58% penetration of this technology across the total fleet for the proposal as well as for alternatives 1 and 2, or 8 speed automatic transmissions which in 2021 we estimate at a 28% penetration rate for the proposed standards as well as for alternatives 1 and 2. There are several other technologies (shown in the Chapter 3 of the DRIA) where there is little differentiation between the proposal and alternatives 1 and 2.

Table III–33 shows that in 2021, for several technologies the proposal requires higher levels of penetration for trucks than alternative 1. For example, for trucks, compared to the proposal, alternative 1 leads to an 8% decrease in the 24 bar turbo-charged/downsized engines, a 10% decrease in the penetration of cooled EGR, and a 12% decrease in the penetration of gasoline direct injection fuel systems. We also see that due to credit transfer between cars and trucks, the lower level of stringency considered for trucks in alternative 1 also impacts the penetration of technology to the car fleet—with alternative 1 leading to a 14% decrease in penetration of 18 bar turbo-downsized engines, 5% decrease in penetration of 24 bar turbo-downsize engines, 8% decrease in penetration of 8 speed dual clutch transmissions, and a 19% decrease in penetration of gasoline direct injection fuel systems in the car fleet. For the more stringent alternative 2, we see increases in the penetration of many of these technologies projected for 2021, for the truck fleet as well as for the car fleet. Table III–34 shows these same overall trends but at the sales weighted fleet level in 2021.

Table III-33: 2021 Projected Technology Penetrations for Proposal and Alternatives 1 and 2 for all Cars and Trucks

	Cars			Trucks		
Technology	Proposal	Alt. 1	Alt. 2	Proposal	Alt. 1	Alt. 2
Turbo-downsize(18 bar)	45%	31%	50%	59%	57%	66%
Turbo-downsize (24 bar)	10%	5%	17%	14%	6%	19%
8 speed DCT	61%	53%	61%	13%	12%	13%
Cooled EGR*	9%	6%	18%	17%	7%	23%
Hybrid Electric Vehicle	8%	7%	9%	4%	4%	7%
LRRT2	62%	53%	72%	74%	62%	74%
IACC2	67%	57%	77%	79%	66%	79%
GDI	60%	41%	73%	76%	64%	91%

* In EPA packages TDS27 engines have cooled EGR, nearly all TDS24 engines also have cooled EGR, virtually none of the TDS18 bar engines have cooled EGR (See Chapter 1 of the draft RIA)

Table III-34: 2021 Projected Technology Penetrations for Proposal and Alternatives 1 and 2 for Fleet

	Proposal	Alt. 1	Alt. 2
Turbo-downsize (18 bar)	50%	40%	55%
Turbo-downsize (24 bar)	11%	5%	18%
8 speed DCT	44%	39%	44%
Cooled EGR	12%	6%	20%
Hybrid Electric Vehicle	7%	6%	8%
LRRT2	66%	56%	73%
IACC2	71%	60%	78%
GDI	65%	49%	79%

Table III–35 shows that in 2025, there is only a small change in many of these technology penetration rates when comparing the proposal to alternative 1 for trucks, and most of the change shows up in the car fleet. One important exception is hybrid electric vehicles, where the less stringent alternative 1 is projected to be met with a 4% decrease in penetration of HEVs compared to the proposal. As in 2021, we see that due to credit transfer between cars and trucks, the lower level of stringency considered for trucks in alternative 1 also impacts the car fleet penetration—with alternative 1 leading to a 8% decrease in penetration of 24 bar turbo-downsized engines, 12% decrease in penetration of cooled EGR, 6% decrease in penetration of HEVs, and a 2% decrease in penetration of electric vehicles. For the more stringent alternative 2, we see only small increases in the penetration of many of these technologies projected for 2025, with a major exception being a significant 14% increase in the penetration of HEVs for trucks compared to the proposal, a 6% increase in the penetration of HEVs for cars compared to the proposal, and a 3% increase in the penetration of EVs for cars compared to the proposal.

Table III-35 2025 Projected Technology Penetrations for Proposal and Alternatives 1 and 2 for all Cars and Trucks

	Cars			Trucks		
	Proposal	Alt. 1	Alt. 2	Proposal	Alt. 1	Alt. 2
Turbo-downsize (18 bar)	14%	23%	8%	27%	24%	26%
Turbo-downsize (24 bar)	65%	57%	63%	57%	57%	56%
8 speed DCT	75%	76%	73%	15%	16%	15%
Cooled EGR	66%	54%	64%	67%	68%	67%
Hybrid Electric Vehicle	15%	9%	21%	13%	9%	27%
EV	4%	2%	7%	1%	0%	1%
LRRT2	96%	96%	96%	99%	99%	99%
IACC2	96%	96%	96%	99%	99%	99%
GDI	93%	88%	90%	97%	94%	97%

Table III-36 2025 Projected Technology Penetrations for Proposal and Alternatives 1 and 2 for Fleet

	Proposal	Alt. 1	Alt. 2
Turbo-downsize (18 bar)	19%	24%	14%
Turbo-downsize (24 bar)	62%	57%	60%
8 speed DCT	55%	56%	54%
Cooled EGR	66%	59%	65%
Hybrid Electric Vehicle	15%	9%	23%
EV	3%	2%	5%
LRRT2	97%	97%	97%
IACC2	97%	97%	97%
GDI	94%	90%	92%

The results are similar for Alternatives 3 and 4, where the truck standard stays at the proposal level and the car stringency varies, +20 g/mi and -20 g/mi respectively. Table III–37 presents our projected per-vehicle cost for the average car, truck and for the fleet in model year 2021 and 2025 for the proposal and for Alternatives 3 and

4. Compared to the proposal, Alternative 3 (with a 2021 and 2025 car target 20 g/mile less stringent then the proposal) is $442 per vehicle less on average than the proposal in 2021 and $708 per vehicle less than the proposal in 2025. Alternative 4 (with a 2021 and 2025 car target 20g/mile more stringent then the proposal) is $635 per vehicle more on average than the proposal in 2021 and $923 per vehicle more than the proposal in 2025. These differences are even more pronounced than Alternatives 1 and 2. As in the analysis above, the costs increases are greater for more stringent alternatives than the reduced costs from the less stringent alternatives.

Note that although the car and truck costs are not too dissimilar for cars and trucks for Alternative 3 in 2025, what is not shown is that cars are over complying by 5 g/mi, while trucks are under complying by 7 g/mi, thus indicating significant flow of credits from cars to trucks. The situation is reversed in Alternative 4, where cars are under complying by 6 g/mi and trucks are over complying by 12 g/mi implying significant flow of credits from truck to cars.

Table III-37 2021 and 2025 Fleet Average Projected Per-Vehicle Costs for Proposal and Alternatives 3 and 4 ($/vehicle)

	Cars	Trucks	Fleet
2021 Proposal	$718	$764	$734
Alternative 3: 2021 Cars+20	$244	$390	$292
Alternative 4: 2021 Cars-20	$1,415	$1,275	$1,369
2025 Proposal	$1,942	$1,954	$1,946
Alternative 3: 2025 Cars+20	$1,161	$1,394	$1,238
Alternative 4: 2025 Cars-20	$2,923	$2,760	$2,869

Table III–38 presents the per-vehicle cost estimates in MY 2021 by company for the proposal, Alternative 3 and Alternative 4. In general, for most of the companies our projected results show the same trends as for the industry as a whole, with Alternative 3 being a several hundred dollars per vehicle less expensive then the proposal, and Alternative 4 being several hundred dollars per vehicle more expensive (with larger increment for more stringent than less stringent alternatives). In some case the differences exceed $1,000 (*e.g.* BMW, Daimler, Geely/Volvo, Mazda, Spyker/Saab, and Tata).

Table III-38 2021 Projected Per-Vehicle Costs for Proposal and Alternatives 3 and 4 by Company

(cars & trucks combined, $/vehicle)

	Proposal	Alt. 3 (cars+20)	Alt. 4 (cars-20)
BMW	$937	-$218	$2,143
Chrysler/Fiat	$698	$272	$1,142
Daimler	$1,702	$567	$3,114
Ferrari	$6,351	$6,351	$6,351
Ford	$696	$240	$1,501
Geely-Volvo	$1,741	$662	$3,215
GM	$590	$245	$1,042
Honda	$556	$292	$993
Hyundai	$669	$318	$1,356
Kia	$582	$326	$1,066
Mazda	$919	$355	$1,957
Mitsubishi	$877	$326	$1,803
Nissan	$729	$287	$1,469
Porsche	$4,482	$3,131	$5,473
Spyker-Saab	$2,986	$1,588	$4,817
Subaru	$994	$478	$1,906
Suzuki	$1,132	$331	$2,128
Tata-JLR	$1,935	$1,097	$2,862
Toyota	$481	$298	$758
VW	$1,457	$186	$2,854
Fleet	$734	$292	$1,369

Table III–39 presents the per-vehicle cost estimates in MY 2025 by company for the proposal, Alternative 3 and Alternative 4. In general, for most of the companies our projected results show the same trends as for the industry as a whole, with Alternative 3 on the order of $500 to $1,400 per vehicle less expensive then the proposal, and Alternative 4 on the order of $700 to $1,600 per vehicle more expensive. Again these differences are more pronounced for the car alternatives than the truck alternatives.

Table III-39 2025 Projected Per-Vehicle Costs for Proposal and Alternatives 3 and 4 by Company (cars & trucks, $/vehicle)

	NPRM	Alt. 3 (cars+20)	Alt. 4 (cars-20)
BMW	$2,174	$1,164	$3,428
Chrysler/Fiat	$2,043	$1,424	$2,757
Daimler	$2,707	$1,616	$4,087
Ferrari	$7,109	$6,292	$7,109
Ford	$2,178	$1,299	$3,214
Geely-Volvo	$2,876	$1,790	$4,307
GM	$2,030	$1,400	$2,843
Honda	$1,595	$1,064	$2,387
Hyundai	$1,739	$1,044	$2,771
Kia	$1,491	$908	$2,408
Mazda	$2,131	$1,229	$3,279
Mitsubishi	$2,133	$1,414	$3,050
Nissan	$2,060	$1,246	$2,957
Porsche	$5,012	$3,685	$6,320
Spyker-Saab	$3,670	$2,296	$5,261
Subaru	$2,202	$1,400	$3,040
Suzuki	$2,225	$1,383	$3,274
Tata-JLR	$2,976	$2,246	$3,953
Toyota	$1,483	$982	$2,252
VW	$2,506	$1,391	$4,001
Fleet	$1,946	$1,238	$2,869

Table III–40 shows that in 2021, for several technologies Alternative 3 leads to lower levels of penetration for cars as well as trucks compared to the proposal. For example (on cars) there is an 13% decrease in the 18 bar turbo-charged/downsized engines, a 5% decrease in the penetration of cooled EGR, and a 22% decrease in the penetration of gasoline direct injection fuel systems. We also see that due to credit transfer between cars and trucks, the lower level of stringency considered for cars in alternative 3 also impacts the penetration of technology to the truck fleet—with alternative 3 leading to 12% decrease in penetration of 24 bar turbo-downsized engines, 13% decrease in penetration of cooled EGR, and a 17% decrease in penetration of gasoline direct injection fuel systems in the car fleet. For the more stringent alternative 4, we see increases in the penetration of many of these technologies projected for 2021, for the truck fleet as well as for the car fleet. Table III–41 shows these same overall trends but at the sales weighted fleet level in 2021.

Table III-40 2021 Projected Technology Penetrations for Proposal and Alternatives 3 and 4 for all Cars and Trucks

Technology	Cars			Trucks		
	Proposal	Alt. 3	Alt. 4	Proposal	Alt. 3	Alt. 4
Turbo-downsize (18 bar)	45%	32%	51%	59%	55%	62%
Turbo-downsize (24 bar)	10%	4%	21%	14%	2%	22%
8 speed DCT	61%	46%	61%	13%	11%	13%
Cooled EGR	9%	4%	20%	17%	4%	26%
Hybrid Electric Vehicle	8%	5%	12%	4%	3%	9%
LRRT2	62%	43%	72%	74%	54%	74%
IACC2	67%	46%	77%	79%	58%	79%
GDI	60%	38%	82%	76%	59%	91%

Table III-41 2021 Projected Technology Penetrations for Proposal and Alternatives 3 and 4 for Fleet

Technologies	Proposal	Alt. 3	Alt. 4
Turbo-downsize (18 bar)	50%	40%	55%
Turbo-downsize (24 bar)	11%	3%	21%
8 speed DCT	44%	34%	44%
Cooled EGR	12%	4%	22%
Hybrid Electric Vehicle	7%	4%	11%
LRRT2	66%	47%	73%
IACC2	71%	50%	78%
GDI	65%	46%	85%

Table III–42 shows that in 2025, there is only a small change in many of these technology penetration rates when comparing the proposal to alternative 3 for cars, and most of the change shows up in the car fleet. There are a few exceptions: There is a 15% decrease in the penetrate rate of 24 bar bmep engines (made up somewhat by a 4% increase in 18 bar engines); there is 20% less EGR boost and GDI, and 9% less hybrid electric vehicles compared to the proposal. As in 2021, we see that due to credit transfer between cars and trucks at the lower level of stringency considered for cars in alternative 3 also impacts the truck fleet penetration—with alternative 3 leading to 7% decrease in penetration of HEVs. For the more stringent alternative 4, we see only small increases in the penetration of many of these technologies projected for 2025, with a major exception being a significant 9% increase in the penetration of HEVs for cars compared to the proposal (along with a drop in advanced engines), and a 20% increase in the penetration of HEVs for trucks compared to the proposal.

Table III-42 2025 Projected Technology Penetrations for Proposal and Alternatives 3 and 4 for all Cars and Trucks

Technologies	Cars			Trucks		
	Proposal	Alt. 3	Alt. 4	Proposal	Alt.3	Alt. 4
Turbo-downsize (18 bar)	14%	18%	6%	27%	25%	26%
Turbo-downsize (24 bar)	65%	50%	59%	57%	58%	55%
8 speed DCT	75%	76%	71%	15%	16%	14%
Cooled EGR	66%	46%	61%	67%	68%	66%
Hybrid Electric Vehicle	15%	6%	24%	13%	6%	33%
EV	4%	1%	9%	1%	0%	2%
LRRT2	96%	96%	96%	99%	98%	99%
IACC2	96%	96%	96%	99%	98%	99%
GDI	93%	73%	88%	97%	94%	97%

Table III-43 2025 Projected Technology Penetrations for Proposal and Alternatives 3 and 4 for Fleet

Technologies	Proposal	Alt. 3	Alt. 4
Turbo-downsize (18 bar)	19%	20%	12%
Turbo-downsize (24 bar)	62%	53%	58%
8 speed DCT	55%	56%	53%
Cooled EGR	66%	54%	63%
Hybrid Electric Vehicle	15%	6%	27%
EV	3%	1%	7%
LRRT2	97%	97%	97%
IACC2	97%	97%	97%
GDI	94%	80%	91%

The trend for Alternatives 3 and 4 have thus far been that the impacts have been more extreme than Alternatives 1 and 2 compared to the proposal. Thus we will focus the discussion of feasibility on Alternatives 1 and 2 (as the same will also then apply to 3 and 4 respectively).

As stated above, EPA's OMEGA analysis indicates that there is a technology pathway for all manufacturers to build vehicles that would meet the proposed standards as well as the alternative standards.[361] The differences lie in the per-vehicle costs and the associated technology penetrations. With the proposed standards, we estimate that the average per-vehicle cost is $734 in 2021 and $1,946 in 2025. We have also shown that the relative rate of increase in the stringencies of cars and trucks are at an appropriate level such that there is greater balance amongst the manufacturers where the distribution of the burden is relatively evenly spread. In Section I.C of the Preamble, we also showed that the benefits of the program are significant, and that this cost can be recovered within the first four years of vehicle ownership.

EPA's analysis of the four alternatives indicates that under all of the alternatives the projected response of the manufacturers is to change both their car and truck fleets. Whether the car or truck standard is being changed, and whether it is being made more or less stringent, the response of the manufacturers is to make changes across their fleet, in light of their ability to transfer credits between cars and trucks. For example, Alternatives 1 and 3 make either the car or trucks standard less stringent, and keep the other standard as is. For both alternatives, manufacturers increase their projected CO_2 g/mile level achieved by their car fleet, and to a lesser extent their truck fleet. For alternatives 2 and 4, where either the truck or car fleet is made more stringent, and the other standard is kept as is, manufacturers reduce the projected CO_2 g/mile level achieved by both their car and trucks fleets, in a generally comparable fashion. This is summarized in Table III–44 for MY 2025.

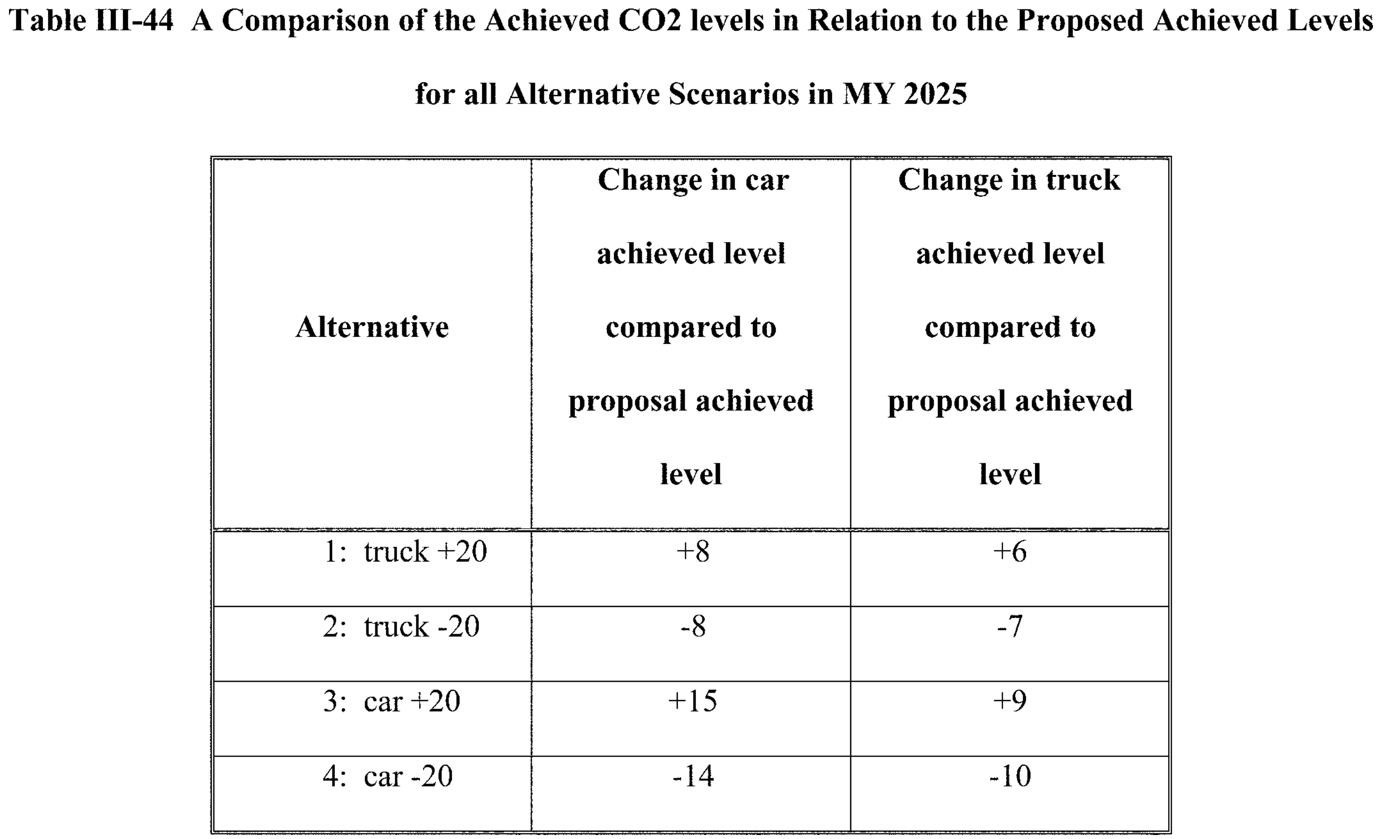

Table III-44 A Comparison of the Achieved CO2 levels in Relation to the Proposed Achieved Levels for all Alternative Scenarios in MY 2025

Alternative	Change in car achieved level compared to proposal achieved level	Change in truck achieved level compared to proposal achieved level
1: truck +20	+8	+6
2: truck -20	-8	-7
3: car +20	+15	+9
4: car -20	-14	-10

This demonstrates that the four alternatives are indicative of what would happen if EPA increased the stringency of both the car and truck fleet at the same time, or decreased the stringency of the car and truck fleet at the same time. *E.g.,* Alternative 4 would be comparable to an alternative where EPA made the car standard more stringent by 14 gm/mi and the truck standard by 10 gm/mile. Under such an alternative, there would logically be little if any net transfer of credits between cars and trucks. In that context, the results from alternatives 1 and 3 can be considered as indicative of what would be expected if EPA decreased the stringency of both the car and truck standards, and alternatives 2 and 4 as indicative of what would happen if EPA increased the stringency of both the car and truck standards. In general, it appears that decreasing the stringency of the standards would lead the manufacturers to focus more on increasing the CO_2 gm/mile of cars than trucks (alternatives 1 and 3). Increasing the stringency of the car and truck standards would generally lead to comparable increases in gm/mi for both cars and trucks.

Alternatives 1 and 3 would achieve significantly lower reductions, and would therefore forego important benefits that the proposed standards would achieve at reasonable costs and

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[361] Except Ferrari.

penetrations of technology. EPA judges that there is not a good reason to forego such benefits, and is not proposing less stringent standards such as alternatives 1 and 3.

Alternatives 2 and 4 increase the per vehicle estimates to $1,077 and $1,369 respectively in 2021 and $2,462 and $2,869 respectively in 2025. This increase in cost from the proposal originates from the dramatic increases in the costlier electrification technologies, such as HEVs and EVs. The following tables and charts show the technology penetrations by manufacturer in greater detail.

Table III–45 and later tables describe the projected penetration rates for the OEMs of some key technologies in MY 2021 and MY2025 under the proposed standards. TDS27, HEV, and PHEV+EV technologies represent the most costly technologies added in the package generation process, and the OMEGA model generally adds them as one of the last technology choices for compliance. They are therefore an indicator of the extent to which the stringency of the standard is pushing the manufacturers to the most costly technology. Cost (as shown above) is a similar indicator.

Table III–45 describes technology penetration for MY2021 under the proposal.

Table III-45 Percent Penetration of Technologies in MY 2021 for the Proposed Standards

(Ferrari has been removed from this table)

	2021 CAR				2021 TRUCK				2021 Fleet			
	TDS24	TDS27	HEV	PHEV +EV	TDS24	TDS27	HEV	PHEV +EV	TDS24	TDS27	HEV	PHEV +EV
BMW	26%	2%	30%	2%	24%	3%	30%	0%	25%	2%	30%	1%
Chrysler/Fiat	7%	1%	0%	0%	25%	3%	0%	0%	15%	2%	0%	0%
Daimler	21%	4%	30%	8%	14%	6%	30%	0%	20%	4%	30%	6%
Ford	15%	1%	2%	0%	17%	6%	2%	0%	16%	3%	2%	0%
Geely/Volvo	15%	8%	30%	9%	27%	2%	30%	0%	18%	6%	30%	6%
GM	9%	1%	0%	0%	19%	5%	0%	0%	14%	3%	0%	0%
Honda	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	2%	0%
Hyundai	0%	0%	0%	0%	30%	0%	0%	0%	6%	0%	0%	0%
Kia	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mazda	20%	0%	0%	0%	30%	0%	0%	0%	22%	0%	0%	0%
Mitsubishi	30%	0%	6%	0%	30%	0%	4%	0%	30%	0%	6%	0%
Nissan	9%	0%	1%	0%	24%	3%	0%	0%	14%	1%	1%	0%
Porsche	25%	3%	30%	29%	24%	8%	30%	0%	25%	4%	30%	22%
Spyker/Saab	25%	3%	30%	16%	19%	6%	30%	0%	24%	3%	30%	13%
Subaru	30%	0%	2%	0%	30%	0%	0%	0%	30%	0%	1%	0%
Suzuki	30%	0%	24%	0%	30%	0%	6%	0%	30%	0%	21%	0%
Tata/JLR	7%	11%	30%	10%	10%	10%	30%	4%	9%	11%	30%	7%
Toyota	0%	0%	15%	0%	0%	3%	5%	0%	0%	1%	12%	0%
VW	29%	1%	30%	6%	23%	3%	30%	0%	27%	1%	30%	5%
Fleet	10%	1%	8%	1%	14%	4%	4%	0%	11%	2%	7%	1%

TDS24 = 24 bar bmep Turbo downsized GDI Engines, where most of these are EGR boosted, TDS27 = EGR boosted turbo downsized GDI 24 bar bmep, HEV= Hybrid Electric Vehicle, EV = Electric Vehicle, PHEV = Plug-in Hybrid Electric Vehicle

It can be seen from this table that the larger volume manufacturers have levels of advanced technologies that are below the phase in caps (described in the next table). On the other hand, smaller "luxury" volume manufacturers tend to require higher levels of these technologies. BMW, Daimler, Volvo, Porsche, Saab, Jaguar/LandRover, and VW all reach the maximum penetration cap for HEVs (30%) in 2021. Suzuki is the only other company with greater than 20% penetration of HEVs and only two manufacturers have greater than 10% penetration of PH/EVs: Porsche and Saab. Together these seven ''luxury'' vehicle manufacturers represent 12% of vehicle sales and their estimated cost of compliance with 2021 proposed standards is $2,178 compared to $744 for the others.

It is important to review some of the caps or limits on the technology phase in rates described in Chapter 3.5.2.3 of the joint TSD as it relates to the remainder of this discussion. These are upper limits on the penetration rates allowed under our modeling, and reflect an estimate of the physical limits for such penetration. It is not a judgment that rates below that cap are practical or reasonable, and is intended to be more of a physical limit of technical capability in light of conditions such as supplier capacity, up-front investment capital requirements, manufacturability, and other factors. For example, in MY 2010, there are presently 3% HEVs in the new vehicle fleet. In MYs 2015, 2021 and 2025 we project that this cap on technology penetration rate increases to 15%, 30% and 50% respectively. For PH/EVs in MY 2010, there is practically none of these technologies. In MYs 2015, 2021 and 2025 we project that this cap on technology penetration rate increases to approximately 5%, 10% and 15% respectively for EVs and PHEVs separately. These highly complex technologies also have the slowest penetration phase-in rates to reflect the relatively long lead time required to implement into substantial fractions of the fleet subject to the manufacturers' product redesign schedules. In contrast, an advanced technology still under development based on an improved engine design, TDS27, has a cap on penetration phase in rate in MYs 2015, 2021, and 2025 of 0%, 15%, and 50% indicative of a longer lead time to develop the technology, but a relatively faster phase in rate once the technology is ''ready'' (consistent with other ''conventional'' evolutionary improvements). Table III–46 summarizes the caps on the phase in rates of some of the key technologies. A penetration rate result from the analysis that approaches the caps for these technologies for a given manufacturer is an indication of how much that manufacturer is being ''pushed'' to technical limits by the standards. This will be in direct correlation to the cost of compliance for that same manufacturer.

Table III-46 Phase-in Rates for Some Key Advanced Technologies

Technology	Abbr.	2016	2021	2025
Turbocharging & downsizing with EGR Level 1 (w/ cooled EGR, 24 bar)	EGRB1 or TDS24	15%	30%	75%
Turbocharging & downsizing with EGR Level 2 (w/ cooled EGR, 27 bar)	EGRB2 or TDS27	0%	15%	50%
Strong Hybrid	HEV	15%	30%	50%
Plug-in Hybrid	PHEV	5%	10%	14%
Electric Vehicle	EV 1	6%	11%	15%

Table III–47 shows the technology penetrations for Alternative 2. Immediately striking is the penetration rates of truck HEVs in the fleet: Even in 2021, it nearly doubles in comparison to the proposal. The Ford truck fleet (to take one of the largest volume manufacturers as an example) increases from 2% HEVs in the proposal trucks to 16% in Alternative 2, an eightfold increase.

There are other significant increases in the larger manufacturers and even more dramatic increases in the HEV penetration in smaller manufacturers' fleets. For example, Suzuki cars now reach the maximum technology penetration cap of 30% for HEVs and Mitsubishi now has 20% HEVs. Also, there are now four manufacturers with total fleet PH/EV penetration rates equal to 10% or greater.

The larger volume manufacturers have an estimated per vehicle cost of compliance with 2021 alternative standards of $1,044, which is $555 higher than the proposed standards. The seven ''luxury'' vehicle manufacturers now have estimated costs of $2,733, which is $300 higher than the proposed standards (See Table III–12 above).

Table III-47 Percent Penetration of Technologies in MY 2021 for Alternative 2

	2021 CAR					2021 TRUCK					2021 Fleet			
	TDS24	TDS27	HEV	PHEV +EV		TDS24	TDS27	HEV	PHEV +EV		TDS24	TDS27	HEV	PHEV +EV
BMW	26%	2%	30%	6%		24%	3%	30%	0%		25%	2%	30%	4%
Chrysler/Fiat	28%	1%	1%	0%		25%	3%	2%	0%		27%	2%	2%	0%
Daimler	21%	4%	30%	12%		14%	6%	30%	0%		20%	4%	30%	9%
Ford	27%	1%	4%	0%		17%	6%	16%	0%		23%	3%	8%	0%
Geely/Volvo	15%	8%	30%	15%		27%	2%	30%	0%		18%	6%	30%	10%
GM	28%	1%	1%	0%		20%	5%	2%	0%		24%	3%	2%	0%
Honda	0%	0%	3%	0%		22%	0%	0%	0%		7%	0%	2%	0%
Hyundai	7%	0%	0%	0%		30%	0%	0%	0%		12%	0%	0%	0%
Kia	0%	0%	0%	0%		9%	0%	0%	0%		2%	0%	0%	0%
Mazda	30%	0%	1%	0%		30%	0%	1%	0%		30%	0%	1%	0%
Mitsubishi	30%	0%	25%	0%		30%	0%	11%	1%		30%	0%	20%	0%
Nissan	30%	0%	1%	0%		24%	3%	0%	0%		28%	1%	1%	0%
Porsche	25%	3%	30%	31%		27%	8%	30%	0%		25%	4%	30%	24%
Spyker/Saab	25%	3%	30%	19%		19%	6%	30%	0%		24%	3%	30%	16%
Subaru	30%	0%	17%	0%		30%	0%	0%	0%		30%	0%	13%	0%
Suzuki	30%	0%	30%	0%		30%	0%	6%	1%		30%	0%	26%	0%
Tata/JLR	7%	11%	30%	13%		10%	10%	30%	11%		9%	11%	30%	12%
Toyota	0%	0%	15%	0%		13%	3%	5%	0%		5%	1%	12%	0%
VW	29%	1%	30%	8%		23%	3%	30%	0%		27%	1%	30%	7%
Fleet	17%	1%	9%	2%		19%	4%	7%	0%		18%	2%	8%	1%

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Table III–48 shows the technology penetrations for Alternative 4 for MY 2021. The large volume manufacturer, Ford now has a 25% penetration rate of truck HEVs (a 23% increase compared to the proposed standards) and the fleet penetration has gone up 11 fold for this company in comparison to the proposed standards.

Mitsubishi, and Suzuki cars now reach the maximum technology penetration cap of 30% for HEVs, and Mazda, Subaru cars as well as Ford trucks now have greater than 20% HEVs. Also, there are now six manufacturers with PH/EV penetration rates greater than 10%.

The larger volume manufacturers now have an estimated per vehicle cost of compliance with 2021 alternative standards of $1,428, which is $683 higher than the proposed standards. The seven ''luxury'' vehicle manufacturers now have estimated costs of $3,499, which is $1,320 higher than the proposed standard (See Table III–32 above). For the seven luxury manufacturers, this per vehicle cost exceeds the costs under the proposal for complying with the considerably more stringent 2025 standards.

Table III-48 Percent Penetration of Technologies in MY 2021 for Alternative 4

	2021 CAR				2021 TRUCK				2021 Fleet			
	TDS24	TDS27	HEV	PHEV +EV	TDS24	TDS27	HEV	PHEV +EV	TDS24	TDS27	HEV	PHEV +EV
BMW	26%	2%	30%	12%	24%	3%	30%	0%	25%	2%	30%	9%
Chrysler/Fiat	28%	1%	1%	0%	25%	3%	2%	0%	27%	2%	2%	0%
Daimler	21%	4%	30%	19%	14%	6%	30%	0%	20%	4%	30%	14%
Ford	27%	1%	14%	0%	17%	6%	25%	1%	23%	3%	18%	0%
Geely/Volvo	15%	8%	30%	21%	27%	2%	30%	0%	18%	6%	30%	15%
GM	28%	1%	0%	0%	20%	5%	2%	0%	24%	3%	1%	0%
Honda	14%	0%	3%	0%	30%	0%	0%	0%	19%	0%	2%	0%
Hyundai	30%	0%	3%	0%	30%	0%	3%	0%	30%	0%	3%	0%
Kia	12%	0%	0%	0%	30%	0%	0%	0%	16%	0%	0%	0%
Mazda	30%	0%	26%	1%	30%	0%	11%	1%	30%	0%	23%	1%
Mitsubishi	30%	0%	30%	3%	30%	0%	11%	2%	30%	0%	23%	2%
Nissan	30%	0%	14%	0%	24%	3%	13%	0%	28%	1%	14%	0%
Porsche	12%	15%	30%	31%	25%	15%	30%	0%	15%	15%	30%	24%
Spyker/Saab	25%	3%	30%	28%	19%	6%	30%	0%	24%	3%	30%	24%
Subaru	30%	0%	27%	1%	30%	0%	23%	0%	30%	0%	26%	1%
Suzuki	30%	0%	30%	7%	30%	0%	6%	2%	30%	0%	26%	6%
Tata/JLR	7%	11%	30%	14%	10%	10%	30%	11%	9%	11%	30%	12%
Toyota	1%	0%	15%	0%	21%	3%	5%	0%	9%	1%	12%	0%
VW	29%	1%	30%	16%	29%	3%	30%	0%	29%	1%	30%	13%
Fleet	21%	1%	12%	3%	22%	4%	9%	0%	21%	2%	11%	2%

Table III–49 shows the technology penetrations for the proposed standards in 2025. The larger volume manufacturers have levels of advanced technologies that are below the phase in caps (described in the next table), though there are some notably high penetration rates for truck HEVs for Ford and Nissan.[362] For the fleet in general, we note a 3% penetration rate of PHEV+EVs—it is interesting to note that this is the penetration rate of HEVs today. EPA believes that there is sufficient lead time to have this level of penetration of these vehicles by 2025. Case in point, it has taken approximately 10 years for HEV penetration to get to the levels that we see today, and that was without an increase in the stringency of passenger car CAFE standards.

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[362] EPA has not conducted an analysis of pickup truck HEV penetration rates compared to the remainder of the truck fleet. This may be conducted for the final rule.

Table III-49 Percent Penetration of Technologies in MY 2025 for the Proposed Standards

	2025 CAR					2025 TRUCK					2025 Fleet			
	TDS24	TDS27	HEV	PHEV +EV		TDS24	TDS27	HEV	PHEV +EV		TDS24	TDS27	HEV	PHEV +EV
BMW	56%	5%	28%	10%		61%	10%	50%	0%		58%	6%	34%	8%
Chrysler/Fiat	70%	2%	19%	1%		61%	8%	10%	1%		66%	5%	15%	1%
Daimler	43%	9%	32%	15%		35%	19%	50%	0%		41%	11%	36%	12%
Ford	64%	4%	13%	4%		40%	20%	31%	3%		56%	9%	19%	4%
Geely/Volvo	31%	16%	41%	15%		66%	6%	50%	0%		42%	13%	44%	11%
GM	68%	2%	15%	3%		51%	15%	3%	1%		60%	8%	10%	2%
Honda	73%	0%	3%	0%		75%	0%	2%	0%		73%	0%	3%	0%
Hyundai	75%	0%	0%	0%		74%	0%	2%	1%		75%	0%	0%	0%
Kia	57%	0%	0%	0%		75%	0%	0%	0%		61%	0%	0%	0%
Mazda	73%	0%	21%	2%		74%	0%	8%	0%		73%	0%	19%	2%
Mitsubishi	69%	0%	21%	6%		71%	0%	9%	4%		70%	0%	17%	5%
Nissan	73%	0%	18%	1%		59%	9%	24%	2%		69%	3%	20%	2%
Porsche	35%	1%	29%	35%		34%	28%	50%	0%		35%	7%	34%	27%
Spyker/Saab	47%	1%	29%	23%		46%	19%	50%	0%		47%	3%	32%	20%
Subaru	70%	0%	20%	5%		74%	0%	19%	1%		71%	0%	19%	4%
Suzuki	66%	0%	25%	9%		72%	0%	5%	3%		67%	0%	22%	8%
Tata/JLR	14%	26%	44%	15%		18%	33%	41%	8%		16%	29%	43%	12%
Toyota	61%	1%	17%	0%		59%	8%	7%	0%		60%	4%	13%	0%
VW	60%	1%	26%	13%		58%	11%	50%	0%		60%	3%	31%	11%
Fleet	65%	2%	15%	4%		57%	11%	13%	1%		62%	5%	15%	3%

Six of the seven luxury vehicle manufacturers reach the maximum penetration cap on their truck portion of their fleet; however, no company reaches 50% for their combined fleet. The seven do have over 30%

penetration rate of HEVs, while Suzuki is the only company to have between 20 and 30% HEVs. Six of the 7 luxury vehicle manufacturers also have greater than 10% penetration of PH/EVs (which has a total cap of 29%). The only company to have large penetration rates (>15%) of TDS27 is Jaguar/LandRover at 29%.

The estimated per vehicle cost of compliance with 2025 proposed standards is $1,943 for the larger volume manufacturers and $3,133 for the seven ''luxury'' vehicle manufacturers.

Table III–50 shows the technology penetrations for Alternative 2 in 2025. In this alternative Chrysler trucks nearly double their penetration rate of HEVs along with dramatic increases in car and truck PH/EVs. GM has a very large increase in truck HEVs as well: From 3% in the proposed to 39% in the alternative standards along with a doubling of PH/EVs. Toyota also has double the number of HEVs. In this alternative there are many more companies with 20–30% HEVs: Chrysler, Ford, GM, Mitsubishi, Nissan, Subaru, Suzuki, and Toyota. Suzuki (in addition to the seven) now also has 10% or greater penetration of PH/EVs. Ford, GM, Chrysler, and Nissan now have more than 20% penetration of HEVs in trucks.

The estimated per vehicle cost of compliance with 2025 alternative 2 standards is $2,354, which is $410 higher than the proposed standards. The seven luxury vehicle manufacturers now have costs of $3,616, which is $483 higher than the proposed standards. See Table III–32 above.

Table III-50 Percent Penetration of Technologies in MY 2025 for Alternative 2

	2025 CAR					2025 TRUCK					2025 Fleet			
	TDS24	TDS27	HEV	PHEV +EV		TDS24	TDS27	HEV	PHEV +EV		TDS24	TDS27	HEV	PHEV +EV
BMW	52%	4%	28%	15%		61%	10%	50%	0%		55%	6%	34%	11%
Chrysler/Fiat	64%	2%	20%	8%		59%	8%	21%	3%		62%	5%	20%	6%
Daimler	42%	6%	32%	19%		35%	19%	50%	0%		41%	9%	36%	15%
Ford	61%	4%	19%	7%		38%	20%	38%	5%		54%	9%	25%	7%
Geely/Volvo	30%	11%	41%	21%		66%	6%	50%	0%		41%	10%	44%	15%
GM	64%	2%	20%	7%		51%	15%	39%	1%		58%	8%	29%	4%
Honda	71%	0%	13%	1%		73%	0%	10%	2%		72%	0%	12%	1%
Hyundai	73%	0%	9%	2%		74%	0%	2%	1%		74%	0%	7%	1%
Kia	75%	0%	0%	0%		75%	0%	0%	0%		75%	0%	0%	0%
Mazda	70%	0%	21%	5%		74%	0%	8%	1%		71%	0%	19%	4%
Mitsubishi	64%	0%	25%	11%		71%	0%	9%	4%		66%	0%	20%	9%
Nissan	69%	0%	24%	5%		59%	9%	27%	2%		66%	3%	25%	4%
Porsche	30%	1%	29%	40%		34%	28%	50%	0%		31%	7%	34%	31%
Spyker/Saab	45%	1%	29%	25%		46%	19%	50%	0%		45%	3%	32%	22%
Subaru	68%	0%	22%	7%		74%	0%	19%	1%		69%	0%	22%	6%
Suzuki	63%	0%	25%	12%		72%	0%	5%	3%		65%	0%	22%	10%
Tata/JLR	14%	22%	44%	19%		10%	33%	41%	15%		13%	27%	43%	18%
Toyota	58%	1%	30%	3%		58%	8%	17%	0%		58%	4%	25%	2%
VW	57%	0%	26%	17%		58%	11%	50%	0%		57%	3%	31%	13%
Fleet	63%	2%	21%	7%		56%	11%	27%	2%		60%	5%	23%	5%

Table III–51 shows the technology penetrations for Alternative 4 in 2025. In this alternative every company except Honda, Hyundai, Kia have greater than 20% HEVs. Many of the large volume manufacturers have even more dramatic increases in the volumes of P/H/EVs than in Alternative 2. Ford, GM, Nissan, and Toyota have greater than 20 or 30% penetration rates of HEVs on trucks. Mazda, Mitsubishi, Subaru, Suzuki (in addition to the seven) now also have 10% or greater penetration of PH/EVs, while Daimler, Volvo, Porsche, Saab, and VW have over 20%.

The estimated per vehicle cost of compliance with 2025 alternative standards is $2,853, which is $910 higher than the proposed standards. The seven luxury vehicle manufacturers now have costs of $4,481, which is $1,348 higher than the proposed standards. Much of this non-linear increase in cost is due to increased penetration of PHEVs and EVs (more so than HEVs).

Table III-51 Percent Penetration of Technologies in MY 2025 for Alternative 4

	2025 CAR					2025 TRUCK					2025 Fleet			
	TDS24	TDS27	HEV	PHEV +EV		TDS24	TDS27	HEV	PHEV +EV		TDS24	TDS27	HEV	PHEV +EV
BMW	48%	1%	28%	23%		61%	10%	50%	0%		51%	3%	34%	17%
Chrysler/Fiat	64%	2%	24%	8%		59%	8%	21%	3%		62%	5%	23%	6%
Daimler	38%	2%	32%	28%		35%	19%	50%	0%		37%	6%	36%	22%
Ford	58%	4%	28%	11%		38%	20%	44%	6%		52%	9%	33%	9%
Geely/Volvo	26%	6%	41%	30%		66%	6%	50%	0%		38%	6%	44%	21%
GM	64%	2%	20%	7%		51%	15%	39%	1%		58%	8%	29%	4%
Honda	68%	0%	16%	4%		71%	0%	17%	4%		69%	0%	16%	4%
Hyundai	67%	0%	20%	8%		74%	0%	7%	1%		69%	0%	17%	6%
Kia	71%	0%	20%	4%		75%	0%	0%	0%		72%	0%	16%	3%
Mazda	62%	0%	22%	13%		72%	0%	42%	3%		64%	0%	25%	11%
Mitsubishi	61%	0%	25%	14%		70%	0%	25%	5%		64%	0%	25%	11%
Nissan	66%	0%	25%	9%		57%	9%	39%	4%		63%	3%	29%	7%
Porsche	0%	14%	41%	45%		11%	50%	50%	0%		2%	22%	43%	35%
Spyker/Saab	34%	1%	29%	36%		46%	19%	50%	0%		36%	3%	32%	31%
Subaru	63%	0%	25%	12%		69%	0%	25%	6%		65%	0%	25%	10%
Suzuki	55%	0%	25%	20%		72%	0%	45%	3%		58%	0%	28%	17%
Tata/JLR	14%	20%	44%	21%		10%	33%	41%	15%		13%	26%	43%	18%
Toyota	57%	1%	30%	5%		57%	8%	26%	1%		57%	4%	28%	3%
VW	47%	0%	26%	27%		58%	11%	50%	0%		49%	2%	31%	21%
Fleet	59%	1%	24%	10%		55%	11%	33%	2%		58%	4%	27%	8%

d. Summary of the Technology Penetration Rates and Costs From the Alternative Scenarios in Relation to the Proposed Standards

As described above, alternatives 2 and 4 would lead to significant increases in the penetration of advanced technologies into the fleet during the time frame of these standards. In general, both alternatives would lead to an increase in the average penetration rate for advanced technologies in 2021, in effect accelerating some of the technology penetration that would otherwise occur in the 2022–2025 timeframe. For the fleet as a whole, in 2021 alternative 2 would lead to a significant increase in cooled EGR use and a limited increase in HEV use, while alternative 4 would lead to an even larger increase in cooled EGR as well as a significant increase in HEV use. In 2025 these alternatives would dramatically affect penetration rates of HEVs, EVs, and PHEVs, in each case leading to very significant increases on average for the fleet. Again, Alternative 4 would lead to greater penetration rates than Alternative 2. When one considers the technology penetration rates for individual manufacturers, in 2021 the alternatives lead to much higher increases than average for some individual large volume manufacturers. Smaller volume manufacturers start out with higher penetration rates and are pushed to even higher levels. This result is even more pronounced in 2025.

This increase in technology penetration rates raises serious concerns about the ability and likelihood manufacturers can smoothly implement the increased technology penetration in a fleet that has so far seen limited usage of these technologies, especially for trucks—and for towing trucks in particular. While this is more pronounced for 2025, there are still concerns for the 2021 technology penetration rates. Although EPA believes that these penetration rates are, in the narrow sense, technically achievable, it is more a question of judgment whether we are confident at this time that these increased rates of advanced technology usage can be practically and smoothly implemented into the fleet—a reason the agencies are attempting to encourage more utilization of this technology with the proposed HEV pickup truck credits but being reasonably prudent in proposing standards that could de facto force high degrees of penetration of this technology on towing trucks.[363]

EPA notes that the same concerns support the proposed decision to steepen the slope of the truck curve in acknowledgement of the special challenges these larger footprint trucks (which in many instances are towing vehicles) would face. Without the steepening, the penetration rates of these challenging technologies would have been even greater.

From a cost point of view, the impacts on cost track fairly closely with the technology penetration rates discussed above. The average cost increases under Alternatives 2 and 4 are significant for 2021 (approximately $300 and $600), and for some manufacturers they result in very large cost increases. For 2025 the cost increases are even higher (approximately $500 and $900). Alternative 4, as expected, is significantly more costly than alternative 2. From another perspective, the average cost of compliance to the industry on average is $23 and $44 billion for the 2021 and 2025 proposed standards respectively. Alternative 2 will cost the industry on average $7 and $9 billion in excess, while Alternative 4 will cost the industry on average $10 and $16 billion in excess of the costs for the proposed standards. These are large increases in percentage terms, ranging from approximately 25% to 45% in 2021, and from approximately 20% to 35% in 2025.

Per vehicle costs will also increase dramatically including for some of the largest, full-line manufacturers. Under Alternative 2, per vehicle costs for Chrysler, Ford, GM, Honda and Nissan increase by an estimated one-third to nearly double (200%) to meet 2021 standards and from roughly 25% to 45% to meet 2025 standards (see Table III–31 and Table III–32 above). The per-vehicle costs to meet Alternative 4 for these manufacturers is significantly greater and in the same proportions, see Table III–38 and Table III–39.

As noted, these cost increases are associated especially with increased utilization of advanced technologies. As shown in Figure below, HEV+PHEV+EV penetration are projected to increase in 2025 from 17% in the proposed standards to 28% and to nearly 35% under Alternatives 2 and 4 respectively for manufacturers with annual sales above 500,000 vehicles (including Chrysler, Ford, GM, Honda, Hyundai, Nissan, Toyota and VW). The differences are less pronounced for 2021, but still (in alternative 4) over double the penetration level of the proposal. EPA regards these differences as significant, given the factors of expense, consumer cost, consumer acceptance, and potentially (for 2021) lead time.

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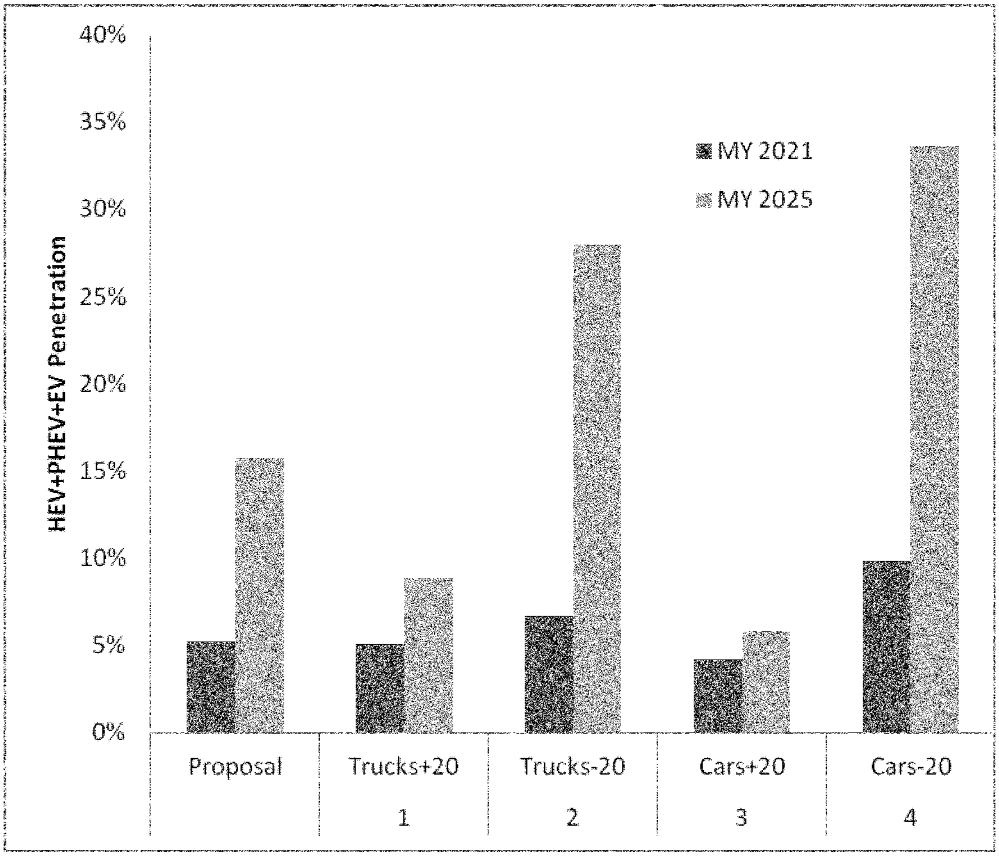
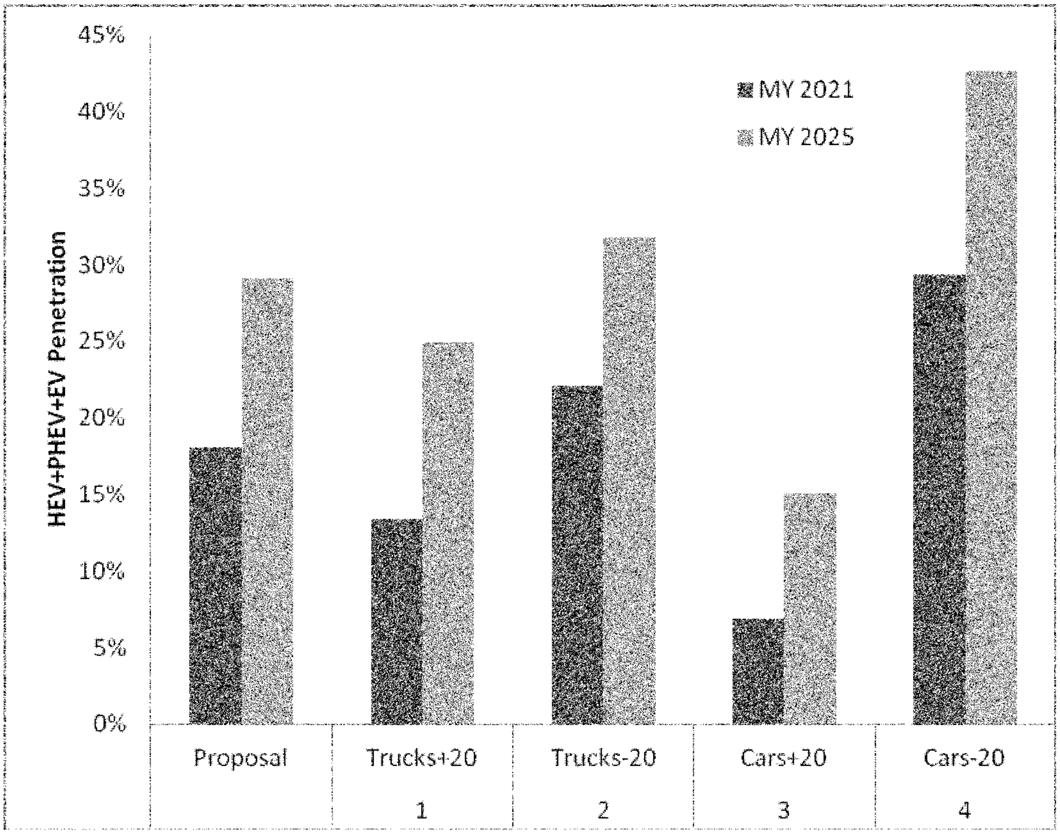
[363] See 76 FR at 57220 discussing a similar issue in the context of the standards for heavy duty pickups and vans: ''Hybrid electric technology likewise could be applied to heavy-duty vehicles, and in fact has already been so applied on a limited basis. However, the development, design, and tooling effort needed to apply this technology to a vehicle model is quite large, and seems less likely to prove cost-effective in this time frame, due to the small sales volumes relative to the light-duty sector. Here again, potential customer acceptance would need to be better understood because the smaller engines that facilitate much of a hybrid's benefit are typically at odds with the importance pickup truck buyers place on engine horsepower and torque, whatever the vehicle's real performance''.

Figure 5- HEV + PHEV + EV Penetration for Manufacturers above 500,000 Sales



The Figure below shows the HEV+PHEV+EV penetration for manufacturers with sales below 500,000 but exceeding 30,000 (including BMW, Daimler, Volvo, Kia, Mazda, Mitsubishi, Porsche, Subaru, Suzuki, and Jaguar/LandRover while excluding Aston Martin, Ferrari, Lotus, Saab, and Tesla). While the penetration rates of these advanced technologies also increase, the distribution within these are shifting to the higher cost EVs and PHEVs as noted above.

Figure 6- HEV + PHEV + EV Penetration for Manufacturers below 500,000 (but above 30,000 Sales)



EPA did not model a number of flexibilities when conducting the analysis for the NPRM. For example, PHEV, EV and fuel cell vehicle incentive multipliers for 2017–2021, full size pickup truck HEV incentive credits, full size pickup truck performance based incentive credits, and off-cycle credits, were not explicitly captured. We plan on modeling these flexibilities for the final rule. For this proposal, while we have not been able to explicitly model the impacts on the program costs, the impact will only be to reduce the estimated costs of the program for most manufacturers. From an industry wide perspective, EPA expects that their overall impact on costs, technology penetration, and emissions reductions and other benefits will be limited. They will provide some additional, important flexibility in achieving the proposed levels and promoting more advanced technology, on a case by case basis, but their impact is not expected to be of enough significance to warrant a change to the standards proposed. Instead they are expected to support the reasonableness of the proposed standards.

Overall, EPA believes that the characteristics and impacts of these and other alternative standards generally reflect a continuum in terms of technical feasibility, cost, lead time, consumer impacts, emissions reductions and oil savings, and other factors evaluated under section 202 (a). In determining the appropriate standard to propose in this context, EPA judges that the proposed standards are appropriate and preferable to more stringent alternatives based largely on consideration of cost—both to manufacturers and to consumers—and the potential for overly aggressive penetration rates for advanced technologies relative to the penetration rates seen in the proposed standards, especially in the face of unknown degree of consumer acceptance of both the increased costs and the technologies themselves. At the same time, the proposal helps to address these issues by providing incentives to promote early and broader deployment of advanced technologies, and so provides a means of encouraging their further penetration while leaving manufacturers alternative technology choices. EPA thus judges that the increase in technology penetration rates and the increase in costs under the increased stringency for the car and truck fleets reflected in alternatives 2 and 4 are such that it would not be appropriate to propose standards that would increase the stringency of the car and truck fleets in this manner.

The two tables below shows the year on year costs as described in greater detail in Chapter 5 of the RIA. These projections show a steady increase in costs from 2017 thru 2025 (as interpolated).

Table III-52 Costs by Manufacturer by MY– Combined Fleet (2009$)

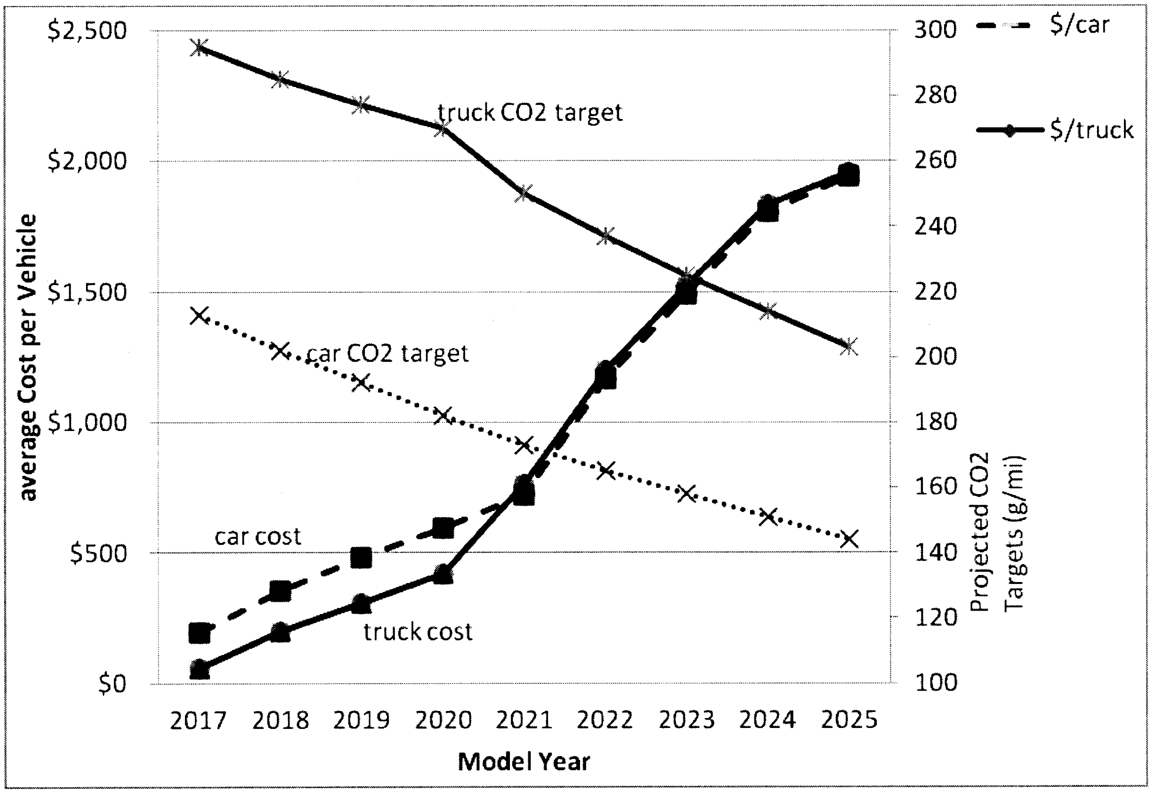
Company	2017	2018	2019	2020	2021	2022	2023	2024	2025
BMW	$154	$370	$531	$696	$937	$1,413	$1,746	$2,058	$2,174
Chrysler/Fiat	$137	$266	$367	$475	$698	$1,179	$1,541	$1,893	$2,043
Daimler	$287	$671	$980	$1,297	$1,702	$2,226	$2,478	$2,704	$2,707
Ferrari	$1,634	$3,080	$4,170	$5,267	$6,351	$7,367	$7,487	$7,598	$7,109
Ford	$147	$293	$403	$501	$696	$1,208	$1,614	$2,003	$2,178
Geely-Volvo	$345	$746	$1,039	$1,339	$1,741	$2,297	$2,585	$2,858	$2,876
GM	$138	$247	$332	$410	$590	$1,080	$1,473	$1,850	$2,030
Honda	$55	$182	$281	$382	$556	$922	$1,201	$1,472	$1,595
Hyundai	$97	$253	$372	$492	$669	$1,062	$1,347	$1,622	$1,739
Kia	$75	$198	$303	$411	$582	$910	$1,155	$1,391	$1,491
Mazda	$134	$362	$534	$696	$919	$1,377	$1,697	$2,012	$2,131
Mitsubishi	$91	$304	$455	$614	$877	$1,349	$1,687	$2,007	$2,133
Nissan	$151	$312	$437	$558	$729	$1,204	$1,565	$1,910	$2,060
Porsche	$1,052	$2,077	$2,840	$3,618	$4,482	$5,262	$5,321	$5,377	$5,012
Spyker-Saab	$755	$1,431	$1,936	$2,444	$2,986	$3,582	$3,721	$3,851	$3,670
Subaru	$178	$410	$582	$755	$994	$1,470	$1,790	$2,096	$2,202
Suzuki	$239	$498	$692	$885	$1,132	$1,592	$1,881	$2,153	$2,225
Tata-JLR	$178	$644	$972	$1,333	$1,935	$2,494	$2,752	$2,994	$2,976
Toyota	$71	$174	$253	$324	$481	$820	$1,096	$1,358	$1,483
Volkswagen	$316	$644	$898	$1,153	$1,457	$1,947	$2,218	$2,472	$2,506
Fleet	$146	$299	$418	$533	$734	$1,176	$1,503	$1,815	$1,946

Table III-53 Industry Average Vehicle Costs Associated with the Proposed Standards (2009$)

Model Year	2017	2018	2019	2020	2021	2022	2023	2024	2025
$/car	$194	$353	$479	$595	$718	$1,165	$1,492	$1,806	$1,942
$/truck	$55	$198	$305	$417	$764	$1,200	$1,525	$1,834	$1,954
Combined	$146	$299	$418	$533	$734	$1,176	$1,503	$1,815	$1,946

Figure 7 below shows graphically the year on year average costs presented in Table III–53 with the per vehicle costs on the left axis and the projected CO_2 target standards on the right axis. It is quite evident and intuitive that as the stringency of the standard gets tighter, the average per vehicle costs increase. It is also clear that the costs for cars exceed that of trucks for the early years of the program, but then progress upwards together starting in MY 2021. It is interesting to note that the slower rate of progression of the standards for trucks seems to result in a slower rate of increase in costs for both cars and trucks. This initial slower rate of stringency for trucks is appropriate due primarily concerns over technology penetration rates and disproportionately higher costs for adding technologies to trucks than cars, as described in Section III.D.6.b above. The figure below corroborates these conclusions and further demonstrates that based on the smooth progression of average costs (from 2017–2025), the year on year increase in stringency of the standards is also reasonable. Though there are undoubtedly a range of minor modifications that could be made to the progression of standards, EPA believes that the progression proposed is reasonable and appropriate. Also, EPA believes that any progression of standards that significantly deviates from the proposed standards (such as those in Alternatives 1 through 4) are much less appropriate for the reasons provided in the discussion above.

Figure 7. Year on Year Progression of Projected (Target) CO2 Standards and Average Cost Per Vehicle



7. To what extent do any of today's vehicles meet or surpass the proposed MY 2017–2025 CO_2 footprint-based targets with current powertrain designs?

In addition to the analysis discussed above regarding what technologies could be added to vehicles in order to achieve the projected CO_2 obligation for each automotive company under the proposed MY 2017 to 2025 standards, EPA performed an assessment of the light-duty vehicles available in the market today to see how such vehicles compare to the proposed MY 2017–2025 footprint-based standard curves. This analysis supports EPA's overall assessment that there are a broad range of effective and available technologies that could be used to achieve the proposed standards, as well as illustrating the need for the lead-time between today and MY 2017 to MY 2025 in order for continued refinement of today's technologies and their broader penetration across the fleet for the industry as a whole as well as individual companies. In addition, this assessment supports EPA's view that the proposed standards would not interfere with consumer utility—footprint-attribute standards provide manufacturers with the ability to offer consumers a full range of vehicles with the utility customers want, and does not require or encourage companies to just produce small passenger cars with very low CO_2 emissions.

Using publicly available data, EPA compiled a list of available vehicles and their 2-cycle CO_2 emissions performance (that is, the performance over the city and highway test cycles required by this proposal). Data is currently available for all MY 2011 vehicles and some MY 2012 vehicles. EPA gathered vehicle footprint data from EPA reports, manufacturer submitted CAFE reports, and manufacturer Web sites.

EPA evaluated these vehicles against the proposed CO_2 footprint-based standard curves to determine which vehicles would meet or exceed the proposed MY 2017–MY 2025 footprint-based CO_2 targets assuming air conditioning credit generation consistent with today's proposal. Under the proposed 2017–2025 greenhouse gas emissions standards, each vehicle will have a unique CO_2 target based on the vehicle's footprint. However, it is important to note that the proposed CO_2 standard is a company-specific sales weighted fleet-wide standard for each company's passenger cars and truck fleets calculated using the proposed footprint-based standard curves. No individual vehicle is required to achieve a specific CO_2 target. In this analysis, EPA assumed usage of air conditioner credits because air conditioner improvements are considered to be among the cheapest and easiest technologies to reduce greenhouse gas emissions, manufacturers are already investing in air conditioner improvements, and air conditioner changes do not impact engine, transmission, or aerodynamic designs so assuming such credits does not affect consideration of cost and leadtime for use of these other technologies. In this analysis, EPA assumed increasing air conditioner credits over time with a phase-in of alternative refrigerant for the generation of HFC leakage reduction credits consistent with the assumed phase-in schedule discussed in Section III.C.I. of this preamble. No adjustments were made to vehicle CO_2 performance other then this assumption of air conditioning credit generation. Under this analysis, a wide range of existing vehicles would meet the MY 2017 proposed CO_2 targets, and a few meet even the proposed MY 2025 CO_2 targets. The details regarding this assessment are in Chapter 3 of the EPA Draft RIA.

This assessment shows that a significant number of vehicles models sold today (nearly 40 models) would meet or be lower than the proposed MY 2017 footprint-based CO_2 targets with current powertrain designs, assuming air conditioning credit generation consistent with our proposal. The list of vehicles includes a full suite of vehicle sizes and classes, including midsize cars, minivans, sport utility vehicles, compact cars, small pickup trucks and full size pickup trucks—all of which meet the proposed MY 2017 target values with no technology improvements other than air conditioning system upgrades. These vehicles utilize a wide variety of powertrain technologies and operate on a variety of different fuels including gasoline, diesel, electricity, and compressed natural gas. Nearly every major manufacturer currently produces vehicles that would meet or exceed the proposed MY 2017 footprint CO_2 target with only improvements in air conditioning systems. For all of these vehicle classes the MY 2017 targets are achieved with conventional gasoline powertrains, with the exception of the full size (or ''standard'') pickup trucks. In the case of full size pickups trucks, only HEV versions of the Chevrolet Silverado and the GMC Sierra fall into this category (though the HEV Silverado and Sierra meet not just the MY 2017 footprint-based CO_2 targets with A/C improvements, but their respective targets through MY 2022). As the CO_2 targets become more stringent each model year, fewer MY 2011 and MY 2012 vehicles achieve or surpass the proposed CO_2 targets, in particular for gasoline powertrains. While approximately 15 unique gasoline vehicle models achieve or surpass the MY 2017 targets, this number falls to approximately 11 for the MY 2018 targets, 9 for the model year 2019 targets, and only 2 unique gasoline vehicle models can achieve the MY 2020 proposed CO_2 targets with A/C improvements.

EPA also assessed the subset of these vehicles that have emissions within 5%, of the proposed CO_2 targets. As detailed in Chapter 3 of the EPA Draft RIA, the analysis shows that there are more than twenty additional vehicle models (primarily with gasoline and diesel powertrains) that are within 5% of the proposed MY 2017 CO_2 targets, including compact cars, midsize cars, large cars, SUVs, station wagons, minivans, small and standard pickup trucks. EPA also receives projected sales data prior to each model year from each manufacturer. Based on this data, approximately 7% of MY 2011 sales will be vehicles that would meet or be better than the proposed MY 2017 targets for those vehicles, requiring only improvements in air conditioning systems. In addition, nearly 15% of projected MY 2011 sales would be within 5% of the proposed MY 2017 footprint CO_2 target with only simple improvements to air conditioning systems, a full six model years before the proposed standard takes effect. With improvements to air conditioning systems, the most efficient gasoline internal combustion engines would meet the MY 2020 proposed footprint targets. After MY 2020, the only current vehicles that continue to meet the proposed footprint-based CO_2 targets (assuming improvements in air conditioning) are hybrid-electric, plug-in hybrid-electric, and fully electric vehicles. However, the proposed MY 2021 standards, if finalized, would not need to be met for another 9 years. Today's Toyota Prius, Ford Fusion Hybrid, Chevrolet Volt, Nissan Leaf, Honda Civic Hybrid, and Hyundai Sonata Hybrid all meet or surpass the proposed footprint-based CO_2 targets through MY 2025. In fact, the current Prius, Volt, and Leaf meet the proposed 2025 CO_2 targets without air conditioning credits.

This assessment of MY 2011 and MY 2012 vehicles makes it clear that HEV technology (and of course EVs and PHEVs) is capable of achieving the MY 2025 standards. However, as discussed earlier in this section, EPA's modeling projects that the MY 2017–2025 standards can primarily be achieved by advanced gasoline vehicles—for example, in MY 2025, we project more than 80 percent of the new vehicles could be advanced gasoline powertrains. The assessment of MY 2011 and MY 2012 vehicles available in the market today indicates advanced gasoline vehicles (as well as diesels) can achieve the targets for the early model years of the proposed standards (*i.e.,* model years 2017–2020) with only improvements in air conditioning systems. However, significant improvements in technologies are needed and penetrations of those technologies must increase substantially in order for individual manufacturers (and the fleet overall) to achieve the proposed standards for the early years of the program, and certainly for the later years (*i.e.,* model years 2021–2025). These technology improvements are the very technologies EPA and NHTSA describe in detail in Chapter 3 of the draft Joint Technical Support Document and which we forecasted penetration rates earlier in this section III.D, and they include for example: gasoline direct injection fuel systems; downsized and turbocharged gasoline engines (including in some cases with the application of cooled exhaust gas recirculation); continued improvements in engine friction reduction and low friction lubricants; transmissions with an increased number of forward gears (*e.g.,* 8 speeds); improvements in transmission shifting logic; improvements in transmission gear box efficiency; vehicle mass reduction; lower rolling resistance tires, and improved vehicle aerodynamics. In many (though not all) cases these technologies are beginning to penetrate the U.S. light-duty vehicle market.

In general, these technologies must go through the automotive product development cycle in order to be introduced into a vehicle. In some cases additional research is needed before the technologies' CO_2 benefits can be fully realized and large-scale manufacturing can be achieved. The subject of technology penetration phase-in rates is discussed in more detail in Chapter 3.5 of the draft Joint Technical Support Document. In that Chapter, we explain that why many CO_2 reducing technologies should be able to penetrate the new vehicle market at high levels between now and MY 2016. There are also many of the key technologies we project as being needed to achieve the proposed 2017–2025 standards which will only be able to penetrate the market at relatively low levels (*e.g.,* a maximum level of 30% or less) by MY 2016, and even by MY 2021. These include important powertrain technologies such as 8-speed transmissions and second or third generation downsized engines with turbocharging,

The majority of these technologies must be integrated into vehicles during the product redesign schedule, which is typically on a 5-year cycle. EPA discussed in the MY 2012–2016 rule the significant costs and potential risks associated with requiring major technologies to be added in-between the typical 5-year vehicle redesign schedule (see 75 FR at 25467–68, May 7, 2010). In addition, engines and transmissions generally have longer lifetimes then 5 years, typically on the order of 10 years. Thus major powertrain technologies generally take longer to penetrate the new vehicle fleet then can be done in a 5-year redesign cycle. As detailed in Chapter 3.5 of the draft Joint TSD, EPA projects that 8-speed transmissions could increase their maximum penetration in the fleet from 30% in MY 2016 to 80% in 2021 and to 100% in MY 2025. Similarly, we project that second generation downsized and turbocharged engines (represented in our assessment as engines with a brake-mean effective pressure of 24 bars) could penetrate the new vehicle fleet at a maximum level of 15% in MY 2016, 30% in MY 2021, and 75% in MY 2025. When coupled with the typical 5-year vehicle redesign schedule, EPA projects that it is not possible for all of the advanced gasoline vehicle technologies we have assessed to penetrate the fleet in a single 5-year vehicle redesign schedule.

Given the status of the technologies we project to be used to achieve the proposed MY2017–2025 standards and the product development and introduction process which is fairly standard in the automotive industry today, our assessment of the MY2011 and MY2012 vehicles in comparison to the proposed standards supports our overall feasibility assessment, and reinforces our assessment of the lead time needed for the industry to achieve the proposed standards.

E. Certification, Compliance, and Enforcement

1. Compliance Program Overview

This section summarizes 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 GHG and Corporate Average Fuel Economy (CAFE) testing and reporting requirements. The EPA and NHTSA programs replicate the compliance protocols established in the MY 2012–2016 rule.[364] The certification, testing, reporting, and associated compliance activities track current practices and are thus familiar to manufacturers. As is the case under the 2012–2016 program, EPA and NHTSA have designed a coordinated compliance approach for 2017–2025 such that the compliance mechanisms for both GHG and CAFE standards are consistent and non-duplicative. Readers are encouraged to review the MY 2012–2016 final rule for background and a detailed description of these certification, compliance, and enforcement requirements.

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. 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

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[364] 75 FR 25468.

Section III.C. The compliance program is summarized 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, 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 II*I.E.*5.h of the MY 2012–2016 final rule preamble (see 75 FR 25481).

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.B). 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 II*I.E.*6 below.

b. Required Minimum Testing For Fleet Average CO_2

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. Please see Section II*I.E.*2.b of the MY 2012–2016 final rule preamble (75 FR 25469) for details.

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.[365]

Since compliance with a fleet average standard depends on actual production volumes, 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 will continue to 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. Please see Section II*I.E.*3 of the MY 2012–2016 final rule preamble (75 FR 25470) for a discussion of how EPA will certify vehicles under the GHG standards.

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. The in-use CO_2 standard under the greenhouse gas program would apply to individual vehicles and is separate from the fleet-average standard. The in-use CO_2 standard for each model would be the model specific CO_2 level used in calculating the fleet average, adjusted to be 10% higher to account for test-to-test and production variability that might affect in-use test results. Please see Section II*I.E.*4 of the MY 2012–2016 final rule preamble (75 FR 25473 for a detailed discussion of the in-use standard, in-use testing requirements, and deterioration factors for CO_2, N_2O, and CH_4.

5. Credit Program Implementation

As described in Section III.C, several credit programs are available under this rulemaking. Please see Section II*I.E.*5 of the MY 2012–2016 final rule preamble (75 FR 25477) for a detailed explanation of credit program implementation, sample credit and deficit calculations, and end-of-year reporting requirements.

6. Enforcement

The enforcement structure EPA promulgated under the MY 2012–2016 rulemaking remains in place. Please see Section II*I.E.*6 of the MY 2012–2016 final rule preamble (75 FR 25482) for a discussion of these provisions.

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. This proposal includes a section that details these prohibited acts, as did the 2012 greenhouse gas regulations.

7. 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 would continue to apply this policy to CO_2, N_2O and CH_4 certification test data and would allow manufacturers 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 covered by this rule.

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 would exempt small entities, and these entities (necessarily) would not be subject to the certification requirements of this rule.

As discussed in Section III.B.7, businesses meeting the Small Business Administration (SBA) criterion of a small business as described in 13 CFR 121.201 would not be subject to the GHG requirements, pending future regulatory action. 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.

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[365] CAA section 206(a)(1).

As discussed in detail in Section III.B.5, small volume manufacturers with annual sales volumes of less than 5,000 vehicles would be required to meet primary GHG standards or to petition the Agency for alternative standards.

d. Onboard Diagnostics (OBD) and CO_2 Regulations

As under the current program, EPA would not require CO_2, N_2O, and CH_4 emissions as one of the applicable standards required for the OBD monitoring threshold.

e. Applicability of Current High Altitude Provisions to Greenhouse Gases

As under the current program, vehicles covered by this rule would be required to meet the CO_2, N_2O and CH_4 standard at altitude but would not normally be required to submit vehicle CO_2 test data for high altitude. Instead, they would submit an engineering evaluation indicating that common calibration approaches will be utilized at high altitude.

f. Applicability of Standards to Aftermarket Conversions

With the exception of the small entity and small business exemptions, EPA's emission standards, including greenhouse gas standards, will continue to apply as stated in the applicability sections of the relevant regulations. EPA expects that some aftermarket conversion companies will qualify for and seek the small entity and/or small business exemption, but those that do not qualify will be required to meet the applicable emission standards, including the greenhouse gas standards to qualify for a tampering exemption under 40 CFR subpart F. Fleet average standards are not generally appropriate for fuel conversion manufacturers because the ''fleet'' of vehicles to which a conversion system may be applied has already been accounted for under the OEM's fleet average standard. Therefore, EPA is proposing to retain the process promulgated in 40 CFR subpart F anti-tampering regulations whereby conversion manufacturers demonstrate compliance at the vehicle rather than the fleet level. Fuel converters will continue to show compliance with greenhouse gas standards by submitting data to demonstrate that the conversion EDV N_2O, CH_4 and CREE results are less than or equal to the OEM's in-use standard for that subconfiguration.. EPA is also proposing to continue to allow conversion manufacturers, on a test group basis, to convert CO_2 overcompliance into CO_2 equivalents of N_2O and/or CH_4 that can be subtracted from the CH_4 and N_2O measured values to demonstrate compliance with CH_4 and/or N_2O standards.

g. Geographical Location of Greenhouse Gas Fleet Vehicles

EPA emission certification regulations require emission compliance[366] 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.

8. Warranty, Defect Reporting, and Other Emission-Related Components Provisions

This rulemaking would retain warranty, defect reporting, and other emission-related component provisions promulgated in the MY 2012–2016 rulemaking. Please see Section II*I.E.*10 of the MY 2012–2016 final rule preamble (75 FR 25486) for a discussion of these provisions.

9. Miscellaneous Technical Amendments and Corrections

EPA is proposing a number of noncontroversial amendments and corrections to the existing regulations. Because the regulatory provisions for the EPA greenhouse gas program, NHTSA's CAFE program, and the joint fuel economy and environment labeling program are all intertwined in 40 CFR Part 600, this proposed rule presents an opportunity to make corrections and clarifications to all or any of these programs. Consequently, a number of minor and non-substantive corrections are being proposed to the regulations that implement these programs.

Amendments include the following:

- In section 86.135–12, we have removed references to the model year applicability of N_2O measurement. This applicability is covered elsewhere in the regulations, and we believe that—where possible—testing regulations should be limited to the specifics of testing and measurement.
- The definition of ''Footprint'' in 86.1803–01 is revised to clarify measurement and rounding. The previous definition stated that track width is ''measured in inches,'' which may inadvertently imply measuring and recording to the nearest inch. The revised definition clarifies that measurements should be to the nearest one tenth of an inch, and average track width should be rounded to the nearest tenth of an inch.

We are also proposing a solution to a situation in which a manufacturer of a clean alternative fuel conversion is attempting to comply with the fuel conversion regulations (see 40 CFR part 85 subpart F) at a point in time before which certain data is available from the original manufacturer of the vehicle. Clean alternative fuel conversions are subject to greenhouse gas standards if the vehicle as originally manufactured was subject to greenhouse gas standards, unless the conversion manufacturer qualifies for exemption as a small business. Compliance with light-duty vehicle greenhouse gas emission standards is demonstrated by complying with the N_2O and CH_4 standards and the in-use CO_2 exhaust emission standard set forth in 40 CFR 86.1818–12(d) as determined by the original manufacturer for the subconfiguration that is identical to the fuel conversion emission data vehicle (EDV). However, the subconfiguration data may not be available to the fuel conversion manufacturer at the time they are seeking EPA certification. Several compliance options are currently provided to fuel conversion manufacturers that are consistent with the compliance options for the original equipment manufacturers. EPA is proposing to add another option that would be applicable starting with the 2012 model year. The new option would allow clean alternative fuel conversion manufacturers to satisfy the greenhouse gas standards if the sum of CH_4 plus N_2O plus CREE emissions from the vehicle pre-conversion is less than the sum post-conversion, adjusting for the global warming potential of the constituents.

10. Base Tire Definition

One of the factors in a manufacturer's calculation of vehicle footprint is the base tire. Footprint is based on a vehicle's wheel base and track width, and track width in turn is ''the lateral distance between the centerlines of the base tires at ground, including the camber angle.''[367] EPA's current definition of base tire is the ''tire specified as standard equipment by the

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[366] 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.''

[367] See 40 CFR 86.1803–01.

manufacturer.''[368] EPA understands that some manufacturers may be applying this base tire definition in different ways, which could lead to differences across manufacturers in how they are ultimately calculating footprints. EPA invites public comment on whether the base tire definition should be clarified to ensure a more uniform application across manufacturers. For example, NHTSA is proposing a specific change to the base tire definition for the CAFE program (see Section IV.I.5.g, and proposed 49 CFR 523.2). Because the calculation of footprint is a fundamental aspect of both the greenhouse gas standards and the CAFE standards, EPA welcomes comments on whether the existing base tire definition should be clarified, and specific changes to the definition that would address this issue.

11. Treatment of Driver-Selectable Modes and Conditions

EPA is requesting comments on whether there is a need to clarify in the regulations how EPA treats driver-selectable modes (such as multi-mode transmissions and other user-selectable buttons or switches) that may impact fuel economy and GHG emissions. New technologies continue to arrive on the market, with increasing complexity and an increasing array of ways a driver can make choices that affect the fuel economy and greenhouse gas emissions. For example, some start-stop systems may offer the driver the option of choosing whether or not the system is enabled. Similarly, vehicles with ride height adjustment or grill shutters may allow drivers to override those features.

Under the current regulations, EPA draws a distinction between vehicles tested for purposes of CO_2 emissions performance and fuel economy and vehicles tested for non-CO_2 emissions performance. When testing emission data vehicles for certification under Part 86 for non-CO_2 emissions standards, a vehicle that has multiple operating modes must meet the applicable emission standards in all modes, and on all fuels. Sometimes testing may occur in all modes, but more frequently the worst-case mode is selected for testing to represent the emission test group. For example, a vehicle that allows the user to disengage the start-stop capability must meet the standards with and without the start-stop system operating (in some cases EPA has determined that the operation of start-stop is the worst case for emissions controlled by the catalyst because of the spike in emissions associated with each start). Similarly, a plug-in hybrid electric vehicle is tested in charge-sustaining (*i.e.,* gasoline-only) operation. Current regulations require the reporting of CO_2 emissions from certification tests conducted under Part 86, but EPA regulations also recognize that these values, from emission data vehicles that represent a test group, are ultimately not the values that are used to establish in-use CO_2 standards (which are established on much more detailed sub-configuration-specific level) or the model type CO_2 and fuel economy values used for fleet averaging under Part 600.

When EPA tests vehicles for fuel economy and CO_2 emissions performance, user-selectable modes are treated somewhat differently, where the goals are different and where worst-case operation may not be the appropriate method. For example, EPA does not believe that the fuel economy and CO_2 emissions value for a PHEV should ignore the use of grid electricity, or that other dual fuel vehicles should ignore the real-world use of alternative fuels that reduce GHG emissions. The regulations address the use of utility factors to properly weight the CO_2 performance on the conventional fuel and the alternative fuel. Similarly, non-CO_2 emission certification testing may be done in a transmission mode that is not likely to be the predominant mode used by consumers. Testing under Part 600 must determine a single fuel economy value for each model type for the CAFE program and a single CO_2 value for each model type for EPA's program. With respect to transmissions, Part 600 refers to 86.128, which states the following:

> All test conditions, except as noted, shall be run according to the manufacturer's recommendations to the ultimate purchaser, *Provided,* That: Such recommendations are representative of what may reasonably be expected to be followed by the ultimate purchaser under in-use conditions.

For multi-mode transmissions EPA relies on guidance letter CISD–09–19 (December 3, 2009) to guide the determination of what is ''representative of what may reasonably be expected to be followed by the ultimate purchaser under in-use conditions.'' If EPA can make a determination that one mode is the ''predominant'' mode (meaning nearly total usage), then testing may be done in that mode. However, if EPA cannot be convinced that a single mode is predominant, then fuel economy and GHG results from each mode are typically averaged with equal weighting. There are also detailed provisions that explain how a manufacturer may conduct surveys to support a statement that a given mode is predominant. However, CISD–09–19 only addresses transmissions, and states the following regarding other technologies:

> ''Please contact EPA in advance to request guidance for vehicles equipped with future technologies not covered by this document, unusual default strategies or driver selectable features, *e.g.,* hybrid electric vehicles where the multimode button or switch disables or modifies any fuel saving features of the vehicle (such as the stop-start feature, air conditioning compressor operation, electric-only operation, etc.).''

The unique operating characteristics of these technologies essentially often requires that EPA determine fuel economy and CO_2 testing and calculations on a case-by-case basis. Because the CAFE and CO_2 programs require a single value to represent a model type, EPA must make a decision regarding how to account for multiple modes of operation. When a manufacturer brings such a technology to us for consideration, we will evaluate the technology (including possibly requiring that the manufacturer give us a vehicle to test) and provide the manufacturer with instructions on how to determine fuel economy and CO_2 emissions. In general we will evaluate these technologies in the same way and following the same principles we use to evaluate transmissions under CISD–09–19, making a determination as to whether a given operating mode is predominant or not (using the criteria for predominance described in CISD–09–19). These instructions are provided to the manufacturer under the authority for special test procedures described in 40 CFR 600.111–08. EPA would apply the same approach to testing for compliance with the in-use CO_2 standard, so testing for the CO_2 fleet average and testing for compliance with the in-use CO_2 standard would be consistent. EPA requests comment on whether the current approach and regulatory provisions are sufficient, or whether additional regulations or guidance should be developed to describe EPA's process. EPA recognizes that ultimately no regulation can anticipate all options, devices, and operator controls that may arrive in the future, and adequate flexibility to address future situations is an important attribute for fuel economy and CO_2 emissions testing.

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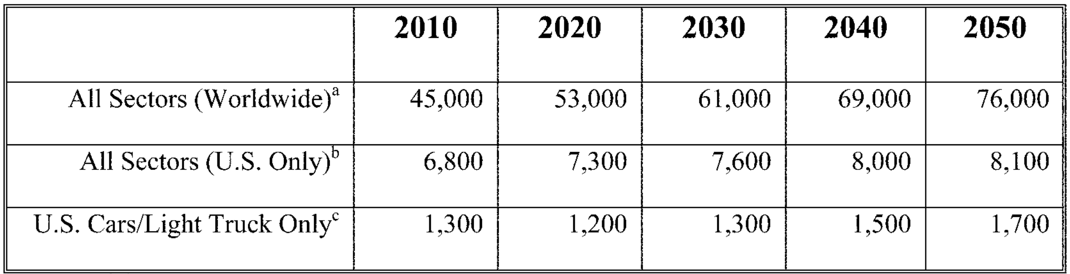
[368] See 40 CFR 86.1803–01, and 40 CFR 600.002. Standard equipment means those features or equipment which are marketed on a vehicle over which the purchaser can exercise no choice.

F. How would this proposal reduce GHG emissions and their associated effects?

This action is an important step towards curbing 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–54 shows emissions of CO_2, methane (CH_4), nitrous oxide (N_2O) and air conditioning refrigerant (HFC–134a) 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 15 percent of total worldwide emissions in 2010. Further, the contribution of direct emissions from cars and light-trucks to this U.S. share reaches an estimated 17 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-54 GHG Emissions by Calendar Year without the Proposed Standards ($MMTCO_2eq$)[369]



	2010	2020	2030	2040	2050
All Sectors (Worldwide)[a]	45,000	53,000	61,000	69,000	76,000
All Sectors (U.S. Only)[b]	6,800	7,300	7,600	8,000	8,100
U.S. Cars/Light Truck Only[c]	1,300	1,200	1,300	1,500	1,700

[a] GCAM model[370]

[b] ADAGE model,[371]

[c] OMEGA model, Tailpipe CO_2 and HFC134a only (includes impacts of MYs 2012-2016 rule)

This rule will result in significant reductions as newer, cleaner vehicles come into the fleet. As discussed in Section I, this GHG rule is part of a joint National Program such that a large part of the projected benefits, but by no means all, 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 2025 standards continue indefinitely post-2025, compared to a reference scenario in which the 2016 model year GHG standards continue indefinitely beyond 2016.

EPA estimated greenhouse impacts from several sources including: (a) The impact of the standards on tailpipe CO_2 emissions, (b) projected improvements in the efficiency of vehicle air conditioning systems, [372] (c) reductions in direct emissions of the refrigerant and potent greenhouse gas HFC–134a from air conditioning systems, (d) ''upstream'' emission reductions from gasoline extraction, production and distribution processes as a result of reduced gasoline demand associated with this rule, and (e) ''upstream'' emission increases from power plants as electric powertrain vehicles increase in prevalence as a result of this rule. EPA additionally accounted for the greenhouse gas impacts of additional vehicle miles travelled (VMT) due to the ''rebound'' effect discussed in Section III.H.

Using this approach EPA estimates the proposed standards would cut annual fleetwide car and light truck tailpipe CO_2 emissions by approximately 230 MMT or 18 percent by 2030, when 85 percent of car and light truck miles will be travelled by vehicles meeting the MY 2017 or later standards. An additional 65 $MMTCO_2eq$ of reduced emissions are attributable to reductions in gasoline production, distribution and transport. 15 $MMTCO_2eq$ of additional emissions will be attributable to increased electricity production. In total, EPA estimates that compared to a baseline of indefinite 2016 model year standards, net GHG emission reductions from the program would be approximately 300 million metric tons CO_2-equivalent ($MMTCO_2eq$) annually by 2030, which represents a reduction of 4% of total U.S. GHG emissions and 0.5% of total worldwide GHG emissions projected in that year. These GHG savings would result in savings of approximately 26 billion gallons of petroleum-based gasoline.[373]

EPA projects the total reduction of the program over the full life of model year 2017–2025 vehicles to be about 1,970 $MMTCO_2eq$, with fuel savings of 170 billion gallons (3.9 billion barrels) of gasoline over the life of these vehicles.

The impacts on atmospheric CO_2 concentrations, global mean surface temperature, sea level rise, and ocean pH resulting from these emission reductions are discussed in Section III.F.3.

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[369] ADAGE and GCAM model projections of worldwide and U.S. GHG emissions are provided for context only. The baseline data in these models differ in certain assumptions from the baseline used in this proposal. For example, the ADAGE baseline is calibrated to AEO 2010, which includes the EISA 35 MPG by 2020 provision, but does not explicitly include the MYs 2012–2016 rule. All emissions data were rounded to two significant digits.

[a] GCAM model.

[370] Based on the Representative Concentration Pathway scenario in GCAM available at *http://www.globalchange.umd.edu/gcamrcp.* See section III.F.3 and DRIA Chapter 6.4 for additional information on GCAM.

[b] ADAGE model.

[371] Based on the ADAGE reference case used in U.S. EPA (2010). ''EPA Analysis of the American Power Act of 2010'' U.S. Environmental Protection Agency, Washington, DC, USA (*http:www.epagov/climatechange/economics/economicanalyses.html).*

[c] OMEGA model, Tailpipe CO_2 and HFC134a only (includes impacts of MYs 2012–2016 rule).

[372] While EPA anticipates that the majority of mobile air conditioning systems will be improved in response to the MY 2012–2016 rulemaking, the agency expects that the remainder will be improved as a result of this action.

[373] All estimates of fuel savings presented here assume that manufacturers use air conditioning leakage credits as part of their compliance strategy. If these credits were not used, the fuel savings would be larger.

1. Impact on GHG Emissions

The modeling of fuel savings and greenhouse gas emissions is substantially similar to that which was conducted in the 2012–2016 Final Rulemaking and the MY 2017–2025 Interim Joint Technical Assessment Report (TAR). As detailed in Draft RIA chapter 4, 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, coupled with VMT projections derived from AEO 2011 Final Release. These estimates reflect the real-world CO_2 emissions reductions projected for the entire U.S. vehicle fleet in a specified calendar year. EPA also estimated full lifetime reductions for model years 2017–2025 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 2017 through 2025 vehicles over their entire life. Upstream impacts from power plant emissions came from OMEGA estimates of EV/penetration into the fleet (approximately 3%). For both calendar year and model year assessments, EPA estimated the environmental impact of the advanced technology multiplier, pickup truck hybrid electric vehicle (HEV) and performance based incentives and air conditioning credits. The impact of the off-cycle credits were not explicitly estimated, as these credits are assumed to be inherently environmentally neutral (Section III.B). EPA also did not assess the impact of the credit banking carry-forward programs.

As in the MY 2012–2016 rulemaking, this proposal allows manufacturers to earn credits for improvements to controls for both direct and indirect AC emissions. Since these improvements are relatively low cost, EPA again 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 HFC–134a, one of the most potent greenhouse gases, would be fully removed from light-duty vehicles through the phase-in of alternative refrigerants. More efficient air conditioning systems would also lead to fuel savings and additional reductions in upstream emissions from fuel production and distribution. Our estimated reductions from the A/C credit program assume that manufacturers will fully utilize the program by MY 2021.

Upstream greenhouse gas emission reductions associated with the production and distribution of fuel were estimated using emission factors from DOE's GREET1.8 model, with modifications as detailed in Chapter 5 of the DRIA. These estimates include both international and domestic emission reductions, since reductions in foreign exports of finished gasoline and/or crude would make up a significant share of the fuel savings resulting from the GHG standards. Thus, significant portions of the upstream GHG emission reductions will occur outside of the U.S.; a breakdown of projected international versus domestic reductions is included in the DRIA.

Electricity emission factors were derived from EPA's Integrated Planning Model (IPM). EPA uses IPM to analyze the projected impact of environmental policies on the electric power sector in the 48 contiguous states and the District of Columbia. IPM is a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. EPA derived average national CO_2 emission factors from the IPM version 4.10 base case run for the ''Proposed Transport Rule.'' [374] As discussed in Draft TSD Chapter 4, for the Final Rulemaking, EPA may consider emission factors other than national power generation, such as marginal power emission factors, or regional emission factors.

a. Calendar Year Reductions for Future Years

Table III–55 shows reductions estimated from these GHG standards assuming a pre-control case of 2016 MY standards continuing indefinitely beyond 2016, and a post-control case in which 2025 MY GHG standards continue indefinitely beyond 2025. 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 297 $MMTCO_2eq$ annually by 2030, and grow to over 540 $MMTCO_2eq$ in 2050 as cleaner vehicles continue to come into the fleet.

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[374] EPA. IPM. *http://www.epa.gov/airmarkt/progsregs/epa-ipm/BaseCasev410.html*. ''Proposed Transport Rule/NODA version'' of IPM. TR_SB_Limited Trading v.4.10.

Table III-55 Projected GHG Deltas (MMTCO$_2$eq per year)

Calendar Year:	**2020**	**2030**	**2040**	**2050**
Net Delta*	**-29**	**-297**	**-462**	**-547**
Net CO_2	*-24*	*-268*	*-420*	*-497*
Net other GHG	*-4*	*-29*	*-42*	*-50*
Downstream	**-24**	**-249**	**-389**	**-461**
CO_2 *(excluding A/C)*	*-19*	*-224*	*-355*	*-421*
A/C – indirect CO_2	*-1*	*-3*	*-4*	*-4*
A/C – direct HFCs	*-4*	*-21*	*-30*	*-36*
CH_4 *(rebound effect)*	*0*	*0*	*0*	*0*
N_2O *(rebound effect)*	*0*	*0*	*0*	*0*
Gasoline Upstream	***-6***	***-63***	***-100***	***-119***
CO_2	*-5*	*-55*	*-87*	*-103*
CH_4	*-1*	*-8*	*-12*	*-15*
N_2O	*0*	*0*	*0*	*0*
Electricity Upstream	**1**	**15**	**27**	**32**
CO_2	*1*	*15*	*26*	*32*
CH_4	*0*	*0*	*0*	*0*
N_2O	*0*	*0*	*0*	*0*

* includes impacts of 10% VMT rebound rate presented in Table III-57

The total program emission reductions yield significant emission decreases relative to worldwide and national total emissions.

Table III-56 Projected GHG Deltas (MMTCO$_2$eq per year)

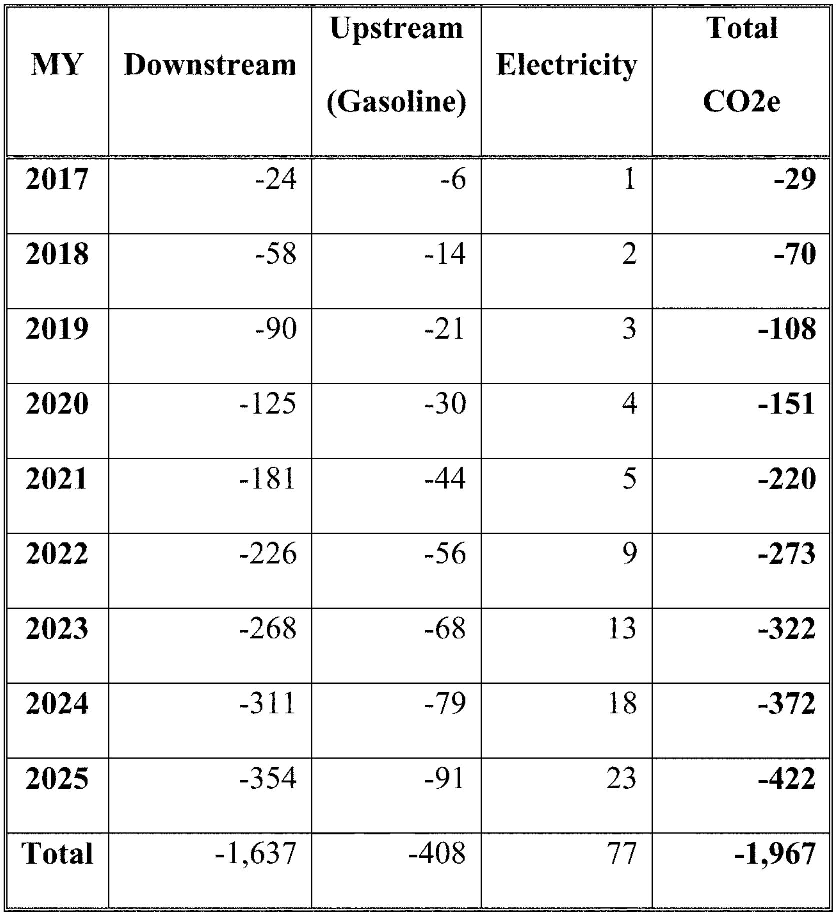
Emission Reduction Relative to:	**2020**	**2030**	**2040**	**2050**
Worldwide reference	-0.1%	-0.5%	-0.7%	-0.7%
U.S. reference (all sectors)	-0.4%	-3.9%	-5.8%	-6.8%
U.S. reference (cars + light trucks)*	-2.4%	-22.9%	-30.8%	-32.2%

*Note that total emission reductions include sectors (such as fuel refineries) that are not part of this reference.

b. Lifetime Reductions for 2017–2025 Model Years

EPA also analyzed the emission reductions over the full life of the 2017–2025 model year cars and light trucks that would be affected by this program.[375] These results, including both upstream and downstream GHG contributions, are presented in Table III–57, showing lifetime reductions of about 2,065 $MMTCO_2eq$.

Table III-57 Projected Net GHG Deltas ($MMTCO_2eq$ per year)



MY	Downstream	Upstream (Gasoline)	Electricity	Total CO2e
2017	-24	-6	1	**-29**
2018	-58	-14	2	**-70**
2019	-90	-21	3	**-108**
2020	-125	-30	4	**-151**
2021	-181	-44	5	**-220**
2022	-226	-56	9	**-273**
2023	-268	-68	13	**-322**
2024	-311	-79	18	**-372**
2025	-354	-91	23	**-422**
Total	-1,637	-408	77	**-1,967**

c. Impacts of VMT Rebound Effect

As noted above and discussed more fully in Section III.H., the effect of a decrease in fuel cost per mile on vehicle use (VMT "rebound") was accounted for in our assessment of economic and environmental impacts of this proposed rule. A 10 percent rebound case was used for this analysis, meaning that VMT for affected model years is modeled as increasing by 10 percent as much as the decrease in fuel cost per mile; *i.e.*, a 10 percent decrease in fuel cost per mile from our proposed standards would result in a 1 percent increase in VMT. Results are shown in Table III–58. This increase is accounted for in the reductions presented in Table III–55 and Table III–56). The table below compares the reductions under two different scenarios; one in which the VMT estimate is entirely insensitive to the cost of travel, and one in which both control and reference scenario VMT are affected by the rebound effect. This topic is further discussed in DRIA chapter 4.

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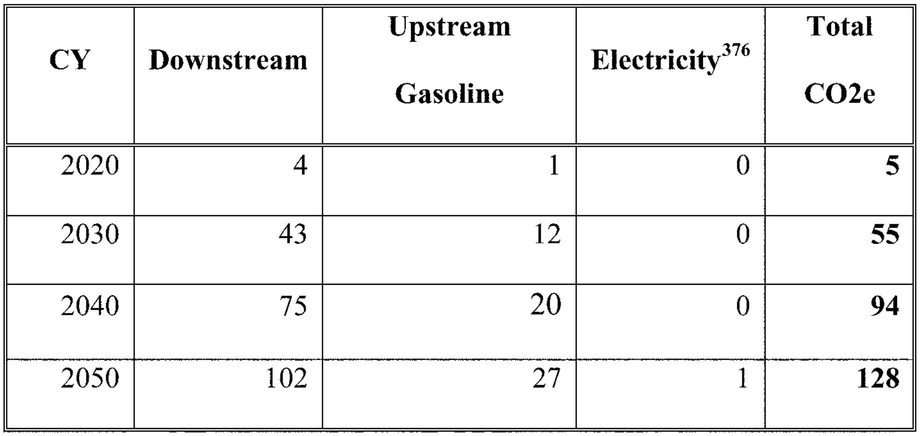
[375] As detailed in DRIA Chapter 4 and TSD Chapter 4, for this analysis the full life of the vehicle is represented by average lifetime mileages for cars (197,000 miles [MY 2017] and 211,000 miles [MY 2025]) and trucks (235,000 miles [MY 2017] and 249,000 miles [MY 2025]). These estimates are a function of how far vehicles are driven per year and scrappage rates.

[376] This assessment assumes that owners of grid-electric powered vehicles react similarly to changes int eh cost of driving s owners of conventional gasoline vehicles. We seek comment on this approach in Section III.H.4c.

Table III-58 Delta GHG Impact Of 10% VMT Rebound[a]

($MMTCO_2eq$ per year)



CY	Downstream	Upstream Gasoline	Electricity[376]	Total CO2e
2020	4	1	0	**5**
2030	43	12	0	**55**
2040	75	20	0	**94**
2050	102	27	1	**128**

[a] These impacts are included in the reductions shown in Table III-55 and Table III-56.

d. Analysis of Alternatives

EPA analyzed four alternative scenarios for this proposal (Table III–59). EPA assumed that manufacturers would use air conditioning improvements and the HEV and performance based pickup incentives in identical penetrations as in the primary scenario. EPA re-estimated the impact of the electric vehicle multiplier under each alternative. Under these assumptions, EPA expects achieved fleetwide average emission levels of 150 g/mile CO_2 to 177 g/mile CO_2eq (6%) in 2025. As in the primary scenario, EPA assumed that the fleet complied with the standards. For full details on modeling assumptions, please refer to DRIA Chapter 4. EPA's assessment of these alternative standards is discussed in Section III.D.6

Table III-59 GHG g/mile Targets of Alternative Scenarios

	2021 CO$_2$ g/mile Targets			2025 CO$_2$ g/mile Targets		
Title	**Cars**	**Trucks**	**Fleet**	**Cars**	**Trucks**	**Fleet**
Primary	173	250	200	144	203	164
A - Cars +20 g/mile	193	250	213	164	203	177
B - Cars -20 g/mile	153	250	187	124	203	150
C - Trucks +20 g/mile	173	270	207	144	223	170
D - Trucks -20 g/mile	173	230	193	144	183	157

Table III-60 Calendar Year Impacts of Alternative Scenarios

	GHG Delta (MMT2 CO2eq)				Fuel Savings (B. Gallons petroleum gasoline)			
Scenario	**2020**	**2030**	**2040**	**2050**	**2020**	**2030**	**2040**	**2050**
Primary	-29	-297	-462	-547	-2.3	-25.6	-40.4	-47.9
A - Cars +20 g/mile	-20	-248	-396	-471	-1.4	-20.3	-33.0	-39.2
B - Cars -20 g/mile	-35	-335	-511	-604	-2.9	-30.8	-48.1	-56.9
C - Trucks +20 g/mile	-28	-275	-431	-510	-2.2	-23.0	-36.5	-43.3
D - Trucks -20 g/mile	-39	-322	-492	-582	-3.2	-28.6	-44.4	-52.7

Table III-61 Model Year Lifetime Impacts of Alternative Scenarios (Summary of MY 2017-MY2025)

	Total CO2e	**Fuel Delta (b gal petroleum gasoline)**	**Fuel Delta (b. barrels petroleum gasoline)**
Primary	-1,967	-165	-3.9
A - Cars +20 g/mile	-1,567	-125	-3.0
B - Cars -20 g/mile	-2,283	-202	-4.8
C - Trucks +20 g/mile	-1,788	-146	-3.5
D - Trucks -20 g/mile	-2,254	-194	-4.6

2. Climate Change Impacts From GHG Emissions

The impact of GHG emissions on the climate has been reviewed in the 2012–2016 light-duty rulemaking and recent heavy-duty GHG rulemaking. See 75 FR at 25491; 76 FR at 57294. This section briefly discusses again some of the climate impact context for transportation emissions. These previous discussions noted that once emitted, GHGs that are the subject of this regulation can remain in the atmosphere for decades to millennia, meaning that 1) their concentrations become well-mixed throughout the global atmosphere regardless of emission origin, and 2) their effects on climate are long lasting. GHG emissions come mainly from the combustion of fossil fuels (coal, oil, and gas), with additional contributions from the clearing of forests, agricultural activities, cement production, and some industrial activities. Transportation activities, in aggregate, were the second largest contributor to total U.S. GHG emissions in 2009 (27 percent of total emissions).[377]

The Administrator relied on thorough and peer-reviewed assessments of climate change science prepared by the Intergovernmental Panel on Climate Change (''IPCC''), the United States Global Change Research Program (''USGCRP''), and the National Research Council of the National Academies (''NRC'') [378] as the primary scientific and technical basis for the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act (74 FR 66496, December 15, 2009). These assessments comprehensively address the scientific issues the Administrator had to examine, providing her both data and information on a wide range of issues pertinent to the Endangerment Finding. These assessments have been rigorously reviewed by the expert community, and also by United States government agencies and scientists, including by EPA itself.

Based on these assessments, the Administrator determined, in essence, that greenhouse gases cause warming; that levels of greenhouse gases are increasing in the atmosphere due to human activity; the climate is warming; recent warming has been attributed to the increase in greenhouse gases; and that warming of the climate threatens human health and welfare. The Administrator further found that emissions of well-mixed greenhouse gases from new motor vehicles and engines contribute to the air pollution for which the endangerment finding was made. Specifically, the Administrator found under section 202(a) of the Act that six greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) taken in combination endanger both the public health and the public welfare of current and future generations, and further found that the combined emissions of these greenhouse gases from new motor vehicles and engines contribute to the greenhouse gas air pollution that endangers public health and welfare.

More recent assessments have produced similar conclusions to those of the assessments upon which the Administrator relied. In May 2010, the NRC published its comprehensive assessment, ''Advancing the Science of Climate Change.'' [379] It concluded that ''climate change is occurring, is caused largely by human activities, and poses significant risks for—and in many cases is already affecting—a broad range of human and natural systems.'' Furthermore, the NRC stated that this conclusion is based on findings that are ''consistent with the conclusions of recent assessments by the U.S. Global Change Research Program, the Intergovernmental Panel on Climate Change's Fourth Assessment Report, and other assessments of the state of scientific knowledge on climate change.'' These are the same assessments that served as the primary scientific references underlying the Administrator's Endangerment Finding. Another NRC assessment, ''Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia,'' was published

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[377] U.S. EPA (2011) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2009. EPA 430–R–11–005. (Docket EPA–HQ–OAR–2010–0799).

[378] For a complete list of core references from IPCC, USGCRP/CCSP, NRC and others relied upon for development of the TSD for EPA's Endangerment and Cause or Contribute Findings see section 1(b), specifically, Table 1.1 of the TSD. (Docket EPA–HQ–OAR–2010–0799).

[379] National Research Council (NRC) (2010). Advancing the Science of Climate Change. National Academy Press. Washington, DC. (Docket EPA–HQ–OAR–2010–0799).

in 2011. This report found that climate change due to carbon dioxide emissions will persist for many centuries. The report also estimates a number of specific climate change impacts, finding that every degree Celsius (C) of warming could lead to increases in the heaviest 15% of daily rainfalls of 3 to 10%, decreases of 5 to 15% in yields for a number of crops (absent adaptation measures that do not presently exist), decreases of Arctic sea ice extent of 25% in September and 15% annually averaged, along with changes in precipitation and streamflow of 5 to 10% in many regions and river basins (increases in some regions, decreases in others). The assessment also found that for an increase of 4 degrees C nearly all land areas would experience summers warmer than all but 5% of summers in the 20th century, that for an increase of 1 to 2 degrees C the area burnt by wildfires in western North America will likely more than double, that coral bleaching and erosion will increase due both to warming and ocean acidification, and that sea level will rise 1.6 to 3.3 feet by 2100 in a 3 degree C scenario. The assessment notes that many important aspects of climate change are difficult to quantify but that the risk of adverse impacts is likely to increase with increasing temperature, and that the risk of abrupt climate changes can be expected to increase with the duration and magnitude of the warming.

In the 2010 report cited above, the NRC stated that some of the largest potential risks associated with future climate change may come not from relatively smooth changes that are reasonably well understood, but from extreme events, abrupt changes, and surprises that might occur when climate or environmental system thresholds are crossed. Examples cited as warranting more research include the release of large quantities of GHGs stored in permafrost (frozen soils) across the Arctic, rapid disintegration of the major ice sheets, irreversible drying and desertification in the subtropics, changes in ocean circulation, and the rapid release of destabilized methane hydrates in the oceans.

On ocean acidification, the same report noted the potential for broad, ‘‘catastrophic’’ impacts on marine ecosystems. Ocean acidity has increased 25 percent since pre-industrial times, and is projected to continue increasing. By the time atmospheric CO_2 content doubles over its preindustrial value, there would be virtually no place left in the ocean that can sustain coral reef growth. Ocean acidification could have dramatic consequences for polar food webs including salmon, the report said.

Importantly, these recent NRC assessments represent another independent and critical inquiry of the state of climate change science, separate and apart from the previous IPCC and USGCRP assessments.

3. Changes in Global Climate Indicators Associated With the Proposal’s GHG Emissions Reductions

EPA examined [380] the reductions in CO_2 and other GHGs associated with this rulemaking and analyzed the projected effects on atmospheric CO_2 concentrations, global mean surface temperature, sea level rise, and ocean pH which are common variables used as indicators of climate change.[381] The analysis projects that the proposed rule, if adopted, will reduce atmospheric concentrations of CO_2, global climate warming, ocean acidification, and sea level rise relative to the reference case. Although the projected reductions and improvements are small in comparison to the total projected climate change, they are quantifiable, directionally consistent, and will contribute to reducing the risks associated with climate change. Climate change is a global phenomenon and EPA recognizes that this one national action alone will not prevent it: EPA notes this would be true for any given GHG mitigation action when taken alone or when considered in isolation. EPA also notes that a substantial portion of CO_2 emitted into the atmosphere is not removed by natural processes for millennia, and therefore each unit of CO_2 not emitted into the atmosphere due to this rule avoids essentially permanent climate change on centennial time scales.

EPA determines that the projected reductions in atmospheric CO_2, global mean temperature and sea level rise are meaningful in the context of this proposed action. In addition, EPA has conducted an analysis to evaluate the projected changes in ocean pH in the context of the changes in emissions from this rulemaking. The results of the analysis demonstrate that relative to the reference case, projected atmospheric CO_2 concentrations are estimated by 2100 to be reduced by 3.29 to 3.68 part per million by volume (ppmv), global mean temperature is estimated to be reduced by 0.0076 to 0.0184 °C, and sea-level rise is projected to be reduced by approximately 0.074–0.166 cm, based on a range of climate sensitivities. The analysis also demonstrates that ocean pH will increase by 0.0018 pH units by 2100 relative to the reference case.

a. Estimated Reductions in Atmospheric CO_2 Concentration, Global Mean Surface Temperatures, Sea Level Rise, and Ocean pH

EPA estimated changes in the atmospheric CO_2 concentration, global mean temperature, and sea level rise out to 2100 resulting from the emissions reductions in this rulemaking using the Global Change Assessment Model (GCAM, formerly MiniCAM), integrated assessment model [382] coupled with the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC, version 5.3v2).[383] GCAM was used to create the globally and temporally consistent set of climate relevant variables required for running MAGICC. MAGICC was then used to estimate the projected change in these variables over time. Given the magnitude of the estimated emissions reductions associated with this action, a simple climate model such as MAGICC is reasonable for estimating the atmospheric and climate response. This widely used, peer reviewed modeling tool was also used to project temperature and sea level rise under different emissions scenarios in the Third and Fourth Assessments of the IPCC.

The integrated impact of the following pollutant and greenhouse gas emissions changes are considered: CO_2, CH_4, N_2O, HFC–134a, NO_X, CO, SO_2, and volatile organic compounds (VOC). For these pollutants an annual time-series of (upstream + downstream) emissions

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[380] Using the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) 5.3v2, *http://www.cgd.ucar.edu/cas/wigley/magicc/*), EPA estimated the effects of this rulemaking’s greenhouse gas emissions reductions on global mean temperature and sea level. Please refer to Chapter 6.4 of the DRIA for additional information.

[381] Due to timing constraints, this analysis was conducted with preliminary estimates of the emissions reductions projected from this proposal, which were similar to the final estimates.

[382] GCAM is a long-term, global integrated assessment model of energy, economy, agriculture and land use, that considers the sources of emissions of a suite of GHGs, emitted in 14 globally disaggregated regions, the fate of emissions to the atmosphere, and the consequences of changing concentrations of greenhouse related gases for climate change. GCAM begins with a representation of demographic and economic developments in each region and combines these with assumptions about technology development to describe an internally consistent representation of energy, agriculture, land-use, and economic developments that in turn shape global emissions. Brenkert A, S. Smith, S. Kim, and H. Pitcher, 2003: Model Documentation for the MiniCAM. PNNL–14337, Pacific Northwest National Laboratory, Richland, Washington. (Docket EPA–HQ–OAR–2010–0799).

[383] Wigley, T.M.L. 2008. MAGICC 5.3.v2 User Manual. UCAR—Climate and Global Dynamics Division, Boulder, Colorado. *http://www.cgd.ucar.edu/cas/wigley/magicc/* (Docket EPA–HQ–OAR–2010–0799).

reductions estimated from the rulemaking were applied as net reductions to a global reference case (or baseline) emissions scenario in GCAM to generate an emissions scenario specific to this proposed rule.[384] The emissions reductions past 2050 for all gases were scaled with total U.S. road transportation fuel consumption from the GCAM reference scenario. Road transport fuel consumption past 2050 does not change significantly and thus emissions reductions remain relatively constant from 2050 through 2100. Specific details about the GCAM reference case scenario can be found in Chapter 6.4 of the DRIA that accompanies this proposal.

MAGICC calculates the forcing response at the global scale from changes in atmospheric concentrations of CO_2, CH_4, N_2O, HFCs, and tropospheric ozone (O_3). It also includes the effects of temperature changes on stratospheric ozone and the effects of CH_4 emissions on stratospheric water vapor. Changes in CH_4, NO_X, VOC, and CO emissions affect both O_3 concentrations and CH_4 concentrations. MAGICC includes the relative climate forcing effects of changes in sulfate concentrations due to changing SO_2 emissions, including both the direct effect of sulfate particles and the indirect effects related to cloud interactions. However, MAGICC does not calculate the effect of changes in concentrations of other aerosols such as nitrates, black carbon, or organic carbon, making the assumption that the sulfate cooling effect is a proxy for the sum of all the aerosol effects. Therefore, the climate effects of changes in $PM_{2.5}$ emissions and precursors (besides SO_2) which are presented in the DRIA Chapter 6 were not included in the calculations in this chapter. MAGICC also calculates all climate effects at the global scale. This global scale captures the climate effects of the long-lived, well-mixed greenhouse gases, but does not address the fact that short-lived climate forcers such as aerosols and ozone can have effects that vary with location and timing of emissions. Black carbon in particular is known to cause a positive forcing or warming effect by absorbing incoming solar radiation, but there are uncertainties about the magnitude of that warming effect and the interaction of black carbon (and other co-emitted aerosol species) with clouds. While black carbon is likely to be an important contributor to climate change, it would be premature to include quantification of black carbon climate impacts in an analysis of these proposed standards. See generally, EPA, Response to Comments to the Endangerment Finding Vol. 9 section 9.1.6.1 and the discussion of black carbon in the endangerment finding at 74 FR at 66520. Additionally, the magnitude of $PM_{2.5}$ emissions changes (and therefore, black carbon emission changes) related to these proposed standards are small in comparison to the changes in the pollutants which have been included in the MAGICC model simulations.

Changes in atmospheric CO_2 concentration, global mean temperature, and sea level rise for both the reference case and the emissions scenarios associated with this action were computed using MAGICC. To calculate the reductions in the atmospheric CO_2 concentrations as well as in temperature and sea level resulting from this proposal, the output from the policy scenario associated with EPA's proposed standards was subtracted from an existing Global Change Assessment Model (GCAM, formerly MiniCAM) reference emission scenario. To capture some key uncertainties in the climate system with the MAGICC model, changes in atmospheric CO_2, global mean temperature and sea level rise were projected across the most current IPCC range of climate sensitivities, from 1.5 °C to 6.0 °C.[385] This range reflects the uncertainty for equilibrium climate sensitivity for how much global mean temperature would rise if the concentration of carbon dioxide in the atmosphere were to double. The information for this range come from constraints from past climate change on various time scales, and the spread of results for climate sensitivity from ensembles of models.[386] Details about this modeling analysis can be found in the DRIA Chapter 6.4.

The results of this modeling, summarized in Table III–62, show small, but quantifiable, reductions in atmospheric CO_2 concentrations, projected global mean temperature and sea level resulting from this action, across all climate sensitivities. As a result of the emission reductions from the proposed standards, relative to the reference case the atmospheric CO_2 concentration is projected to be reduced by 3.29–3.68 ppmv by 2100, the global mean temperature is projected to be reduced by approximately 0.0076–0.0184 °C by 2100, and global mean sea level rise is projected to be reduced by approximately 0.074–0.166 cm by 2100. The range of reductions in global mean temperature and sea level rise is larger than that for CO_2 concentrations because CO_2 concentrations are only weakly coupled to climate sensitivity through the dependence on temperature of the rate of ocean absorption of CO_2, whereas the magnitude of temperature change response to CO_2 changes (and therefore sea level rise) is more tightly coupled to climate sensitivity in the MAGICC model.

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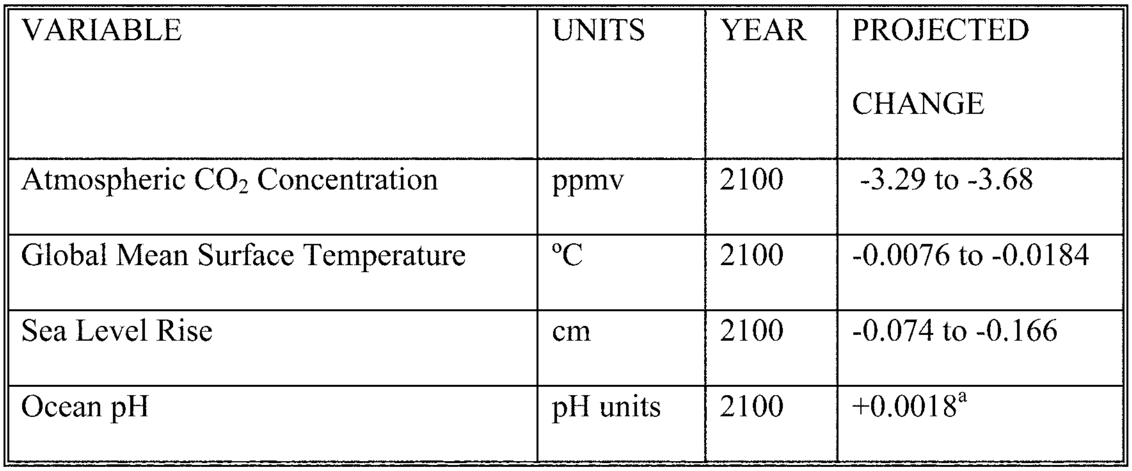
[384] Due to timing constraints, this analysis was conducted with preliminary estimates of the emissions reductions projected from this proposal, which were similar to the final estimates.

[385] 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/* (Docket EPA–HQ–OAR–2010–0799).

[386] 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. (Docket EPA–HQ–OAR–2010–0799).

Table III-62 Impact of GHG Emissions Reductions on Projected Changes in Global Climate Associated with EPA's Proposed Rulemaking (Based on a range of climate sensitivities from 1.5-6°C)



VARIABLE	UNITS	YEAR	PROJECTED CHANGE
Atmospheric CO_2 Concentration	ppmv	2100	-3.29 to -3.68
Global Mean Surface Temperature	°C	2100	-0.0076 to -0.0184
Sea Level Rise	cm	2100	-0.074 to -0.166
Ocean pH	pH units	2100	+0.0018[a]

[a] The value for projected change in ocean pH is based on a climate sensitivity of 3.0.

The projected reductions are small relative to the change in temperature (1.8–4.8 °C), sea level rise (23–55 cm), and ocean acidity (−0.30 pH units) from 1990 to 2100 from the MAGICC simulations for the GCAM reference case. However, this is to be expected given the magnitude of emissions reductions expected from the program in the context of global emissions. This uncertainty range does not include the effects of uncertainty in future emissions. It should also be noted that the calculations in MAGICC do not include the possible effects of accelerated ice flow in Greenland and/or Antarctica: the recent NRC report estimated a likely sea level increase for a business-as-usual scenario of 0.5 to 1.0 meters.[387] Further discussion of EPA's modeling analysis is found in the DRIA, Chapter 6.

EPA used the computer program CO2SYS,[388] version 1.05, to estimate projected changes in ocean pH for tropical waters based on the atmospheric CO_2 concentration change (reduction) resulting from this proposal. The program performs calculations relating parameters of the CO_2 system in seawater. EPA used the program to calculate ocean pH as a function of atmospheric CO_2 concentrations, among other specified input conditions. Based on the projected atmospheric CO_2 concentration reductions resulting from this proposal, the program calculates an increase in ocean pH of 0.0018 pH units in 2100 relative to the reference case (compared to a decrease of 0.3 pH units from 1990 to 2100 in the reference case). Thus, this analysis indicates the projected decrease in atmospheric CO_2 concentrations from the program will result in an increase in ocean pH. For additional validation, results were generated using different known constants from the literature. A comprehensive discussion of the modeling analysis associated with ocean pH is provided in the DRIA, Chapter 6.

As discussed in III.F.2, the 2011 NRC assessment on ''Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia'' determined how a number of climate impacts—such as heaviest daily rainfalls, crop yields, and Arctic sea ice extent—would change with a temperature change of 1 degree Celsius (C) of warming. These relationships of impacts with temperature change could be combined with the calculated reductions in warming in Table III–56 to estimate changes in these impacts associated with this rulemaking.

b. Program's Effect on Climate

As a substantial portion of CO_2 emitted into the atmosphere is not removed by natural processes for millennia, each unit of CO_2 not emitted into the atmosphere avoids essentially permanent climate change on centennial time scales. Reductions in emissions in the near-term are important in determining long-term climate stabilization and associated impacts experienced not just over the next decades but in the coming centuries and millennia.[389] Though the magnitude of the avoided climate change projected here is small in comparison to the total projected changes, these reductions represent a reduction in the adverse risks associated with climate change (though these risks were not formally estimated for this action) across a range of equilibrium climate sensitivities.

EPA's analysis of the program's impact on global climate conditions is intended to quantify these potential reductions using the best available science. EPA's modeling results show repeatable, consistent reductions relative to the reference case in changes of CO_2 concentration, temperature, sea-level rise, and ocean pH over the next century.

G. How would the proposal impact non-GHG emissions and their associated effects?

Although this rule focuses on GHGs, it will also have an impact on non-GHG pollutants. Sections G.1 of this preamble details the criteria pollutant and air toxic inventory changes of this proposed rule. The following sections, G.2 and G.3, discuss the health and environmental effects associated with

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[387] National Research Council (NRC), 2011. Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia. Washington, DC: National Academies Press. (Docket EPA–HQ–OAR–2010–0799).

[388] 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. (Docket EPA–HQ–OAR–2010–0799).

[389] National Research Council (NRC) (2011). Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia. National Academy Press. Washington, DC. (Docket EPA–HQ–OAR–2010–0799).

the criteria and toxic air pollutants that are being impacted by this proposed rule. In Section G.4 we discuss the potential impact of this proposal on concentrations of criteria and air toxic pollutants in the ambient air. The tools and methodologies used in this analysis are substantially similar to those used in the MYs 2012–2016 light duty rulemaking.

1. Inventory

a. Impacts

In addition to reducing the emissions of greenhouse gases, this rule would influence ''non-GHG'' pollutants, *i.e.,* ''criteria'' air pollutants and their precursors, and air toxics. The proposal would affect emissions of carbon monoxide (CO), fine particulate matter ($PM_{2.5}$), sulfur dioxide (SO_X), volatile organic compounds (VOC), nitrogen oxides (NO_X), 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 both in total and broken down by the three drivers of these changes: a) ''downstream'' emission changes, reflecting the estimated effects of VMT rebound (discussed in Sections III.F and III.H) and decreased consumption of fuel; b) ''upstream'' emission reductions due to decreased extraction, production and distribution of motor vehicle gasoline; c) ''upstream'' emission increases from power plants as electric powertrain vehicles increase in prevalence as a result of this rule. Program impacts on criteria and toxics emissions are discussed below, followed by individual discussions of the methodology used to calculate each of these three sources of impacts.

As shown in Table III–63, EPA estimates that the proposed light duty vehicle program would result in reductions of NO_X, VOC, $PM_{2.5}$ and SO_X, but would increase CO emissions.[390] For $NO_{X,}$ VOC, and $PM_{2.5}$, we estimate net reductions because the net emissions reductions from reduced fuel refining, distribution and transport is larger than the emission increases due to increased VMT and increased electricity production. In the case of CO, we estimate slight emission increases, because there are relatively small reductions in upstream emissions, and thus the projected emission increases due to VMT rebound and electricity production 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 downstream and fuel refining sources.

For all criteria pollutants the overall impact of the proposed program would be small compared to total U.S. inventories across all sectors. In 2030, EPA estimates that 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 1.1 percent, while increasing the total national CO inventory by 0.5 percent.

As shown in Table III–64, EPA estimates that the proposed program would result in similarly small changes for air toxic emissions compared to total U.S. inventories across all sectors. In 2030, EPA estimates the proposed program would increase total 1,3 butadiene and acetaldehyde emissions by 0.1 to 0.4 percent. Total acrolein, benzene and formaldehyde emissions would decrease by similarly small amounts.

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[390] While estimates for CY 2020 and 2030 are shown here, estimates through 2050 are shown in RIA Ch. 4.

Table III-63 Annual Criteria Emission Impacts of Program (short tons)

		CY 2020		CY 2030	
	Pollutant	Impacts (Short Tons)	% of Total US Inventory	Impacts (Short Tons)	% of Total US Inventory
Total	VOC	-12,467	-0.1%	-135,566	-1.1%
	CO	21,242	0.0%	397,861	0.7%
	NO_X	-2,449	0.0%	-16,008	-0.2%
	PM2.5	-351	0.0%	-3,123	-0.1%
	SO_X	-1,650	0.0%	-9,443	-0.1%
Downstream	VOC	379	0.0%	8,623	0.1%
	CO	22,212	0.0%	405,260	0.7%
	NO_X	779	0.0%	14,872	0.1%
	PM2.5	63	0.0%	1,023	0.0%
	SO_X	-449	0.0%	-5,051	-0.1%
Fuel Production and Distribution	VOC	-12,860	-0.1%	-144,503	-1.1%
	CO	-1,229	0.0%	-13,810	0.0%
	NO_X	-3,846	0.0%	-43,215	-0.4%
	PM2.5	-524	0.0%	-5,890	-0.1%
	SO_X	-2,353	0.0%	-26,443	-0.3%
Electricity	VOC	14	0.0%	6,411	0.1%
	CO	259	0.0%	6,411	0.0%
	NO_X	617	0.0%	12,335	0.1%
	PM2.5	110	0.0%	1,743	0.0%
	SO_X	1,153	0.0%	22,051	0.3%

Table III-64 Annual Air Toxic Emission Impacts of Program (short tons)

		CY 2020		CY 2030	
	Pollutant	Impacts (Short Tons)	% of Total US Inventory	Impacts (Short Tons)	% of Total US Inventory
Total	1,3- Butadiene	2	0.02%	47	0.4%
	Acetaldehyde	4	0.00%	112	0.2%
	Acrolein	0	0.01%	-6	0.0%
	Benzene	-15	-0.01%	-26	0.0%
	Formaldehyde	-5	0.00%	3	0.0%
Downstream	1,3- Butadiene	2	0.02%	49	0.4%
	Acetaldehyde	6	0.01%	124	0.2%
	Acrolein	0	0.01%	5	0.0%
	Benzene	13	0.01%	285	0.1%
	Formaldehyde	5	0.00%	118	0.1%
Fuel Production and Distribution	1,3- Butadiene	0	0.00%	-3	0.0%
	Acetaldehyde	-1	0.00%	-15	0.0%
	Acrolein	0	-0.01%	-15	0.0%
	Benzene	-28	-0.01%	-313	-0.1%
	Formaldehyde	-10	0.00%	-115	-0.1%
Electricity	1,3- Butadiene	0	0.00%	2	0.0%
	Acetaldehyde	0	0.00%	3	0.0%
	Acrolein	0	0.01%	4	0.0%
	Benzene	0	0.00%	2	0.0%
	Formaldehyde	0	0.00%	1	0.0%

b. Methodology

As in the MYs 2012–2016 rulemaking, for the downstream analysis, the current version of the EPA motor vehicle emission simulator (MOVES2010a) was used to estimate base VOC, CO, NO_X, PM and air toxics emission rates. Additional emissions from light duty cars and trucks attributable to the rebound effect were then calculated using the OMEGA model post-processor. A more complete discussion of the inputs, methodology, and results is contained in RIA Chapter 4.

This proposal assumes that MY 2017 and later vehicles are compliant with the agency's Tier 2 emission standards. This proposal does not model any future Tier 3 emission standards, because these standards have not yet been proposed (see Section III.A). We intend for the analysis assessing the impacts of both the final Tier 3 emission standards and the final 2017–2025 LD GHG to be included in the final Tier 3 rule. For the proposals, we are taking care to coordinate the modeling of each rule to properly assess the air quality impact of each action independently without double counting.

As in the MYs 2012–2016 GHG rulemaking, for this analysis we attribute decreased fuel consumption from this program to petroleum-based fuels only, while assuming no effect on volumes of ethanol and other renewable fuels because they are mandated under the Renewable Fuel Standard (RFS2). For the purposes of this emission analysis, we assume that all gasoline in the timeframe of the analysis is blended with 10 percent ethanol (E10). However, as a consequence of the fixed volume of renewable fuels mandated in the RFS2 rulemaking and the decreasing petroleum consumption predicted here, we anticipate that this proposal would in fact increase the fraction of the U.S. fuel supply that is made up by renewable fuels. Although we are not modeling this effect in our analysis of this proposal, the Tier 3 rulemaking will make more refined assumptions about future fuel properties, including (in a final Tier 3 rule) accounting for the impacts of the LD GHG rule. In this rulemaking EPA modeled the three impacts on criteria pollutant emissions (rebound driving, changes in fuel production, and changes in electricity production) discussed above.

While electric vehicles have zero tailpipe emissions, EPA assumes that manufacturers will plan for these vehicles in their regulatory compliance strategy for non-GHG emissions standards, and will not over-comply with those standards. Since the Tier 2 emissions standards are fleet-average standards, we assume that if a manufacturer introduces EVs into its fleet, that it would correspondingly compensate through changes to vehicles elsewhere in its fleet, rather than meet an overall lower fleet-average emissions level.[391] Consequently, EPA assumes neither tailpipe pollutant benefit (other than CO_2) nor an evaporative emission benefit from the introduction of electric vehicles into the fleet. Other factors which may impact downstream non-GHG emissions, but are not estimated in this analysis, include: The potential for decreased criteria pollutant emissions due to increased air conditioner efficiency; reduced refueling emissions due to less frequent refueling events and reduced annual refueling volumes resulting from the GHG standards; and increased hot soak evaporative emissions due to the likely increase in number of trips associated with VMT rebound modeled in this proposal. In all, these additional analyses would likely result in small changes relative to the national inventory.

To determine the upstream fuel production 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,[392] but in some cases the GREET values were modified or updated by EPA to be consistent with the National Emission Inventory (NEI).[393] 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 a memo to the docket. These emission factors were incorporated into the OMEGA post-processor.

As with the GHG emission analysis discussed in section III.F, electricity emission factors were derived from EPA's Integrated Planning Model (IPM). EPA uses IPM to analyze the projected impact of environmental policies on the electric power sector in the 48 contiguous states and the District of Columbia. IPM is a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. EPA derived average national CO_2 emission factors from the IPM version 4.10 run for the ''Proposed Transport Rule.'' [394] As discussed in Draft TSD Chapter 4, for the Final Rulemaking, EPA may consider emission factors other than national power generation, such as marginal power emission factors, or regional emission factors.

2. Health Effects of Non-GHG Pollutants

In this section we discuss health effects associated with exposure to some of the criteria and air toxic pollutants impacted by the proposed vehicle standards.

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).[395] Current National Ambient Air Quality Standards (NAAQS) use $PM_{2.5}$ as the indicator for fine particles (with $PM_{2.5}$ generally referring to particles with a nominal mean aerodynamic diameter less than or equal to 2.5 micrometers (μm), and use PM_{10} as the indicator for purposes of regulating the coarse fraction of PM_{10} (referred to as thoracic coarse particles or coarse-fraction particles; generally including particles with a nominal mean aerodynamic diameter greater than 2.5 μm and less than or equal to 10 μm, or $PM_{10-2.5}$). Ultrafine particles are a subset of fine particles, generally less than 100 nanometers (0.1 μm) in diameter.

Fine particles are produced primarily by combustion processes and by transformations of gaseous emissions (*e.g.,* sulfur oxides (SO_X), nitrogen oxides (NO_X), and volatile organic compounds (VOC)) in the atmosphere. The chemical and physical properties of $PM_{2.5}$ may vary greatly with time, region, meteorology, and source

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[391] Historically, manufacturers have reduced precious metal loading in catalysts in order to reduce costs. See *http://www.platinum.matthey.com/media-room/our-view-on-.-.-./thrifting-of-precious-metals-in-autocatalysts/* Accessed 11/08/2011. Alternatively, manufacturers could also modify vehicle calibration.

[392] 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/.*

[393] U.S. EPA. 2002 National Emissions Inventory (NEI) Data and Documentation, *http://www.epa.gov/ttn/chief/net/2002inventory.html.*

[394] EPA. IPM. *http://www.epa.gov/airmarkt/progsregs/epa-ipm/BaseCasev410.html.* ''Proposed Transport Rule/NODA version'' of IPM. TR_SB_Limited Trading v.4.10.

[395] Regulatory definitions of PM size fractions, and information on reference and equivalent methods for measuring PM in ambient air, are provided in 40 CFR parts 50, 53, and 58.

category. Thus, $PM_{2.5}$ may include a complex mixture of different components including sulfates, nitrates, organic compounds, elemental carbon and metal compounds. These particles can remain in the atmosphere for days to weeks and travel hundreds to thousands of kilometers.

ii. Health Effects of Particulate Matter

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 (ISA) for Particulate Matter.[396] Further discussion of health effects associated with PM can also be found in the draft RIA. The ISA summarizes health effects evidence associated with both short-term and long-term exposures to $PM_{2.5}$, $PM_{10-2.5}$, and ultrafine particles.

The ISA concludes that health effects associated with short-term exposures (hours to days) to ambient $PM_{2.5}$ include mortality, cardiovascular effects, such as altered vasomotor function and hospital admissions and emergency department visits for ischemic heart disease and congestive heart failure, and respiratory effects, such as exacerbation of asthma symptoms in children and hospital admissions and emergency department visits for chronic obstructive pulmonary disease and respiratory infections.[397] The ISA notes that long-term exposure (months to years) to $PM_{2.5}$ 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.[398] The ISA concludes that the currently available scientific evidence from epidemiologic, controlled human exposure, and toxicological studies supports a causal association between short- and long-term exposures to $PM_{2.5}$ and cardiovascular effects and mortality. Furthermore, the ISA concludes that the collective evidence supports likely causal associations between short- and long-term $PM_{2.5}$ exposures and respiratory effects. The ISA also concludes that the scientific evidence is suggestive of a causal association for reproductive and developmental effects and cancer, mutagenicity, and genotoxicity and long-term exposure to $PM_{2.5}$.[399]

For $PM_{10-2.5}$, the ISA concludes that the current evidence is suggestive of a causal relationship between short-term exposures and cardiovascular effects. There is also suggestive evidence of a causal relationship between short-term $PM_{10-2.5}$ exposure and mortality and respiratory effects. Data are inadequate to draw conclusions regarding the health effects associated with long-term exposure to $PM_{10-2.5}$.[400]

For ultrafine particles, the ISA concludes that there is suggestive evidence of a causal relationship between short-term exposures and cardiovascular effects, such as changes in heart rhythm and blood vessel function. It also concludes that there is suggestive evidence of association between short-term exposure to ultrafine particles and respiratory effects. Data are inadequate to draw conclusions regarding the health effects associated with long-term exposure to ultrafine particles.[401]

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 sunlight. These pollutants, often referred to as ozone precursors, are emitted by many types of pollution sources, such as highway and nonroad motor vehicles and engines, power plants, chemical plants, refineries, makers of consumer and commercial products, industrial facilities, and smaller area sources.

The science of ozone formation, transport, and accumulation is complex. Ground-level ozone is produced and destroyed in a cyclical set of chemical reactions, many of which are sensitive to temperature and sunlight. When ambient temperatures and sunlight levels remain high for several days and the air is relatively stagnant, ozone and its precursors can build up and result in more ozone than typically occurs on a single high-temperature day. Ozone can be transported hundreds of miles downwind from precursor emissions, resulting in elevated ozone levels even in areas with low local VOC or NO_X emissions.

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 and 2007 Staff Paper.[402] [403] People who are more susceptible to effects associated with exposure to ozone can include children, the elderly, and individuals with respiratory disease such as asthma. Those with greater exposures to ozone, for instance due to time spent outdoors (*e.g.,* children and outdoor workers), are of particular concern. Ozone can irritate the respiratory system, causing coughing, throat irritation, and breathing discomfort. Ozone can reduce lung function and cause pulmonary inflammation in healthy individuals. Ozone can also aggravate asthma, leading to more asthma attacks that require medical attention and/or the use of additional medication. Thus, ambient ozone may cause both healthy and asthmatic individuals to limit their outdoor activities. In addition, there is suggestive evidence of a contribution of ozone to cardiovascular-related morbidity and highly suggestive evidence that short-term ozone exposure directly or indirectly contributes to non-accidental and cardiopulmonary-related mortality, but additional research is needed to clarify the underlying mechanisms causing these effects. In a report on the estimation of ozone-related premature mortality published by NRC, a panel of experts and reviewers concluded that short-term exposure to ambient ozone is likely to contribute to premature deaths and that ozone-related mortality should be included in estimates of the health benefits of reducing ozone exposure.[404] Animal toxicological evidence indicates that with repeated exposure, ozone can inflame and damage the lining of the lungs, which may lead to permanent changes in lung tissue and irreversible reductions in lung function. The respiratory effects observed in controlled human exposure studies and animal studies are coherent with the evidence from epidemiologic studies supporting a causal relationship between acute ambient ozone exposures and increased respiratory-related emergency room visits and

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[396] U.S. EPA (2009) Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F, Docket EPA–HQ–OAR–2010–0799.

[397] *See* U.S. EPA, 2009 Final PM ISA, Note 396, at Section 2.3.1.1.

[398] *See* U.S. EPA 2009 Final PM ISA, Note 396, at page 2–12, Sections 7.3.1.1 and 7.3.2.1.

[399] *See* U.S. EPA 2009 Final PM ISA, Note 396, at Section 2.3.2.

[400] *See* U.S. EPA 2009 Final PM ISA, Note 396, at Section 2.3.4, Table 2–6.

[401] *See* U.S. EPA 2009 Final PM ISA, Note 396, at Section 2.3.5, Table 2–6.

[402] U.S. EPA. (2006). Air Quality Criteria for Ozone and Related Photochemical Oxidants (Final). EPA/600/R–05/004aF–cF. Washington, DC: U.S. EPA. Docket EPA–HQ–OAR–2010–0799.

[403] U.S. EPA. (2007). Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper. EPA–452/R–07–003. Washington, DC, U.S. EPA. Docket EPA–HQ–OAR–2010–0799.

[404] National Research Council (NRC), 2008. *Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution.* The National Academies Press: Washington, DC Docket EPA–HQ–OAR–2010–0799.

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. Nitrogen Oxides and Sulfur Oxides

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. Sulfur Dioxide (SO_2) a member of the sulfur oxide (SO_X) family of gases, is formed from burning fuels containing sulfur (*e.g.,* coal or oil derived), extracting gasoline from oil, or extracting metals from ore.

SO_2 and NO_2 can dissolve in water droplets and further oxidize to form sulfuric and nitric acid which react with ammonia to form sulfates and nitrates, both of which are important components of ambient PM. The health effects of ambient PM are discussed in Section III.G.3.a.ii of this preamble. NO_X and NMHC are the two major precursors of ozone. The health effects of ozone are covered in Section III.G.3.b.ii.

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.[405] 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. 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. Small but significant increases in non-specific airway hyperresponsiveness were reported following 1-hour exposures of asthmatics to 0.1 ppm NO_2. 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.[406] 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 CO can be found in the EPA Integrated Science Assessment (ISA) for Carbon Monoxide.[407] The ISA concludes that ambient concentrations of CO are associated with a number of adverse health effects.[408] This section provides a summary of the health effects associated with exposure to ambient concentrations of CO.[409]

Human clinical studies of subjects with coronary artery disease show a decrease in the time to onset of exercise-induced angina (chest pain) and electrocardiogram changes following CO exposure. In addition, epidemiologic studies show associations between short-term CO exposure and cardiovascular morbidity, particularly increased emergency room visits and hospital admissions for coronary heart disease (including ischemic heart disease, myocardial infarction, and angina). Some epidemiologic evidence is also available for increased hospital admissions and emergency room visits for congestive heart failure and cardiovascular disease as a whole. The ISA concludes that a causal relationship is likely to exist between short-term exposures to CO and cardiovascular morbidity. It also concludes that available data are inadequate to conclude that a causal relationship exists between long-term exposures to CO and cardiovascular morbidity.

Animal studies show various neurological effects with in-utero CO exposure. Controlled human exposure studies report inconsistent neural and behavioral effects following low-level CO exposures. The ISA concludes the evidence is suggestive of a causal relationship with both short- and long-term exposure to CO and central nervous system effects.

A number of epidemiologic and animal toxicological studies cited in the ISA have evaluated associations between CO exposure and birth outcomes such as preterm birth or cardiac birth defects. The epidemiologic studies provide limited evidence of a CO-induced effect on preterm births and birth defects, with weak evidence for a decrease in birth weight. Animal

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[405] U.S. EPA (2008). *Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (Final Report).* EPA/600/R–08/071. Washington, DC: U.S. EPA. Docket EPA–HQ–OAR–2010–0799.

[406] U.S. EPA. (2008). *Integrated Science Assessment (ISA) for Sulfur Oxides—Health Criteria (Final Report).* EPA/600/R–08/047F. Washington, DC: U.S. Environmental Protection Agency. Docket EPA–HQ–OAR–2010–0799.

[407] U.S. EPA, 2010. Integrated Science Assessment for Carbon Monoxide (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–09/019F, 2010. Available at *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=218686.* Docket EPA–HQ–OAR–2010–0799.

[408] The ISA evaluates the health evidence associated with different health effects, assigning one of five ''weight of evidence'' determinations: causal relationship, likely to be a causal relationship, suggestive of a causal relationship, inadequate to infer a causal relationship, and not likely to be a causal relationship. For definitions of these levels of evidence, please refer to Section 1.6 of the ISA.

[409] 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.

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

Light-duty vehicle emissions contribute to ambient levels of air toxics known or suspected as human or animal carcinogens, or that have noncancer health effects. The population experiences an elevated risk of cancer and other noncancer health effects from exposure to the class of pollutants known collectively as ''air toxics.''[410] These compounds include, but are not limited to, benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, polycyclic organic matter, and naphthalene. These compounds were identified as national or regional risk drivers or contributors in the 2005 National-Scale Air Toxics Assessment and have significant inventory contributions from mobile sources.[411]

i. Benzene

The EPA's Integrated Risk Information System (IRIS) database lists benzene as a known human carcinogen (causing leukemia) by all routes of exposure, and concludes that exposure is associated with additional health effects, including genetic changes in both humans and animals and increased proliferation of bone marrow cells in mice.[412] [413] [414] 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.[415] [416]

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.[417] [418] The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.[419] [420] In addition, published 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.[421] [422] [423] [424] EPA's IRIS program has not yet evaluated these new data.

ii. 1,3-Butadiene

EPA has characterized 1,3-butadiene as carcinogenic to humans by inhalation.[425] [426] 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.[427] [428] There

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[410] U.S. EPA. (2011) Summary of Results for the 2005 National-Scale Assessment. *http://www.epa.gov/ttn/atw/nata2005/05pdf/sum_results.pdf.* Docket EPA–HQ–OAR–2010–0799.

[411] U.S. EPA (2011) 2005 National-Scale Air Toxics Assessment. *http://www.epa.gov/ttn/atw/nata2005.* Docket EPA–HQ–OAR–2010–0799.

[412] 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–2010–0799.

[413] International Agency for Research on Cancer. 1982. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29. Some industrial chemicals and dyestuffs, World Health Organization, Lyon, France, p. 345–389. Docket EPA–HQ–OAR–2010–0799.

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[415] See IARC, Note 413, above.

[416] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at: *http://ntp.niehs.nih.gov/go/16183.* Docket EPA–HQ–OAR–2010–0799.

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[419] Rothman, N., G.L. Li, M. Dosemeci, W.E. Bechtold, G.E. Marti, Y.Z. Wang, M. Linet, L.Q. Xi, W. Lu, M.T. Smith, N. Titenko-Holland, L.P. Zhang, W. Blot, S.N. Yin, and R.B. Hayes (1996) Hematotoxicity among Chinese workers heavily exposed to benzene. Am. J. Ind. Med. 29: 236–246. Docket EPA–HQ–OAR–2010–0799.

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[424] Turtletaub, K.W. and Mani, C. (2003) Benzene metabolism in rodents at doses relevant to human exposure from Urban Air. Research Reports Health Effect Inst. Report No. 113. Docket EPA–HQ–OAR–2010–0799.

[425] U.S. EPA (2002) Health Assessment of 1,3-Butadiene. Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC. Report No. EPA600–P–98–001F. This document is available electronically at *http://www.epa.gov/iris/supdocs/buta-sup.pdf.* Docket EPA–HQ–OAR–2010–0799.

[426] U.S. EPA (2002) Full IRIS Summary for 1,3-butadiene (CASRN 106–99–0). Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington, DC *http://www.epa.gov/iris/subst/0139.htm.* Docket EPA–HQ–OAR–2010–0799.

[427] International Agency for Research on Cancer (1999) Monographs on the evaluation of

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.[429]

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.[430] EPA is currently reviewing epidemiological data published since that time. For instance, research conducted by the National Cancer Institute found an increased risk of nasopharyngeal cancer and lymphohematopoietic malignancies such as leukemia among workers exposed to formaldehyde.[431, 432] In an analysis of the lymphohematopoietic cancer mortality from an extended follow-up of these workers, the National Cancer Institute confirmed an association between lymphohematopoietic cancer risk and peak exposures.[433] A National Institute of Occupational Safety and Health study of garment workers also found increased risk of death due to leukemia among workers exposed to formaldehyde.[434] 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.[435] In 2006, the IARC re-classified formaldehyde as a human carcinogen (Group 1).[436]

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.[437][438]

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.[439] 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.[440][441] 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.[442] In short-term (4 week) rat studies, degeneration of olfactory epithelium was observed at various concentration levels of acetaldehyde exposure.[443][444] 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.[445] 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

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carcinogenic risk of chemicals to humans, Volume 71, Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide and Volume 97 (in preparation), World Health Organization, Lyon, France. Docket EPA–HQ–OAR–2010–0799.

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[437] 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–2010–0799.

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[441] International Agency for Research on Cancer. 1999. Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemical to Humans, Vol 71. Lyon, France. Docket EPA–HQ–OAR–2010–0799.

[442] See Integrated Risk Information System File of Acetaldehyde, Note 439, above.

[443] Appleman, L. M., R. A. Woutersen, V. J. Feron, R. N. Hooftman, and W. R. F. Notten. 1986. Effects of the variable versus fixed exposure levels on the toxicity of acetaldehyde in rats. *J. Appl. Toxicol.* 6: 331–336. Docket EPA–HQ–OAR–2010–0799.

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sensory reactions within minutes of exposure.[446] 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.[447] 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.[448] Lesions to the lungs and upper respiratory tract of rats, rabbits, and hamsters have been observed after subchronic exposure to acrolein.[449] Acute exposure effects in animal studies report bronchial hyper-responsiveness.[450] In one 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.[451] 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.[452] The IARC determined in 1995 that acrolein was not classifiable as to its carcinogenicity in humans.[453]

vi. Polycyclic Organic Matter

The term polycyclic organic matter (POM) defines a broad class of compounds that includes the polycyclic aromatic hydrocarbon compounds (PAHs). One of these compounds, naphthalene, is discussed separately below. POM compounds are formed primarily from combustion and are present in the atmosphere in gas and particulate form. Cancer is the major concern from exposure to POM. Epidemiologic studies have reported an increase in lung cancer in humans exposed to diesel exhaust, coke oven emissions, roofing tar emissions, and cigarette smoke; all of these mixtures contain POM compounds.[454] [455] Animal studies have reported respiratory tract tumors from inhalation exposure to benzo[a]pyrene and alimentary tract and liver tumors from oral exposure to benzo[a]pyrene. In 1997 EPA classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens.[456] Since that time, studies have found that maternal exposures to PAHs in a population of pregnant women were associated with several adverse birth outcomes, including low birth weight and reduced length at birth, as well as impaired cognitive development in preschool children (3 years of age).[457] [458] EPA has not yet evaluated these 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.[459] The draft reassessment completed external peer review.[460] 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.[461] California EPA has released a new risk assessment for naphthalene, and the IARC has reevaluated naphthalene and re-classified it as Group 2B: possibly carcinogenic to humans.[462] Naphthalene also causes a number of chronic non-cancer effects in animals, including abnormal cell changes and growth in respiratory and nasal tissues.[463]

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[446] U.S. EPA (U.S. Environmental Protection Agency). (2003) Toxicological review of acrolein in support of summary information on Integrated Risk Information System (IRIS) National Center for Environmental Assessment, Washington, DC. EPA/635/R–03/003. p. 10. Available online at: *http://www.epa.gov/ncea/iris/toxreviews/0364tr.pdf.* Docket EPA–HQ–OAR–2010–0799.

[447] See U.S. EPA 2003 Toxicological review of acrolein, Note 446, above.

[448] *See* U.S. EPA 2003 Toxicological review of acrolein, Note 446, at p. 11.

[449] Integrated Risk Information System File of Acrolein. Office of Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available at *http://www.epa.gov/iris/subst/0364.htm* Docket EPA–HQ–OAR–2010–0799.

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[453] International Agency for Research on Cancer. 1995. Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 63. Dry cleaning, some chlorinated solvents and other industrial chemicals, World Health Organization, Lyon, France. Docket EPA–HQ–OAR–2010–0799.

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[457] 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.

[458] 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.

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[461] National Toxicology Program (NTP). (2004). 11th Report on Carcinogens. Public Health Service, U.S. Department of Health and Human Services, Research Triangle Park, NC. Available from: *http://ntp-server.niehs.nih.gov.* Docket EPA–HQ–OAR–2010–0799.

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viii. Other Air Toxics

In addition to the compounds described above, other compounds in gaseous hydrocarbon and PM emissions from light-duty vehicles will be affected by this proposal. Mobile source air toxic compounds that would potentially be impacted include ethylbenzene, propionaldehyde, toluene, and xylene. Information regarding the health effects of these compounds can be found in EPA's IRIS database.[464]

f. Exposure and Health Effects Associated With Traffic-Related Air Pollution

Populations who live, work, or attend school near major roads experience elevated exposure 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.[465] 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.[466] 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.[467] The HEI report also concludes that there is ''suggestive'' evidence for pulmonary function deficits associated with traffic exposure, but concluded that there is ''inadequate and insufficient'' evidence for causal associations with respiratory health care utilization, adult-onset asthma, chronic obstructive pulmonary disease symptoms, and allergy. A review by Holguin (2008) notes that the effects of traffic on asthma may be modified by nutrition status, medication use, and genetic factors.[468]

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.[469]

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.[470]

There is a large population in the United States living in close proximity of major roads. According to the Census Bureau's American Housing Survey for 2007, approximately 20 million residences in the United States, 15.6% of all homes, are located within 300 feet (91 m) of a highway with 4+ lanes, a railroad, or an airport.[471] Therefore, at current population of approximately 309 million, assuming that population and housing are similarly distributed, there are over 48 million people in the United States living near such sources. The HEI report also notes that in two North American cities, Los Angeles and Toronto, over 40% of each city's population live within 500 meters of a highway or 100 meters of a major road. It also notes that about 33% of each city's population resides within 50 meters of major roads. Together, the evidence suggests that a large U.S. population lives in areas with elevated traffic-related air pollution.

People living near roads are often socioeconomically disadvantaged. According to the 2007 American Housing Survey, a renter-occupied property is over twice as likely as an owner-occupied property to be located near a highway with 4+ lanes, railroad or airport. In the same survey, the median household income of rental housing occupants was less than half that of owner-occupants ($28,921/$59,886). Numerous studies in individual urban areas report higher levels of traffic-related air pollutants in areas with high minority or poor populations.[472] [473] [474]

Students may also be exposed in situations where schools are located

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Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0436.htm* Docket EPA–HQ–OAR–2010–0799.

[464] U.S. EPA Integrated Risk Information System (IRIS) database is available at: *http://www.epa.gov/iris.*

[465] Zhou, Y.; Levy, J.I. (2007) Factors influencing the spatial extent of mobile source air pollution impacts: a meta-analysis. BMC Public Health 7: 89. doi:10.1186/1471–2458–7–89 Docket EPA–HQ–OAR–2010–0799.

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[468] Holguin, F. (2008) Traffic, outdoor air pollution, and asthma. Immunol Allergy Clinics North Am 28: 577–588. Docket EPA–HQ–OAR–2010–0799.

[469] Adar, S.D.; Kaufman, J.D. (2007) Cardiovascular disease and air pollutants: evaluating and improving epidemiological data implicating traffic exposure. Inhal Toxicol 19: 135–149. Docket EPA–HQ–OAR–2010–0799.

[470] Raaschou-Nielsen, O.; Reynolds, P. (2006) Air pollution and childhood cancer: a review of the epidemiological literature. Int J Cancer 118: 2920–2929. Docket EPA–HQ–OAR–2010–0799.

[471] U.S. Census Bureau (2008) American Housing Survey for the United States in 2007. Series H–150 (National Data), Table 1A–7. [Accessed at *http://www.census.gov/hhes/www/housing/ahs/ahs07/ahs07.html* on January 22, 2009] Docket EPA–HQ–OAR–2010–0799.

[472] Lena, T.S.; Ochieng, V.; Carter, M.; Holguín-Veras, J.; Kinney, Public Law (2002) Elemental carbon and $PM^{2.5}$ levels in an urban community heavily impacted by truck traffic. Environ Health Perspect 110: 1009–1015. Docket EPA–HQ–OAR–2010–0799.

[473] Wier, M.; Sciammas, C.; Seto, E.; Bhatia, R.; Rivard, T. (2009) Health, traffic, and environmental justice: collaborative research and community action in San Francisco, California. Am J Public Health 99: S499–S504. Docket EPA–HQ–OAR–2010–0799.

[474] Forkenbrock, D.J. and L.A. Schweitzer, *Environmental Justice and Transportation Investment Policy.* Iowa City: University of Iowa, 1997. Docket EPA–HQ–OAR–2010–0799.

near major roads. In a study of nine metropolitan areas across the United States, Appatova et al. (2008) found that on average greater than 33% of schools were located within 400 m of an Interstate, U.S., or state highway, while 12% were located within 100 m.[475] The study also found that among the metropolitan areas studied, schools in the Eastern United States were more often sited near major roadways than schools in the Western United States.

Demographic studies of students in schools near major roadways suggest that this population is more likely than the general student population to be of non-white race or Hispanic ethnicity, and more often live in low socioeconomic status locations.[476, 477, 478] 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.

3. 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.

a. Visibility

Visibility can be defined as the degree to which the atmosphere is transparent to visible light.[479] Visibility impairment is caused by light scattering and absorption by suspended particles and gases. Visibility is important because it has direct significance to people's enjoyment of daily activities in all parts of the country. Individuals value good visibility for the well-being it provides them directly, where they live and work, and in places where they enjoy recreational opportunities. Visibility is also highly valued in significant natural areas, such as national parks and wilderness areas, and special emphasis is given to protecting visibility in these areas. For more information on visibility see the final 2009 p.m. ISA.[480]

EPA is pursuing a two-part strategy to address visibility impairment. First, EPA developed the regional haze program (64 FR 35714) which was put in place in July 1999 to protect the visibility in Mandatory Class I Federal areas. There are 156 national parks, forests and wilderness areas categorized as Mandatory Class I Federal areas (62 FR 38680–38681, July 18, 1997). 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. Second, EPA has concluded that $PM_{2.5}$ causes adverse effects on visibility in other areas that are not protected by the Regional Haze Rule, depending on $PM_{2.5}$ concentrations and other factors that control their visibility impact effectiveness such as dry chemical composition and relative humidity (*i.e.,* an indicator of the water composition of the particles), and has set secondary $PM_{2.5}$ standards to address these areas. The existing annual primary and secondary $PM_{2.5}$ standards have been remanded and are being addressed in the currently ongoing PM NAAQS review.

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.,* polycyclic organic matter, dioxins, furans) and inorganic compounds (*e.g.,* nitrate, sulfate) to terrestrial and aquatic ecosystems. The chemical form of the compounds deposited depends on a variety of factors including ambient conditions (*e.g.,* temperature, humidity, oxidant levels) and the sources of the material. Chemical and physical transformations of the compounds occur in the atmosphere as well as the media onto which they deposit. These transformations in turn influence the fate, bioavailability and potential toxicity of these compounds. Atmospheric deposition has been identified as a key component of the environmental and human health hazard posed by several pollutants including mercury, dioxin and PCBs.[481]

Adverse impacts on water quality can occur when atmospheric contaminants deposit to the water surface or when material deposited on the land enters a waterbody through runoff. Potential impacts of atmospheric deposition to waterbodies include those related to both nutrient and toxic inputs. Adverse effects to human health and welfare can occur from the addition of excess nitrogen via atmospheric deposition. The nitrogen-nutrient enrichment

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[475] Appatova, A.S.; Ryan, P.H.; LeMasters, G.K.; Grinshpun, S.A. (2008) Proximal exposure of public schools and students to major roadways: a nationwide U.S. survey. J Environ Plan Mgmt Docket EPA–HQ–OAR–2010–0799.

[476] Green, R.S.; Smorodinsky, S.; Kim, J.J.; McLaughlin, R.; Ostro, B. (2004) Proximity of California public schools to busy roads. Environ Health Perspect 112: 61–66. Docket EPA–HQ–OAR–2010–0799.

[477] Houston, D.; Ong, P.; Wu, J.; Winer, A. (2006) Proximity of licensed child care facilities to near-roadway vehicle pollution. Am J Public Health 96: 1611–1617. Docket EPA–HQ–OAR–2010–0799.

[478] Wu, Y.; Batterman, S. (2006) Proximity of schools in Detroit, Michigan to automobile and truck traffic. J Exposure Sci Environ Epidemiol 16: 457–470. Docket EPA–HQ–OAR–2010–0799.

[479] National Research Council, 1993. Protecting Visibility in National Parks and Wilderness Areas. National Academy of Sciences Committee on Haze in National Parks and Wilderness Areas. National Academy Press, Washington, DC. Docket EPA–HQ–OAR–2010–0799. This book can be viewed on the National Academy Press Web site at *http://www.nap.edu/books/0309048443/html/.*

[480] *See* U.S. EPA 2009 Final PM ISA, Note 396.

[481] U.S. EPA (2000) Deposition of Air Pollutants to the Great Waters: Third Report to Congress. Office of Air Quality Planning and Standards. EPA–453/R–00–0005. Docket EPA–HQ–OAR–2010–0799.

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 freshwater and marine ecosystem components, 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.[482, 483, 484, 485, 486]

Atmospheric deposition of nitrogen and sulfur contributes to acidification, altering biogeochemistry and affecting animal and plant life in terrestrial and aquatic ecosystems across the United States. The sensitivity of terrestrial and aquatic ecosystems to acidification from nitrogen and sulfur deposition is predominantly governed by geology. Prolonged exposure to excess nitrogen and sulfur deposition in sensitive areas acidifies lakes, rivers and soils. Increased acidity in surface waters creates inhospitable conditions for biota and affects the abundance and nutritional value of preferred prey species, threatening biodiversity and ecosystem function. Over time, acidifying deposition also removes essential nutrients from forest soils, depleting the capacity of soils to neutralize future acid loadings and negatively affecting forest sustainability. Major effects include a decline in sensitive forest tree species, such as red spruce (Picea rubens) and sugar maple (Acer saccharum), and a loss of biodiversity of fishes, zooplankton, and macro invertebrates.

In addition to the role nitrogen deposition plays in acidification, nitrogen deposition also leads to nutrient enrichment and altered biogeochemical cycling. In aquatic systems increased nitrogen can alter species assemblages and cause eutrophication. In terrestrial systems nitrogen loading can lead to loss of nitrogen sensitive lichen species, decreased biodiversity of grasslands, meadows and other sensitive habitats, and increased potential for invasive species. For a broader explanation of the topics treated here, refer to the description in Section 6.1.2.2 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, damage to forest productivity and reductions in ecosystem services. 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

Emissions from producing, transporting and combusting fuel contribute to ambient levels of pollutants that contribute to adverse effects on vegetation. Volatile organic compounds, some of which are considered air toxics, have long been suspected to play a role in vegetation damage.[487] In laboratory experiments, a wide range of tolerance to VOCs has been observed.[488] 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.[489]

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.[490] [491] [492] 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.

4. Air Quality Impacts of Non-GHG Pollutants

a. Current Levels of Non-GHG Pollutants

This proposal may have impacts on ambient concentrations of criteria and air toxic pollutants. Nationally, levels of $PM_{2.5}$, ozone, NO_X, SO_X, CO and air toxics are declining.[493] However, approximately 127 million people lived in counties that exceeded any NAAQS in 2008.[494] These numbers do not include the people living in areas where there is a future risk of failing to maintain or attain the NAAQS. It is important to note that these numbers do not account for potential ozone, $PM_{2.5}$, CO, SO_2, NO_2 or lead nonattainment

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[482] U.S. EPA (2004) National Coastal Condition Report II. Office of Research and Development/ Office of Water. EPA–620/R–03/002. Docket EPA–HQ–OAR–2010–0799.

[483] Gao, Y., E.D. Nelson, M.P. Field, et al. 2002. Characterization of atmospheric trace elements on PM2.5 particulate matter over the New York-New Jersey harbor estuary. *Atmos. Environ.* 36: 1077–1086. Docket EPA–HQ–OAR–2010–0799.

[484] Kim, G., N. Hussain, J.R. Scudlark, and T.M. Church. 2000. Factors influencing the atmospheric depositional fluxes of stable Pb, 210Pb, and 7Be into Chesapeake Bay. *J. Atmos. Chem.* 36: 65–79. Docket EPA–HQ–OAR–2010–0799.

[485] Lu, R., R.P. Turco, K. Stolzenbach, et al. 2003. Dry deposition of airborne trace metals on the Los Angeles Basin and adjacent coastal waters. *J. Geophys. Res.* 108(D2, 4074): AAC 11–1 to 11–24. Docket EPA–HQ–OAR–2010–0799.

[486] Marvin, C.H., M.N. Charlton, E.J. Reiner, et al. 2002. Surficial sediment contamination in Lakes Erie and Ontario: A comparative analysis. *J. Great Lakes Res.* 28(3): 437–450. Docket EPA–HQ–OAR–2010–0799.

[487] U.S. EPA. 1991. Effects of organic chemicals in the atmosphere on terrestrial plants. EPA/600/3–91/001. Docket EPA–HQ–OAR–2010–0799.

[488] Cape JN, ID Leith, J Binnie, J Content, M Donkin, M Skewes, DN Price AR Brown, AD Sharpe. 2003. Effects of VOCs on herbaceous plants in an open-top chamber experiment. Environ. Pollut. 124:341–343. Docket EPA–HQ–OAR–2010–0799.

[489] Cape JN, ID Leith, J Binnie, J Content, M Donkin, M Skewes, DN Price AR Brown, AD Sharpe. 2003. Effects of VOCs on herbaceous plants in an open-top chamber experiment. Environ. Pollut. 124:341–343. Docket EPA–HQ–OAR–2010–0799.

[490] Viskari E–L. 2000. Epicuticular wax of Norway spruce needles as indicator of traffic pollutant deposition. Water, Air, and Soil Pollut. 121:327–337. Docket EPA–HQ–OAR–2010–0799.

[491] Ugrekhelidze D, F Korte, G Kvesitadze. 1997. Uptake and transformation of benzene and toluene by plant leaves. Ecotox. Environ. Safety 37:24–29. Docket EPA–HQ–OAR–2010–0799.

[492] Kammerbauer H, H Selinger, R Rommelt, A Ziegler-Jons, D Knoppik, B Hock. 1987. Toxic components of motor vehicle emissions for the spruce Picea abies. Environ. Pollut. 48:235–243. Docket EPA–HQ–OAR–2010–0799.

[493] U.S. EPA (2010) Our Nation's Air: Status and Trends through 2008. Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA 454/R–09–002. *http://www.epa.gov/airtrends/2010/*. Docket EPA–HQ–OAR–2010–0799.

[494] *See* U.S. EPA Trends, Note 493.

areas which have not yet been designated. Further, the majority of Americans continue to be exposed to ambient concentrations of air toxics at levels which have the potential to cause adverse health effects.[495] The levels of air toxics to which people are exposed vary depending on where people live and work and the kinds of activities in which they engage, as discussed in detail in U.S. EPA's recent mobile source air toxics rule.[496]

b. Impacts of Proposed Standards on Future Ambient Concentrations of PM$_{2.5}$, Ozone and Air Toxics

Full-scale photochemical air quality modeling is necessary to accurately project levels of criteria pollutants and air toxics. For the final rulemaking, a national-scale air quality modeling analysis will be performed to analyze the impacts of the standards on PM$_{2.5}$, ozone, and selected air toxics (*i.e.,* benzene, formaldehyde, acetaldehyde, acrolein and 1,3-butadiene). The length of time needed to prepare the necessary emissions inventories, in addition to the processing time associated with the modeling itself, has precluded us from performing air quality modeling for this proposal.

Sections III.G.1 and III.G.2 of the preamble present projections of the changes in criteria pollutant and air toxics emissions due to the proposed vehicle standards; the basis for those estimates is set out in Chapter 4 of the draft RIA. The atmospheric chemistry related to ambient concentrations of PM$_{2.5}$, ozone and air toxics is very complex, and making predictions based solely on emissions changes is extremely difficult. However, based on the magnitude of the emissions changes predicted to result from the proposed standards, EPA expects that there will be an improvement in ambient air quality, pending a more comprehensive analysis for the final rulemaking.

For the final rulemaking, EPA intends to use a Community Multi-scale Air Quality (CMAQ) modeling platform as the tool for the air quality modeling. The CMAQ modeling system is a comprehensive three-dimensional grid-based Eulerian air quality model designed to estimate the formation and fate of oxidant precursors, primary and secondary PM concentrations and deposition, and air toxics, over regional and urban spatial scales (*e.g.,* over the contiguous United States).[497] [498] [499] [500] The CMAQ model is a well-known and well-established tool and is commonly used by EPA for regulatory analyses and by States in developing attainment demonstrations for their State Implementation Plans. The CMAQ model version 4.7 was most recently peer-reviewed in February of 2009 for the U.S. EPA.[501]

CMAQ includes many science modules that simulate the emission, production, decay, deposition and transport of organic and inorganic gas-phase and particle-phase pollutants in the atmosphere. EPA intends to use the most recent version of CMAQ, which reflects updates to version 4.7 to improve the underlying science. These include aqueous chemistry mass conservation improvements, improved vertical convective mixing and lowered CB05 mechanism unit yields for acrolein from 1,3-butadiene tracer reactions which were updated to be consistent with laboratory measurements.

5. Other Unquantified Health and Environmental Effects

In addition, EPA seeks comment on whether there are any other health and environmental impacts associated with advancements in vehicle GHG reduction technologies that should be considered. For example, the use of technologies and other strategies to reduce GHG emissions could have effects on a vehicle's life-cycle impacts (*e.g.,* materials usage, manufacturing, end of life disposal), beyond the issues regarding fuel production and distribution (upstream) GHG emissions discussed in Section III.C.2. EPA seeks comment on any studies or research in this area that should be considered in the future to assess a fuller range of health and environmental impacts from the light-duty vehicle fleet moving to advanced GHG-reducing technologies.

EPA is aware of some studies examining the lifecycle GHG emissions, including vehicle production-related emissions, for advanced technology vehicles.[502] The American Iron and Steel Institute (AISI) has recommended that EPA consider basing future standards on lifecycle assessments that include vehicle production, use, and end-of-life impacts; AISI is working on related research with the University of California, Davis.[503] At this point, EPA believes there is insufficient information about the lifecycle impacts of future advanced technologies to conduct the type of detailed assessments that would be needed in a regulatory context, but EPA seeks comment on any current or future studies and research underway on this topic.

H. What are the estimated cost, economic, and other impacts of the proposal?

In this section, EPA presents the costs and impacts of the proposed GHG 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 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, will be 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 increase in vehicle prices due to costs of the technology, fuel savings, and the benefits of additional driving and reduced refueling. Other

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[495] U.S. Environmental Protection Agency (2007). Control of Hazardous Air Pollutants from Mobile Sources; Final Rule. 72 FR 8434, February 26, 2007.

[496] *See* U.S. EPA 2007, Note 495.

[497] U.S. Environmental Protection Agency, Byun, D.W., and Ching, J.K.S., Eds, 1999. Science algorithms of EPA Models-3 Community Multiscale Air Quality (CMAQ modeling system, EPA/600/R–99/030, Office of Research and Development). Docket EPA–HQ–OAR–2010–0799.

[498] Byun, D.W., and Schere, K.L., 2006. Review of the Governing Equations, Computational Algorithms, and Other Components of the Models-3 Community Multiscale Air Quality (CMAQ) Modeling System, J. Applied Mechanics Reviews, 59 (2), 51–77. Docket EPA–HQ–OAR–2010–0799.

[499] Dennis, R.L., Byun, D.W., Novak, J.H., Galluppi, K.J., Coats, C.J., and Vouk, M.A., 1996. The next generation of integrated air quality modeling: EPA's Models-3, Atmospheric Environment, 30, 1925–1938. Docket EPA–HQ–OAR–2010–0799.

[500] Carlton, A., Bhave, P., Napelnok, S., Edney, E., Sarwar, G., Pinder, R., Pouliot, G., and Houyoux, M. *Model Representation of Secondary Organic Aerosol in CMAQv4.7.* Ahead of Print in Environmental Science and Technology. Accessed at: *http://pubs.acs.org/doi/abs/10.1021/es100636q?prevSearch=CMAQ&searchHistoryKey* Docket EPA–HQ–OAR–2010–0799.

[501] Allen, D. et al (2009). Report on the Peer Review of the Atmospheric Modeling and Analysis Division, National Exposure Research Laboratory, Office of Research and Development, U.S. EPA. *http://www.epa.gov/asmdnerl/peer/reviewdocs.html* Docket EPA–HQ–OAR–2010–0799.

[502] For examples, see Chapter 6 of NHTSA's Draft Environmental Impact Statement for this proposed rulemaking, ''Literature Synthesis of Life-cycle Environmental Impacts of Certain Vehicle Materials and Technologies,'' Docket NHTSA–2011–0056.

[503] See AISI comments on the 2012–2016 rulemaking and NOI/Interim Joint TAR: Document ID # EPA–HQ–OAR–2009–0472–7088 and EPA–HQ–OAR–2010–0799–0313, respectively.

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 standards.

There is some debate about the behavior of private markets in the context of these standards: If consumers optimize their purchases of fuel economy, with full information and perfect foresight, in perfectly efficient markets, they should 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. Section III.H.1 discusses this issue more fully.

The net benefits of EPA's proposal consist of the effects of the proposed standards on:

- The vehicle costs;
- Fuel savings associated with reduced fuel usage resulting from the proposed program
- Greenhouse gas emissions;
- Other air pollutants;
- Other impacts, including noise, congestion, accidents;
- Energy security impacts;
- Changes in refueling events;
- Increased driving due to the ''rebound'' effect.

EPA also presents the cost per ton of GHG reductions associated with the proposed GHG standards on a CO_2eq basis, in Section III.H.3 below.

The total present value of monetized benefits (excluding fuel savings) under the proposed standards are projected to be between $275 to $764 billion, using a 3 percent discount rate and depending on the value used for the social cost of carbon. With a 7 percent discount rate, the total present value of monetized benefits (excluding fuel savings) under the proposed standards are projected to be between $124 to $614 billion, depending on the value used for the social cost of carbon. These benefits are summarized below in Table III–80. The present value of costs of the proposed standards are estimated to be between $243 to $551 billion for new vehicle technology (assuming a 7 and 3 percent discount rate, respectively), less $579 to $1,510 billion in savings realized by consumers through fewer fuel expenditures (calculated using pre-tax fuel prices and using a 7 and 3 percent discount rate, respectively). These costs are summarized below in Table III–78 and the fuel savings are summarized in Table III–79. The total net present value of net benefits under the proposed standards are projected to be between $1.2 and $1.7 trillion, using a 3 percent discount rate and depending on the value used for the social cost of carbon. With a 7 percent discount rate, the total net present value of net benefits under the proposed standards are projected to be between $460 billion to $950 billion, depending on the value used for the social cost of carbon. The estimates developed here use as a baseline for comparison the greenhouse gas performance and fuel economy associated with MY 2016 standards. 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 these proposed standards), the analysis overestimates private and social net benefits.

While NHTSA and EPA each modeled their respective regulatory programs, the analyses were generally consistent and featured similar parameters. For this proposal, EPA has not conducted an overall uncertainty analysis of the impacts associated with its regulatory program, though it did conduct sensitivity analyses of individual components of the analysis (*e.g.,* alternative SCC estimates, rebound effect, battery costs, mass reduction costs, the indirect cost markup factor, and cost learning curves); these analyses are found in Chapters 3, 4, and 7 of the EPA DRIA. NHTSA, however, conducted a Monte Carlo simulation of the uncertainty associated with its regulatory program. The focus of the simulation model was variation around the chosen uncertainty parameters and their resulting impact on the key output parameters, fuel savings, and net benefits. Because of the similarities between the two analyses, EPA references NHTSA RIA Chapters X and XII as indicative of the relative magnitude, uncertainty and sensitivities of parameters of the cost/benefit analysis. For the final rule, EPA plans to perform sensitivity analyses for a wider variety of parameters. EPA has also analyzed the potential impact of this proposed rule on vehicle sales and employment. These impacts are not included in the analysis of overall costs and benefits of the proposed standards. Further information on these and other aspects of the economic impacts of EPA's proposed rule are summarized in the following sections and are presented in more detail in the DRIA for this rulemaking.

EPA requests comment on all aspects of the cost, savings, and benefits analysis presented here and in the DRIA. EPA also requests comment on the inputs used in these analyses as described in the Draft Joint TSD.

1. Conceptual Framework for Evaluating Consumer Impacts

For this proposed rule, EPA projects significant private gains to consumers in three major areas: (1) Reductions in spending on fuel, (2) for gasoline-fueled vehicles, time saved due to less refueling, and (3) additional driving that results from the rebound effect. In combination, these private benefits, mostly from fuel savings, appear to outweigh the costs of the standards, 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 is smaller than the fuel savings. Yet many of 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, with the above assumptions, there must be additional costs of these private net benefits that are not accounted for. This calculation assumes that consumers accurately predict and act on all the fuel-saving benefits they will get from a new vehicle, and that producers market products providing those benefits. The estimate 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.

This subsection discusses the economic principles underlying the assessment of impacts on consumer well-being due to the proposed changes in the vehicles. Because conventional gasoline- and diesel-fueled vehicles have quite different characteristics from advanced technology vehicles (especially electric vehicles), the principles for these different kinds vehicles are discussed separately below.

a. Conventional Vehicles

For conventional vehicles, the estimates of technology costs developed for this proposed rule take into account the cost needed to ensure that vehicle utility (including performance, reliability, and size) stay constant, except for fuel economy and vehicle price, with some minor exceptions (*e.g.,* see the discussion of the ''Atkinson-cycle'' engine and towing capacity in III.D.3). For example, using a 4-cylinder engine instead of a 6-cylinder engine reduces fuel economy, but also reduces performance; turbocharging the 4-cylinder engine, though, produces fuel savings while maintaining performance. The cost estimates assume turbocharging accompanies engine downsizing. As a result, if the market for fuel economy is efficient and these cost estimates are correct, then the existence of large private net benefits implies that there would need to be some other changed qualities, missed in the cost estimates, that would reduce the benefits consumers receive from their vehicles.[504] We seek comments that identify any such changed qualities omitted from the analysis. Such comments should describe how changed qualities affect consumer benefits from vehicles, and provide cost estimates for eliminating the effects of the changes.

The central conundrum observed in this market, that consumers appear not to purchase products featuring levels of energy efficiency that are in their economic self-interest, has been referred to as the Energy Paradox in this setting (and in several others).[505] There are many possible reasons discussed in academic research why this might occur:[506]

- Consumers might be ''myopic'' and hence undervalue future fuel savings in their purchasing decisions.
- Consumers might lack the information necessary to estimate the value of future fuel savings, or not have a full understanding of this information even when it is presented.
- Consumer may be accounting for uncertainty in future fuel savings when comparing upfront cost to future returns.
- Consumers may consider fuel economy after other vehicle attributes and, as such, not optimize the level of this attribute (instead ''satisficing'' or selecting vehicles that have some sufficient amount of fuel economy).
- Consumers might be especially averse to the short-term losses associated with the higher prices of energy efficient products relative to the future fuel savings (the behavioral phenomenon of ''loss aversion'').
- Consumers might associate higher fuel economy with inexpensive, less well designed vehicles.
- Even if consumers have relevant knowledge, selecting a vehicle is a highly complex undertaking, involving many vehicle characteristics. In the face of such a complicated choice, consumers may use simplified decision rules.
- 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.[507]

A great deal of work in behavioral economics identifies and elaborates factors of this sort, which help account for the Energy Paradox.[508] 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 frequency and additional driving. For example, it might well be questioned whether significant reductions in refueling frequency, and corresponding private savings, are fully internalized when consumers are making purchasing decisions.

EPA discussed this issue at length in the 2012–2016 light duty rulemaking and in the medium- and heavy-duty greenhouse gas rulemaking. See 75 FR at 25510–13; 76 FR 57315–19. Considerable research indicates that the Energy Paradox may be a real and significant phenomenon, although 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[509] argue that consumers make decisions without the benefit of 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.[510] 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.[511] The attribute of fuel economy may be insufficiently salient, leading to a situation in which

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[504] It should be noted that adding fuel-saving technology does not preclude future improvements in performance, safety, or other attributes, though it is possible that the costs of these additions may be affected by the presence of fuel-saving technology.

[505] 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–2010–0799.

[506] For an overview, see Helfand, Gloria and Ann Wolverton, ''Evaluating the Consumer Response to Fuel Economy: A Review of the Literature.'' *International Review of Environmental and Resource Economics* 5 (2011): 103–146. Docket EPA–HQ–OAR–2010–0799.

[507] For instance, in MY 2010, the range of fuel economy (combined city and highway) available among all listed 6-cylinder minivans was 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.

[508] 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–2010–0799. See also Allcott and Wozny, supra note.

[509] Sanstad, A., and R. Howarth (1994). '' 'Normal' Markets, Market Imperfections, and Energy Efficiency.'' *Energy Policy* 22(10): 811–818 (Docket EPA–HQ–OAR–2010–0799).

[510] 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–2010–0799); 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–2010–0799); 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–2010–0799); 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–2010–0799); 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–2010–0799); 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–2010–0799).

[511] 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–2010–0799).

consumers are not willing to pay $1 for an expected $1 present value of reduced gasoline costs.[512] Larrick and Soll (2008) find that consumers do not understand how to translate changes in miles-per-gallon into fuel savings.[513] 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.[514] In addition, it is possible that factors that might help explain why consumers don't purchase more fuel efficiency, such as transaction costs and differences in quality, may not be adequately measured.[515] 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.[516] A review commissioned by EPA finds great variability in estimates of the role of fuel economy in consumers' vehicle purchase decisions.[517] 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 of value from the literature. Thus, estimating consumer response to higher vehicle fuel economy is still unsettled science.

EPA and NHTSA recently revised the fuel economy label on new vehicles in ways intended to improve information for consumers.[518] For instance, it presents fuel consumption data in addition to miles per gallon, in response to the concern over the difficulties of translating mpg into fuel savings; it also reports expected fuel savings or additional costs relative to an average vehicle. Whether the new label will help consumers to overcome the ''energy paradox'' is not known at this point. A literature review that contributed to the fuel economy labeling rule points out that consumers increasingly do a great deal of research on the internet before going to an auto dealer.[519] To the extent that the label improves consumers' understanding of the value of fuel economy, purchase decisions could change. Until the newly revised labels enter the marketplace with MY 2013 vehicles (or optionally sooner), the agencies may not be able to determine how vehicle purchase decisions are likely to change as a result of the new labels.

If there is a difference between expected fuel savings and consumers' willingness to pay for those 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.

While acknowledging the conundrum, EPA continues to value fuel savings from the proposed standards using the projected market value over the vehicles' entire lifetimes, and to report that value among private benefits of the proposed rule. Improved fuel economy will significantly reduce consumer expenditures on fuel, thus benefiting consumers. Real money is being saved and accrued by the initial buyer and subsequent owners. In addition, using a measure based on consumer consideration at the time of vehicle purchase would involve a very wide range of uncertainty, due to the lack of consensus on the value of additional fuel economy in vehicle choice models. Due partly to this factor, 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 in the deployment process due to shifts in consumer demand for fuel economy, or due to expectations by auto makers of future GHG/fuel economy standards. It is not impossible that some of these savings would have occurred in the absence of the proposed standards.[520] 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 proposed standards), the analysis overestimates private and social benefits and costs. 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. Helfand and Wolverton discuss the wide variation in the

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[512] 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,%* (Docket EPA–HQ–OAR–2010–0799). U.S. Department of Energy, 2011. ''Transportation and the Economy,'' Chapter 10 in ''Transportation Energy Data Book,'' http://cta.ornl.gov/data/tedb30/Edition30_Chapter10.pdf, Table 10.13, estimates that gas and oil costs were 15.4% of vehicle costs per mile in 2010.

[513] Sanstad, A., and R. Howarth (1994). '' 'Normal' Markets, Market Imperfections, and Energy Efficiency.''*Energy Policy* 22(10): 811–818 (Docket EPA–HQ–OAR–2010–0799); Larrick, R. P., and J.B. Soll (2008). ''The MPG illusion.'' *Science* 320: 1593–1594 (Docket EPA–HQ–OAR–2010–0799).

[514] Hausman J., Joskow P. (1982). ''Evaluating the Costs and Benefits of Appliance Efficiency Standards.'' American Economic Review 72: 220–25 (Docket EPA–HQ–OAR–2010–0799).

[515] Jaccard, Mark. ''Paradigms of Energy Efficiency's Cost and their Policy Implications: Déjà Vu All Over Again.'' Modeling the Economics of Greenhouse Gas Mitigation: Summary of a Workshop, K. John Holmes, Rapporteur. National Academies Press, 2010. *http://www.nap.edu/openbook.php?record_id=13023&page=42* (Docket EPA–HQ–OAR–2010–0799).

[516] *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–2010–0799); 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–2010–0799); 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 11/1/11), available at *http://web.mit.edu/knittel/www/papers/gaspaper_latest.pdf* (Docket EPA–HQ–OAR–2010–0799).

[517] Greene, David L. ''How Consumers Value Fuel Economy: A Literature Review.'' EPA Report EPA–420–R–10–008, March 2010 (Docket EPA–HQ–OAR–2010–0799).

[518] Environmental Protection Agency and Department of Transportation, ''Revisions and Additions to Motor Vehicle Fuel Economy Label,'' **Federal Register** 76(129) (July 6, 2011): 39478–39587.

[519] PRR, Inc., ''Environmental Protection Agency Fuel Economy Label: Literature Review.'' EPA–420–R–10–906, August 2010, available at *http://www.epa.gov/fueleconomy/label/420r10906.pdf* 2010 (Docket EPA–HQ–OAR–2010–0799).

[520] However, as discussed at section III.D above, the assumption of a flat baseline absent this rule rests on strong historic evidence of lack of increase in fuel economy absent either regulatory control or sharply rising fuel prices.

structure and results of these models.[521] 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.

In order to develop greater understanding of these models, EPA is in the process of developing a vehicle choice model. It uses a ''nested logit'' structure common in the vehicle choice modeling literature. ''Nesting'' refers to the decision-tree structure of buyers' choices among vehicles the model employs, and ''logit'' refers to the specific pattern by which buyers' choices respond to differences in the overall utility that individual vehicle models and their attributes provide.[522] The nesting structure in EPA's model involves a hierarchy of choices. In its current form, at the initial decision node, consumers choose between buying a new vehicle or not. Conditional on choosing a new vehicle, consumers then choose among passenger vehicles, cargo vehicles, and ultra-luxury vehicles. The next set of choices subdivides each of these categories into vehicle type (*e.g.,* standard car, minivan, SUV, etc.). Next, the vehicle types are divided into classes (small, medium, and large SUVs, for instance), and then, at the bottom, are the individual models. At this bottom level, vehicles that are similar to each other (such as standard subcompacts, or prestige large vehicles) end up in the same ''nest.'' Substitution within a nest is considered much more likely than substitution across nests, because the vehicles within a nest are more similar to each other than vehicles in different nests. For instance, a person is more likely to substitute between a Chevrolet Aveo and a Toyota Yaris (both subcompacts) than between an Aveo and a pickup truck. In addition, substitution is greater at low decision nodes (such as individual vehicles) than at higher decision nodes (such as the buy/no buy decision), because there are more choices at lower levels than at higher levels. Parameters for the model (including demand elasticities and the value of fuel economy in purchase decisions) are being selected based on a review of values found in the literature on vehicle choice modeling. Additional discussion of this model can be found in Chapter 8.1.2.8 of the DRIA. The model is still undergoing development; the agency will seek peer review on it before it is utilized. In addition, concerns remain over the ability of any vehicle choice model to make reasonable predictions of the response of the total number and composition of new vehicle sales to changes in the prices and characteristics of specific vehicle models. EPA seeks comments on the use of vehicle choice modeling for predicting changes in sales mix due to policies, and on methods to test the ability of a vehicle choice model to produce reasonable estimates of changes in fleet mix.

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.3 of this preamble), the technology cost estimates developed here for conventional vehicles take into account the costs to hold other vehicle attributes, such as size and performance, constant.[523] 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,[524] the price increase measures the loss to the buyer.[525] Assuming that the full technology cost gets passed along to the buyer as an increase in price, the technology cost thus measures the welfare loss to the 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 bounded by the technology costs.

b. Electric Vehicles and Other Advanced Technology Vehicles

This proposal finds that electric vehicles (EVs) may form a part (albeit limited) of some manufacturers' compliance strategy. The following discussion will focus on EVs, because they are expected to play more of a role in compliance than vehicles with other alternative fuels, but related issues may arise for other alternatively fueled vehicles. It should be noted that EPA's projection of the penetration of EVs in the MY 2025 fleet is very small (under 3%).

Electric vehicles (EVs), at the time of this rulemaking, have very different refueling infrastructures than conventional gasoline- or diesel-fueled vehicles: Refueling EVs requires either access to electric charging facilities or battery replacement. In addition, because of the expense of increased battery capacity, EVs commonly have a smaller driving range than conventional vehicles. Because of these differences, the vehicles cannot be considered conventional vehicles unmodified except for cost and fuel economy. As a result, the consumer welfare arguments presented above need to be modified to account for these differences.

A first important point to observe is that, although auto makers are required to comply with the proposed standards, producing EVs as a compliance strategy is not specifically required. Auto makers will choose to provide EVs either if they have few alternative ways to comply, or if EVs are, for some range of production, likely to be more profitable (or less unprofitable) than other ways of complying.

From the consumer perspective, it is important to observe that there is no mandate for any consumer to choose any particular kind of vehicle. An individual consumer will buy an EV only if the price and characteristics of the vehicle make it more attractive to her than other vehicles. If the range of vehicles in the conventional fleet does not shrink, the availability of EVs should not reduce consumer welfare compared to a fleet with no EVs: Increasing options should not reduce consumer well-being, because other existing options still are available. On the other hand, if the variety of vehicles in the conventional market does change, there may be consumers who are forced

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[521] Helfand, Gloria and Ann Wolverton, ''Evaluating the Consumer Response to Fuel Economy: A Review of the Literature.'' *International Review of Environmental and Resource Economics* 5 (2011): 103–146 (Docket EPA–HQ–OAR–2010–0799).

[522] Logit refers to a statistical analysis method used for analyzing the factors that affect discrete choices (*i.e.*, yes/no decisions or the choice among a countable number of options).

[523] If the reference-case vehicles include different vehicle characteristics, such as improved acceleration or towing capacity, then the costs for the proposed standards would be, as here, the costs of adding compliance technologies to those reference-case vehicles. These costs may differ from those estimated here, due to our lack of information on how those vehicle characteristics might change between now and 2025.

[524] 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 for marketed goods.

[525] 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, unaccounted for in the costs, that make the vehicle less desirable to consumers.

to substitute to alternative vehicles. The use of the footprint-based standard is intended in part to help maintain the diversity of vehicle sizes. Because the agencies do not expect any vehicle classes to become unavailable, consumers who buy EVs therefore are expected to choose them voluntarily, in preference to the other vehicles available to them.

From a practical perspective, the key issue is whether the consumer demand for EVs is large enough to absorb all the EVs that automakers will produce in order to comply with these standards, or whether automakers will need to increase consumer purchases by providing subsidies to consumers. If enough consumers find EVs more attractive than other vehicles, and automakers therefore do not need to subsidize their purchase, then both consumers and producers will benefit from the introduction of EVs. On the other hand, it is possible that automakers will find EVs to be part of a cost-effective compliance technology but nevertheless need to price them below cost them to sell sufficient numbers. If so, then there is a welfare loss associated with the sale of EVs beyond those that would be sold in the free market. The deadweight loss can be approximated as one-half of the size of the subsidy needed for the marginal purchaser, times the number of sales that would need the subsidy. Estimating this value would require knowing the number of sales necessary beyond the expected sales level in an unregulated market, and the amount of the subsidy that would be necessary to induce the desired number of sales. Given the fledgling state of the market for EVs, neither of these values is easily knowable for the 2017 to 2025 time frame.

A number of factors will affect the likelihood of consumer acceptance of EVs. People with short commutes may find little obstacle in the relatively short driving range, but others who regularly drive long distances may find EVs' ranges limiting. The reduced tailpipe emissions and reduced noise may be attractive features to some consumers.[526] Recharging at home could be a convenient, desirable feature for people who have garages with electric charging capability, but not for people who park on the street. If an infrastructure develops for recharging vehicles with the convenience approaching that of buying gasoline, range or home recharging may become less of a barrier to purchase. Of course, other attributes of the marketed EVs, such as their performance and their passenger and storage capacity, will also affect the share of consumers who will consider them. As infrastructure, EV technology, and costs evolve over time, consumer interest in EVs will adjust as well. Thus, modeling consumer response to advanced technology vehicles in the 2017–2025 time frame poses even more challenges than those associated with modeling consumer response for conventional vehicles.

Because range is a major factor in EV acceptability, it is starting to draw attention in the research community. For instance, several studies have examined consumers' willingness to pay for increased vehicle range. Results vary, depending on when the survey was conducted (studies from the early 1990s have much higher values than more recent studies) and on household income and other demographic factors; some find range to be statistically indistinguishable from zero, while others find the value of increasing range from 150 to 300 miles to be as much as $59,000 (2009$) (see RIA Chapter 8 for more discussion).

Other research has examined how the range limitation may affect driving patterns. Pearre et al. observed daily driving patterns for 484 vehicles in the Atlanta area over a year.[527] In their sample, 9 percent of vehicles never exceeded 100 miles in one day, and 21 percent never exceeded 150 miles in one day. Lin and Greene compared the cost of reduced range to the cost of additional battery capacity for EVs.[528] They find that an ''optimized'' range of about 75 miles would be sufficient for 98% of days for ''modest'' drivers (those who average about 25 miles per day); the optimized EV range for ''average'' drivers (who average about 43 miles per day), close to 120 miles, would meet their needs on 97 percent of days. Turrentine et al. studied drivers who leased MINI E EVs (a conversion of the MINI Cooper) for a year.[529] They found that drivers adapted their driving patterns in response to EV ownership: For instance, they modified where they shopped and increased their use of regenerative braking in order to reduce range as a constraint. These finding suggest that, for some consumers, range may be a limiting factor only occasionally. If those consumers are willing to consider alternative ways of driving long distances, such as renting a gasoline vehicle or exchanging vehicles within the household, then limited range may not be a barrier to adoption for them. These studies also raise the question whether analysis of EV use should be based on the driving patterns from conventional vehicles, because consumers may use EVs differently than conventional vehicles.

EVs themselves are expected to change over time, as battery technologies and costs develop. In addition, consumer interest in EVs is likely to change over time, as early adopters share their experiences. The initial research in the area suggests that consumers put a high value on increased range, though this value appears to be changing over time. The research also suggests that some segments of the driving public may experience little, if any, restriction on their driving due to range limitations if they were to purchase EVs. At this time it is not possible to estimate whether the number of people who will choose to purchase EVs at private-market prices will be more or less than the number that auto makers are expected to produce to comply with the standards. We note that our projections of technology penetrations indicate that a very small portion (fewer than 3 percent) of new vehicles produced in 2025 will need to be EVs. For the purposes of the analysis presented here for this proposal, we assume that the consumer market will be sufficient to absorb the number of EVs expected to be used for compliance under this rule. We seek comment and further research that might provide evidence on the consumer market for EVs in the 2017–2025 period.

c. Summary

The Energy Paradox, also known as the efficiency gap, raises the question, why do private markets not provide energy savings that engineering, technology cost analyses find are cost-

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[526] For instance, Hidrue et al. (Hidrue, Michael K., George R. Parsons, Willett Kempton, and Meryl P. Gardner. ''Willingness to Pay for Electric Vehicles and their Attributes.'' *Resource and Energy Economics* 33(3) (2011): 686–705 (Docket EPA–HQ–OAR–2010–0799)) find that some consumers are willing to pay $5100 for vehicles with 95% lower emissions than the vehicles they otherwise aim to purchase.

[527] Pearre, Nathaniel S., Willett Kempton, Randall L. Guensler, and Vetri V. Elango. ''Electric vehicles: How much range is required for a day's driving?'' *Transportation Research Part C* 19(6) (2011): 1171–1184 (Docket EPA–HQ–OAR–2010–0799).

[528] Lin, Zhenhong, and David Greene. ''Rethinking FCV/BEV Vehicle Range: A Consumer Value Trade-off Perspective.'' The 25th World Battery, Hybrid and Fuel Cell Electric Vehicle Symposium and Exhibition, Shenzhen, China, Nov. 5–9, 2010 (Docket EPA–HQ–OAR–2010–0799).

[529] Turrentine, Tom, Dahlia Garas, Andy Lentz, and Justin Woodjack. ''The UC Davis MINI E Consumer Study.'' UC Davis Institute of Transportation Research Report UCD–ITS–RR–11–05, May 4, 2011 (Docket EPA–HQ–OAR–2010–0799).

effective? Though a number of hypotheses have been raised to explain the paradox, studies have not been able at this time to identify the relative importance of different explanations. As a result, it is not possible at this point to state with any degree of certainty whether the market for fuel efficiency is operating efficiently, or whether the market has failings.

For conventional vehicles, the key implication is that the there may be two different estimates of the value of fuel savings. One value comes from the engineering estimates, based on consumers' expected driving patterns over the vehicle's lifetime; the other value is what the consumer factors into the purchase decision when buying a vehicle. Although economic theory suggests that these two values should be the same in a well functioning market, if engineering estimates accurately measure fuel savings that consumers will experience, the available evidence does not provide support for that theory. The fuel savings estimates presented here are based on expected consumers' in-use fuel consumption rather than the value they estimate at the time that they consider purchasing a vehicle. Though the cost estimates may not have taken into account some changes that consumers may not find desirable, those omitted costs would have to be of very considerable magnitude to have a significant effect on the net benefits of this rule. The costs imposed on the consumer are measured by the costs of the technologies needed to comply with the standards. Because the cost estimates have built into them the costs required to hold other vehicle attributes constant, then, in principle, compensating consumers for the increased costs would hold them harmless, even if they paid no attention to the fuel efficiency of vehicles when making their purchase decisions.

For electric vehicles, and perhaps for other advanced-technology vehicles, other vehicle attributes are not expected to be held constant. In particular, their ranges and modes of refueling will be different from those of conventional vehicles. From a social welfare perspective, the key question is whether the number of consumers who will want to buy EVs at their private-market prices will exceed the number that auto makers are expected to produce to comply with the standards. If too few consumers are willing to buy them at their private-market prices, then auto makers will have to subsidize their prices. Though current research finds that consumers typically have a high value for increasing the range of EVs (and thus would consider a shorter range a cost of an EV), current research also suggests that consumers may find ways to adapt to the shorter range so that it is less constraining. The technologies, prices, infrastructure, and consumer experiences associated with EVs are all expected to evolve between the present and the period when this rule becomes effective. The analysis in this proposal assumes that the consumer market is sufficient to absorb the expected number of EVs without subsidies.

We seek comment and further research on the efficiency of the market for fuel economy for conventional vehicles and on the likely size of the consumer market for EVs in 2017–2025.

2. Costs Associated With the Vehicle Standards

In this section, EPA presents our estimate of the costs associated with the proposed vehicle program. The presentation here summarizes the vehicle level costs associated with the new technologies expected to be added to meet the proposed GHG standards, including hardware costs to comply with the proposed A/C credit program. The analysis summarized here provides our estimate of incremental costs on a per vehicle basis and on an annual total basis.

The presentation here summarizes the outputs of the OMEGA model that was discussed in some detail in Section III.D of this preamble. For details behind the analysis such as the OMEGA model inputs and the estimates of costs associated with individual technologies, the reader is directed to Chapter 1 of the EPA's draft RIA and Chapter 3 of the draft 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 3 and 5 of EPA's draft RIA.

With respect to the aggregate cost estimations presented here, 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 advanced vehicle technology credits.

a. Costs per Vehicle

To develop costs per vehicle, EPA has used the same methodology as that used in the recent 2012–2016 final rule and the 2010 TAR. Individual technology direct manufacturing costs have been estimated in a variety of ways—vehicle and technology tear down, models developed by outside organizations, and literature review—and indirect costs have been estimated using the updated and revised indirect cost multiplier (ICM) approach that was first developed for the 2012–2016 final rule. All of these individual technology costs are described in detail in Chapter 3 of the draft joint TSD. Also described there are the ICMs used in this proposal and the ways the ICMs have been updated and revised since the 2012–2016 final rule which results in considerably higher indirect costs in this proposal than estimated in the 2012–2016 final rule. Further, we describe in detail the adjustments to technology costs to account for manufacturing learning and the cost reductions that result from that learning. We note here that learning impacts are applied only to direct manufacturing costs which differs from the 2012–2016 final rule which applied learning to both direct and indirect costs. Lastly, we have included costs associated with stranded capital (*i.e.,* capital investments that are not fully recaptured by auto makers because they would be forced to update vehicles on a more rapid schedule than they may have intended absent this proposal). Again, this is detailed in Chapter 3 of the draft joint TSD.

EPA then used the technology costs to build GHG and fuel consumption reducing packages of technologies for each of 19 different vehicle types meant to fully represent the range of baseline vehicle technologies in the marketplace (*i.e.,* number of cylinders, valve train configuration, vehicle class). This package building process as well as the process we use to determine the most cost effective packages for each of the 19 vehicle types is detailed in Chapter 1 of EPA's draft RIA. These packages are then used as inputs to the OMEGA model to estimate the most cost effective means of compliance with the proposed standards giving due consideration to the timing required for manufacturers to implement the needed technologies. That is, we assume that manufacturers cannot add the full suite of needed technologies in the first year of implementation. Instead, we expect them to add technologies to vehicles during the typical 4 to 5 year redesign cycle. As such, we expect that every vehicle can be redesigned to add significant levels of new technology every 4 to 5 years. Further, we do not expect manufacturers to redesign or refresh vehicles at a pace more rapid than the industry standard four to five year cycle.

The results, including costs associated with the air conditioning program and estimates of stranded capital as described in Chapter 3 of the draft joint TSD, are shown in Table III–65.

Table III-65 Industry Average Vehicle Costs Associated with the Proposed Standards

(2009 dollars)

Model Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
$/car	$194	$353	$479	$595	$718	$1,165	$1,492	$1,806	$1,942	$1,926	$1,926	$1,926
$/truck	$55	$198	$305	$417	$764	$1,200	$1,525	$1,834	$1,954	$1,938	$1,938	$1,938
Combined	$146	$299	$418	$533	$734	$1,176	$1,503	$1,815	$1,946	$1,930	$1,929	$1,929

b. Annual Costs of the Proposed National Program

The costs presented here represent the incremental costs for newly added technology to comply with the proposed program. Together with the projected increases in car and truck sales, the increases in per-car and per-truck average costs shown in Table III–65, above result in the total annual costs presented in Table III–66 below. Note that the costs presented in Table III–66 do not include the fuel savings that consumers would experience as a result of driving a vehicle with improved fuel economy. Those impacts are presented in Section III.H.4. Note also that the costs presented here represent costs estimated to occur presuming that the proposed MY 2025 standards would continue in perpetuity. Any changes to the proposed standards would be considered as part of a future rulemaking. In other words, the proposed standards would not apply only to 2017–2025 model year vehicles—they would, in fact, apply to all 2025 and later model year vehicles.

Table III-66 Undiscounted Annual Costs, & Proposed Program Costs Discounted back to 2012

(millions of 2009 dollars)

Calendar Year	Cars	Truck	Total Annual Costs
2017	$1,940	$322	$2,300
2018	$3,500	$1,130	$4,660
2019	$4,780	$1,700	$6,510
2020	$6,120	$2,340	$8,470
2021	$7,540	$4,340	$11,900
2022	$12,500	$6,840	$19,300
2023	$16,400	$8,680	$25,000
2024	$20,300	$10,400	$30,700
2025	$22,400	$11,200	$33,600
2030	$24,100	$11,600	$35,700
2040	$27,100	$12,600	$39,800
2050	$30,500	$14,100	$44,600
NPV, 3%	$373,000	$177,000	$551,000
NPV, 7%	$165,000	$78,300	$243,000

Annual costs represent undiscounted values; net present values represent annual costs discounted to 2012.

3. Cost per Ton of Emissions Reduced

EPA has calculated the cost per ton of GHG reductions associated with the proposed GHG standards on a CO_2eq basis using the costs and the emissions reductions described in Section III.F. These values are presented in Table III–67 for cars, trucks and the combined fleet. The cost per metric ton of GHG emissions reductions has been calculated in the years 2020, 2030, 2040, and 2050 using the annual vehicle compliance costs and emission reductions for each of those years. The value in 2050 represents the long-term cost per ton of the emissions reduced. 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 program such as those associated with energy security benefits as discussed later in Section III. By including the fuel savings, the cost per ton is generally less than $0 since the estimated value of fuel savings outweighs the program costs.

Table III-67 Annual Cost per Metric Ton of CO_2eq Reduced (2009 dollars)

	Calendar Year	Undiscounted Annual Costs ($millions)	Undiscounted Annual Pre-tax Fuel Savings ($millions)	Annual CO_2eq Reduction (mmt)	$/ton (w/o fuel savings)	$/ton (w/ fuel savings
Cars	2020	$6,120	$4,840	19	$318	$67
	2030	$24,100	$54,300	183	$132	-$165
	2040	$27,100	$91,200	284	$95	-$226
	2050	$30,500	$117,000	332	$92	-$260
Trucks	2020	$2,340	$2,340	10	$245	$0
	2030	$11,600	$34,000	114	$102	-$196
	2040	$12,600	$57,500	178	$71	-$252
	2050	$14,100	$76,000	215	$66	-$288
Combined	2020	$8,470	$7,180	29	$294	$45
	2030	$35,700	$88,300	297	$120	-$177
	2040	$39,800	$149,000	462	$86	-$236
	2050	$44,600	$193,000	547	$81	-$271

4. Reduction in Fuel Consumption and Its Impacts

a. What are the projected changes in fuel consumption?

The proposed 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. While gasoline consumption would decrease under the proposed GHG standards, electricity consumption would increase slightly due to the small penetration of EVs and PHEVs (1–3% for the 2021 and 2025 MYs). The fuel savings includes both the gasoline consumption reductions and the electricity consumption increases. Note that the total number of miles that vehicles are driven each year is different under the control case than in the reference case due to the ''rebound effect,'' which is discussed in Section III.H.4.c and in Chapter 4 of the draft joint TSD. 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–68. The gallons reduced and kilowatt hours increased (kWh) as shown in the tables reflect impacts from the proposed CO_2 standards, including the A/C credit program, and include increased consumption resulting from the rebound effect.

Table III-68 Fuel Consumption Impacts of the Proposed Standards and A/C Credit Programs

Calendar Year	Petroleum-based Gasoline Reference (million gallons)	Petroleum-based Gasoline Reduced (million gallons)	Electricity Increased (million kWh)[a]
2017	130,544	194	115
2018	129,503	641	345
2019	128,680	1,326	695
2020	128,229	2,277	1,177
2021	128,387	3,673	1,796
2022	128,599	5,424	2,952
2023	129,312	7,520	4,673
2024	130,087	9,919	6,980
2025	131,289	12,658	9,911
2030	140,602	25,581	24,298
2040	159,582	40,391	42,369
2050	184,136	47,883	51,123
Total	5,079,096	941,839	951,392

[a] Electricity increase by vehicles not by power plants.

b. What are the fuel savings to the consumer?

Using the fuel consumption estimates presented in Section III.H.4.a, EPA can calculate the monetized fuel savings associated with the proposed 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 2011 Final Release.[530] These estimates do not

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[530] In the Preface to AEO 2011, the Energy Information Administration describes the reference case. They state that, "Projections by EIA are not

Continued

account for the significant uncertainty in future fuel prices; the monetized fuel savings would be understated if actual future fuel prices are higher (or overstated if fuel prices are lower) than estimated. AEO is a standard reference used by NHTSA and EPA and many other government agencies to estimate the projected price of fuel. This has been done using both the pre-tax and post-tax gasoline prices. Since the post-tax gasoline prices are the prices paid at fuel pumps, the fuel savings calculated using these prices represent the savings consumers would see. The pre-tax fuel savings are those savings that society would see. Assuming no change in gasoline tax rates, the difference between these two columns represents the reduction in fuel tax revenues that will be received by state and federal governments—about $82 million in 2017 and $17 billion by 2050. These results are shown in Table III–69. Note that in Section III.H.9, the overall benefits and costs of the proposal are presented and, for that reason, only the pre-tax fuel savings are presented there.

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statements of what will happen but of what might happen, given the assumptions and methodologies used for any particular scenario. The Reference case projection is a business-as-usual trend estimate, given known technology and technological and demographic trends.

Table III-69 Undiscounted Annual Fuel Savings, & Proposed Program Fuel Savings Discounted back to 2012 (millions of 2009 dollars)

Calendar Year	Gasoline Savings (pre-tax)	Gasoline Savings (taxed)	Electricity Costs	Total Fuel Savings (pre-tax)	Total Fuel Savings (taxed)
2017	$581	$663	$11.1	$570	$652
2018	$1,950	$2,230	$32.8	$1,920	$2,200
2019	$4,120	$4,670	$66.0	$4,060	$4,600
2020	$7,180	$8,110	$113	$7,060	$7,990
2021	$11,600	$13,100	$172	$11,400	$12,900
2022	$17,400	$19,700	$286	$17,100	$19,400
2023	$24,400	$27,500	$458	$24,000	$27,000
2024	$32,700	$36,800	$691	$32,000	$36,100
2025	$42,400	$47,200	$1,000	$41,400	$46,200
2030	$88,300	$98,100	$2,550	$85,800	$95,600
2040	$149,000	$164,000	$4,850	$144,000	$159,000
2050	$193,000	$210,000	$6,350	$187,000	$204,000
NPV, 3%	$1,550,000	$1,720,000	$47,800	$1,510,000	$1,670,000
NPV, 7%	$596,000	$660,000	$17,800	$579,000	$642,000

Annual values represent undiscounted values; net present values represent annual costs discounted to 2012.

As shown in Table III–69, the agencies are projecting that consumers would realize very large fuel savings as a result of the proposed standards. As discussed further in the introductory paragraphs of 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.

c. VMT Rebound Effect

The rebound effect refers to the increase in vehicle use that results if an increase in fuel efficiency lowers the cost per mile of driving. For this proposal, EPA is using an estimate of 10 percent for the rebound effect (*i.e.,* we assume a 10 percent decrease in fuel cost per mile from our proposed standards would result in a 1 percent increase in VMT).

As we discussed in the 2012–2016 rulemaking and in Chapter 4 of the Joint TSD, this 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. This value is consistent with the rebound estimate for the most recent time period analyzed in the Small and Van Dender 2007 paper,[531] and falls within the range of the larger body of historical work on the rebound effect.[532] Recent work by David Greene on the rebound effect for light-duty vehicles in the U.S. supports the hypothesis that the rebound effect is decreasing over time,[533] which could mean that rebound estimates based on recent time period data may be more reliable than historical estimates that are based on older time period data. New work by Hymel, Small, and Van Dender also supports the theory that the rebound effect is declining over time, although the Hymel et al. estimates are higher than the 2007 Small and Van Dender estimates.[534] Furthermore, by using an estimate of the future rebound effect, analysis by Small and Greene show that the rebound effect could be in the range of 5% or lower.[535]

Most studies that estimate the rebound effect use the fuel cost per mile of driving or gasoline prices as a surrogate for fuel efficiency. Recent work conducted by Kenneth Gillingham, however, provides suggestive evidence that consumers may be less responsive to changes in fuel efficiency than to changes in fuel prices.[536] While this research pertains specifically to California, this finding suggests that the common assumption that consumers respond similarly to changes in gasoline prices and changes in fuel efficiency may overstate the potential rebound effect. Additional research is needed in this area, and EPA requests comments and data on this topic.

Another factor discussed by Gillingham is whether consumers actually respond the same way to an increase in the cost of driving compared to a decrease in the cost of driving. There is some evidence in the literature that consumers are more responsive to an increase in prices than to a decrease in prices.[537] [538] [539] Furthermore, it is also possible that consumers respond more to a large shock than a small, gradual change in prices. Since these proposed standards would decrease the cost of driving gradually over time, it is possible that the rebound effect would be much smaller than some of the estimates included in the historical literature. More research in this area is also important, and EPA invites comment and data on this aspect of the rebound effect.

Finally, for purposes of analyzing the proposed standards, EPA assumes the rebound effect will be the same whether a consumer is driving a conventional gasoline vehicle or a vehicle powered by grid electricity. We are not aware of any research that has examined consumer responses to changes in the cost per mile of driving that result from driving an electric-powered vehicle instead of a conventional gasoline vehicle. EPA requests comment and data on this topic.

Chapter 4.2.5 of the Joint TSD reviews the relevant literature and discusses in more depth the reasoning for the rebound value used here. The rebound effect is also discussed in Section II.E of the preamble. While EPA has used a weight of evidence approach for determining that 10 percent is a reasonable value to use for the rebound effect, EPA requests comments on this and alternative methodologies for estimating the rebound effect over the period that our proposed standards would go into effect. EPA also invites the submission of new data regarding estimates of the rebound effect. We also discuss two approaches for modeling the rebound effect in Chapter 4 of the DRIA; we request comment on these modeling approaches.

5. CO_2 Emission Reduction Benefits

EPA has assigned a dollar value to reductions in CO_2 emissions using global estimates of the social cost of carbon (SCC). The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change. The SCC estimates used in this analysis were developed through an interagency process that included EPA, DOT/NHTSA, and other executive branch entities, and concluded in February 2010. We first used these SCC estimates in the benefits analysis for the 2012–2016 light-duty GHG rulemaking; see 75 FR at 25520. We have continued to use these estimates in other rulemaking analyses, including the heavy-duty GHG rulemaking; see 76 FR at 57332. The SCC Technical Support Document (SCC TSD) provides a complete discussion of the methods used to develop these SCC estimates.[540]

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[531] Small, K. and K. Van Dender, 2007. ''Fuel Efficiency and Motor Vehicle Travel: The Declining Rebound Effect'', The Energy Journal, vol. 28, no. 1, pp. 25–51 (Docket EPA–HQ–OAR–2010–0799).

[532] 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–2010–0799).

[533] Greene, David, ''Rebound 2007: Analysis of National Light-Duty Vehicle Travel Statistics,'' February 9, 2010 (Docket EPA–HQ–OAR–2010–0799). This paper has been accepted for an upcoming special issue of Energy Policy, although the publication date has not yet been determined.

[534] Hymel, Kent M., Kenneth A. Small, and Kurt Van Dender, ''Induced demand and rebound effects in road transport,'' Transportation Research Part B: Methodological, Volume 44, Issue 10, December 2010, Pages 1220–1241, ISSN 0191–2615, DOI: 10.1016/j.trb.2010.02.007. (Docket EPA–HQ–OAR–2010–0799).

[535] 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–2010–0799). See also Greene, 2010.

[536] Gillingham, Kenneth. ''The Consumer Response to Gasoline Price Changes: Empirical Evidence and Policy Implications.'' Ph.D. diss., Stanford University, 2011. (Docket EPA–HQ–OAR–2010–0799).

[537] Dargay, J.M., Gately, D., 1997. ''The demand for transportation fuels: imperfect price-reversibility?'' Transportation Research Part B 31(1). (Docket EPA–HQ–OAR–2010–0799).

[538] Dermot Gately, 1993. ''The Imperfect Price-Reversibility of World Oil Demand,'' The Energy Journal, International Association for Energy Economics, vol. 14(4), pages 163–182. (Docket EPA–HQ–OAR–2010–0799).

[539] Sentenac-Chemin, E. (2010) Is the price effect on fuel consumption symmetric? Some evidence from an empirical study, Energy Policy (2010), doi:10.1016/j.enpol.2010.07.016 (Docket EPA–HQ–OAR–2010–0799).

[540] Docket ID EPA–HQ–OAR–2010–0799, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, Interagency Working Group on Social Cost of Carbon,* with participation by Council of Economic Advisers, Council on Environmental Quality, Department of Agriculture, Department of Commerce, Department of Energy,

The interagency group selected four SCC values for use in regulatory analyses, which we have applied in this analysis: \$5, \$22, \$36, and \$67 per metric ton of CO_2 emissions in 2010, in 2009 dollars.[541] [542] The first three values are based on the average SCC from three integrated assessment models, at discount rates of 5, 3, and 2.5 percent, respectively. SCCs at several discount rates are included because the literature shows that the SCC is quite sensitive to assumptions about the discount rate, and because no consensus exists on the appropriate rate to use in an intergenerational context. The fourth value is the 95th percentile of the SCC from all three models at a 3 percent discount rate. It is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. Low probability, high impact events are incorporated into all of the SCC values through explicit consideration of their effects in two of the three models as well as the use of a probability density function for equilibrium climate sensitivity. Treating climate sensitivity probabilistically results in more high temperature outcomes, which in turn lead to higher projections of damages.

The SCC increases over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change. Note that the interagency group estimated the growth rate of the SCC directly using the three integrated assessment models rather than assuming a constant annual growth rate. This helps to ensure that the estimates are internally consistent with other modeling assumptions. Table III–70 presents the SCC estimates used in this analysis.

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of serious challenges. A recent report from the National Academies of Science points out that any assessment will suffer from uncertainty, speculation, and lack of information about (1) Future emissions of greenhouse gases, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages.[543] 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.

The interagency group noted a number of limitations to the SCC analysis, including the incomplete way in which the integrated assessment models capture catastrophic and non-catastrophic impacts, their incomplete treatment of adaptation and technological change, uncertainty in the extrapolation of damages to high temperatures, and assumptions regarding risk aversion. The limited amount of research linking climate impacts to economic damages makes the interagency modeling exercise even more difficult. The interagency group hopes that over time researchers and modelers will work to fill these gaps and that the SCC estimates used for regulatory analysis by the Federal government will continue to evolve with improvements in modeling.

Another limitation of the GHG benefits analysis in this proposed rule is that it does not monetize the impacts associated with the non-CO_2 GHG reductions expected under the proposed standards (in this case, nitrous oxides, methane, and hydorfluorocarbons). The interagency group did not estimate the social costs of non-CO_2 GHG emissions when it developed the current social cost of CO_2 values. EPA recently requested comment on a methodology to estimate the benefits associated with non-CO_2 GHG reductions under the proposed New Source Performance Standards (NSPS) for oil and gas exploration (76 FR at 52792). Referred to as the ''global warming potential (GWP) approach,'' the calculation uses the GWP of the non-CO_2 gas to estimate CO_2 equivalents and then multiplies these CO_2 equivalent emission reductions by the social cost of CO_2.

EPA presented and requested comment on the GWP approach in the NSPS proposal as an interim method to produce estimates of the social cost of methane until the Administration develops such values. Similarly, we request comments in this proposed rulemaking on using the GWPs as an interim approach and more broadly about appropriate methods to monetize the climate benefits of non-CO_2 GHG reductions.

In addition, the U.S. government intends to revise the SCC estimates, taking into account new research findings that were not included in the first round, and has set a preliminary goal of revisiting the SCC values in the next few years or at such time as substantially updated models become available, and to continue to support research in this area. In particular, DOE and EPA hosted a series of workshops to help motivate and inform this process.[544] The first workshop focused on conceptual and methodological issues related to integrated assessment modeling and valuing climate change impacts, along with methods of incorporating these estimates into policy analysis.

Applying the global SCC estimates, shown in Table III–70, to the estimated reductions in CO_2 emissions under the proposed standards, we estimate the dollar value of the GHG related benefits for each analysis year. For internal consistency, the annual benefits are discounted back to net present value terms using the same discount rate as each SCC estimate (*i.e.,* 5%, 3%, and 2.5%) rather than 3% and 7%.[545] These estimates are provided in Table III–71.

Department of Transportation, Environmental Protection Agency, National Economic Council, Office of Energy and Climate Change, Office of Management and Budget, Office of Science and Technology Policy, and Department of Treasury (February 2010). Also available at *http://epa.gov/otaq/climate/regulations.htm.*

[541] The interagency group decided that these estimates apply only to CO_2 emissions. Given that warming profiles and impacts other than temperature change (e.g., ocean acidification) vary across GHGs, the group concluded ''transforming gases into CO_2-equivalents using GWP, and then multiplying the carbon-equivalents by the SCC, would not result in accurate estimates of the social costs of non-CO_2 gases'' (SCC TSD, pg 13).

[542] The SCC estimates were converted from 2007 dollars to 2008 dollars using a GDP price deflator (1.021) and again to 2009 dollars using a GDP price deflator (1.009) obtained from the Bureau of Economic Analysis, National Income and Product Accounts Table 1.1.4, *Prices Indexes for Gross Domestic Product.*

[543] National Research Council (2009). *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* National Academies Press. See docket ID EPA–HQ–OAR–2010–0799.

[544] *Improving the Assessment and Valuation of Climate Change Impacts for Policy and Regulatory Analysis,* held November 18–19, 2010 and January 27–28, 2011. Materials available at: *http://yosemite.epa.gov/ee/epa/eerm.nsf/vwRepNumLookup/EE–0564?OpenDocument* and *http://yosemite.epa.gov/ee/epa/eerm.nsf/vwRepNumLookup/EE–0566?OpenDocument.* See also Docket ID EPA–HQ–OAR–2010–0799.

[545] It is possible that other benefits or costs of final regulations unrelated to CO_2 emissions will be discounted at rates that differ from those used to develop the SCC estimates.

Table III-70: Social Cost of CO_2, 2017 – 2050[a] (in 2009 dollars per Metric Ton)

YEAR	DISCOUNT RATE AND STATISTIC			
	5% Average	3% Average	2.5% Average	3% 95th Percentile
2017	$6.36	$25.59	$40.94	$78.28
2020	$7.01	$27.10	$42.98	$83.17
2025	$8.53	$30.43	$47.28	$93.11
2030	$10.05	$33.75	$51.58	$103.06
2035	$11.57	$37.08	$55.88	$113.00
2040	$13.09	$40.40	$60.19	$122.95
2045	$14.63	$43.34	$63.59	$131.66
2050	$16.18	$46.27	$66.99	$140.37

[a] The SCC values are dollar-year and emissions-year specific.

Table III-71: Undiscounted Annual Monetized CO_2 Benefits of Proposed Vehicle Program, Annual CO_2 Emission Reductions[a] & CO_2 Benefits Discounted back to 2012 (dollar values in Millions of 2009$)

YEAR	CO_2 EMISSIONS REDUCTION (MMT)	BENEFITS			
		Avg SCC at 5% ($6-$16)[a]	Avg SCC at 3% ($26-$46)[a]	Avg SCC at 2.5% ($41-$67)[a]	95th percentile SCC at 3% ($78-$140)[a]
2017	2.1	$13	$53	$85	$162
2018	6.9	$45	$179	$286	$549
2019	14.2	$97	$378	$602	$1,160
2020	24.4	$171	$662	$1,050	$2,030
2021	39.5	$289	$1,100	$1,730	$3,360
2022	58.1	$443	$1,650	$2,600	$5,060
2023	80.2	$635	$2,330	$3,650	$7,150
2024	105.3	$866	$3,130	$4,890	$9,600
2025	133.8	$1,140	$4,070	$6,320	$12,500
2030	267.8	$2,690	$9,040	$13,800	$27,600
2040	419.8	$5,490	$17,000	$25,300	$51,600
2050	497.3	$8,050	$23,000	$33,300	$69,800
Net Present Value[b]		$32,800	$172,000	$292,000	$522,000

Notes:

[a] Except for the last row (net present value), the SCC values are dollar-year and emissions-year specific.

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

6. Non-Greenhouse Gas Health and Environmental Impacts

This section presents EPA's analysis of the non-GHG health and environmental impacts that can be expected to occur as a result of the proposed 2017–2025 light-duty vehicle GHG standards. CO_2 emissions are predominantly the byproduct of fossil fuel combustion processes that also produce criteria and hazardous air pollutants. The vehicles that are subject to the proposed standards are also significant sources of mobile source air pollution such as direct PM, NO_X, VOCs and air toxics. The proposed standards would affect exhaust emissions of these pollutants from vehicles. They would also affect emissions from upstream sources related to changes in fuel consumption. Changes in ambient ozone, $PM_{2.5}$, and air toxics that would result from the proposed standards are expected to affect human health in the form of premature deaths and other serious human health effects, as well as other important public health and welfare effects.

It is important to quantify the health and environmental impacts associated with the proposed standard because a failure to adequately consider these ancillary co-pollutant impacts could lead to an incorrect assessment of their net costs and benefits. Moreover, co-pollutant impacts tend to accrue in the near term, while any effects from reduced climate change mostly accrue over a time frame of several decades or longer.

EPA typically quantifies and monetizes the health and environmental impacts related to both PM and ozone in its regulatory impact analyses (RIAs) when possible. However, EPA was unable to do so in time for this proposal. EPA attempts to make emissions and air quality modeling decisions early in the analytical process so that we can complete the photochemical air quality modeling and use that data to inform the health and environmental impacts analysis. Resource and time constraints precluded the Agency from completing this work in time for the proposal. Instead, EPA is using PM-related benefits-per-ton values as an interim approach to estimating the PM-related benefits of the proposal. EPA also provides a characterization of the health and environmental impacts that will be quantified and monetized for the final rulemaking.

This section is split into two sub-sections: The first presents the PM-related benefits-per-ton values used to monetize the PM-related co-benefits associated with the proposal; the second explains what PM- and ozone-related health and environmental impacts EPA will quantify and monetize in the analysis for the final rule. EPA bases its analyses on peer-reviewed studies of air quality and health and welfare effects and peer-reviewed studies of the monetary values of public health and welfare improvements, and is generally consistent with benefits analyses performed for the analysis of the final Cross-State Air Pollution Rule,[546] the final 2014–2018 MY Heavy-Duty Vehicle Greenhouse Gas Rule,[547] and the final Portland Cement National Emissions Standards for Hazardous Air Pollutants (NESHAP) RIA.[548]

Though EPA is characterizing the changes in emissions associated with toxic pollutants, we will not be able to quantify or monetize the human health effects associated with air toxic pollutants for either the proposal or the final rule analyses. Please refer to Section III.G for more information about the air toxics emissions impacts associated with the proposed standards.

a. Economic Value of Reductions in Criteria Pollutants

As described in Section III.G, the proposed standards would reduce emissions of several criteria and toxic pollutants and precursors. In this analysis, EPA estimates the economic value of the human health benefits associated with reducing $PM_{2.5}$ exposure. Due to analytical limitations, this analysis does not estimate benefits related to other criteria pollutants (such as ozone, NO_2 or SO_2) or toxic pollutants, nor does it monetize all of the potential health and welfare effects associated with $PM_{2.5}$.

This analysis uses a ''benefit-per-ton'' method to estimate a selected suite of $PM_{2.5}$-related health benefits described below. These $PM_{2.5}$ benefit-per-ton estimates provide the total monetized human health benefits (the sum of premature mortality and premature morbidity) of reducing one ton of directly emitted $PM_{2.5}$, or its precursors (such as NO_X, SO_X, and VOCs), from a specified source. Ideally, the human health benefits would be estimated based on changes in ambient $PM_{2.5}$ as determined by full-scale air quality modeling. However, this modeling was not possible in the timeframe for this proposal.

The dollar-per-ton estimates used in this analysis are provided in Table III–72. In the summary of costs and benefits, Section III.H.9 of this preamble, EPA presents the monetized value of PM-related improvements associated with the proposal.

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[546] Final Cross-State Air Pollution Rule. (76 FR 48208, August 8, 2011).

[547] U.S. Environmental Protection Agency. (2011). *Final Rulemaking to Establish Heavy-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards: Regulatory Impact Analysis,* Assessment and Standards Division, Office of Transportation and Air Quality, EPA–420–R–10–009, July 2011. Available on the internet: *http://www.epa.gov/otaq/climate/regulations/420r10009.pdf.*

[548] U.S. Environmental Protection Agency (U.S. EPA). 2010. 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. Augues. Available on the Internet at < *http://www.epa.gov/ttn/ecas/regdata/RIAs/portlandcementfinalria.pdf* >. EPA–HQ–OAR–2009–0472–0241.

Table III-72 Benefits-per-ton Values (2009$) Derived Using the American Cancer Society Cohort Study for PM-related Premature Mortality (Pope et al., 2002)[a]

Year[c]	All Sources[d]		Stationary (Non-EGU) Sources[e]		Mobile Sources	
	SO_X	VOC	NO_X	Direct PM2.5	NO_X	Direct PM2.5
Estimated Using a 3 Percent Discount Rate[b]						
2015	$29,000	$1,200	$4,800	$230,000	$5,000	$280,000
2020	$32,000	$1,300	$5,300	$250,000	$5,500	$300,000
2030	$38,000	$1,600	$6,300	$290,000	$6,600	$360,000
2040	$44,000	$1,900	$7,500	$340,000	$7,900	$430,000
Estimated Using a 7 Percent Discount Rate[b]						
2015	$27,000	$1,100	$4,400	$210,000	$4,600	$250,000
2020	$29,000	$1,200	$4,800	$220,000	$5,000	$280,000
2030	$34,000	$1,400	$5,700	$260,000	$6,000	$330,000
2040	$40,000	$1,700	$6,800	$310,000	$7,200	$390,000

[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 two-and-a-half times larger. See below for a description of these studies.

[b] The benefit-per-ton estimates presented in this table assume either a 3 percent or 7 percent discount rate in the valuation of premature mortality to account for a twenty-year segmented cessation lag.

[c] Benefit-per-ton values were estimated for the years 2015, 2020, and 2030. For intermediate years, such as 2017 (the year the standards begin), we interpolated exponentially. For years beyond 2030 (including 2040), EPA and NHTSA extrapolated exponentially based on the growth between 2020 and 2030.

[d] Note that the benefit-per-ton value for SOx is based on the value for Stationary (Non-EGU) sources; no SOx value was estimated for mobile sources. The benefit-per-ton value for VOCs was estimated across all sources.

[e] Non-EGU denotes stationary sources of emissions other than electric generating units.

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[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 two-and-a-half times larger. See below for a description of these studies.

[b] The benefit-per-ton estimates presented in this table assume either a 3 percent or 7 percent discount rate in the valuation of premature mortality to account for a twenty-year segmented cessation lag.

[c] Benefit-per-ton values were estimated for the years 2015, 2020, and 2030. For intermediate years, such as 2017 (the year the standards begin), we

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The benefit per-ton technique has been used in previous analyses, including EPA's 2012–2016 Light-Duty Vehicle Greenhouse Gas Rule,[549] [550] and the Portland Cement National Emissions Standards for Hazardous Air Pollutants (NESHAP) RIA.[551] Table III–73 shows the quantified and unquantified $PM_{2.5}$-related co-benefits captured in those benefit-per-ton estimates.

Table III-73 Human Health and Welfare Effects of $PM_{2.5}$

Pollutant / Effect	**Quantified and Monetized in Primary Estimates**	**Unquantified Effects Changes in:**
$PM_{2.5}$	Adult premature mortality Bronchitis: chronic and acute Hospital admissions: respiratory and cardiovascular Emergency room visits for asthma Nonfatal heart attacks (myocardial infarction) Lower and upper respiratory illness Minor restricted-activity days Work loss days Asthma exacerbations (asthmatic population) Infant mortality	Subchronic bronchitis cases Low birth weight Pulmonary function Chronic respiratory diseases other than chronic bronchitis Non-asthma respiratory emergency room visits Visibility Household soiling

Consistent with the cost-benefit analysis that accompanied the NO_2 NAAQS,[552] [553] 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.

A more detailed description of the benefit-per-ton estimates is provided in Chapter 4 of the Draft Joint TSD that accompanies this rulemaking. Readers interested in reviewing the complete methodology for creating the benefit-per-ton estimates used in this analysis can consult the Technical Support

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interpolated exponentially. For years beyond 2030 (including 2040), EPA and NHTSA extrapolated exponentially based on the growth between 2020 and 2030.

[d] Note that the benefit-per-ton value for SOx is based on the value for Stationary (Non-EGU) sources; no SOx value was estimated for mobile sources. The benefit-per-ton value for VOCs was estimated across all sources.

[e] Non-EGU denotes stationary sources of emissions other than electric generating units.

[549] U.S. Environmental Protection Agency (U.S. EPA), 2010. Regulatory Impact Analysis, Final Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards. Office of Transportation and Air Quality. April. Available at *http://www.epa.gov/otaq/climate/regulations/420r10009.pdf.* EPA-420-R-10-009.

[550] 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.*

[551] U.S. Environmental Protection Agency (U.S. EPA). 2010. 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. Augues. Available on the Internet at < *http://www.epa.gov/ttn/ecas/regdata/RIAs/portlandcementfinalria.pdf.* EPA-HQ-OAR-2009-0472-0241

[552] Although we summarize the main issues in this chapter, we encourage interested readers to see benefits chapter of the RIA that accompanied the NO_2 NAAQS for a more detailed description of recent changes to the PM benefits presentation and preference for the no-threshold model. Note that the cost-benefit analysis was prepared solely for purposes of fulfilling analysis requirements under Executive Order 12866 and was not considered, or otherwise played any part, in the decision to revise the NO_2 NAAQS.

[553] 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 U.S. Environmental Protection Agency (U.S. EPA). 2009.

Document (TSD)[554] accompanying the recent final ozone NAAQS RIA (U.S. EPA, 2008).[555] Readers can also refer to Fann et al. (2009)[556] for a detailed description of the benefit-per-ton methodology.[557]

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.

As Table III–72 indicates, EPA projects that the per-ton values for reducing emissions of non-GHG pollutants from both vehicle use and stationary sources such as fuel refineries and storage facilities will increase over time.[558] 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.[559] They also reflect future population growth and increased life expectancy, which expands the size of the population exposed to air pollution in both urban and rural areas, especially in older age groups with the highest mortality risk.[560]

The benefit-per-ton estimates are subject to a number of assumptions and uncertainties:

- They do not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors that might lead to an overestimate or underestimate of the actual benefits of controlling fine particulates. EPA will conduct full-scale air quality modeling for the final rulemaking in an effort to capture this variability.
- This analysis assumes that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because $PM_{2.5}$ produced via transported precursors emitted from stationary sources may differ significantly from direct $PM_{2.5}$ released from diesel engines and other industrial sources, but no clear scientific grounds exist for supporting differential effects estimates by particle type.
- This analysis assumes that the health impact function for fine particles is linear within the range of ambient concentrations under consideration. Thus, the estimates include health benefits from reducing fine particles in areas with varied concentrations of $PM_{2.5}$, including both regions that are in attainment with fine particle standard and those that do not meet the standard down to the lowest modeled concentrations.
- There are several health benefits categories that EPA was unable to quantify due to limitations associated with using benefits-per-ton estimates, several of which could be substantial. Because the NO_X and VOC emission reductions associated with this proposal are also precursors to ozone, reductions in NO_X and VOC would also reduce ozone formation and the health effects associated with ozone exposure. Unfortunately, ozone-related benefits-per-ton estimates do not exist due to issues associated with the complexity of the atmospheric air chemistry and nonlinearities associated with ozone formation. The PM-related benefits-per-ton estimates also do not include any human welfare or ecological benefits. Please refer to Chapter 6.3 of the DRIA that accompanies this proposal for a description of the agecy's plan to quantify and monetize the PM- and ozone-related health impacts for the FRM and a description of the unquantified co-pollutant benefits associated with this rulemaking.
- There are many uncertainties associated with the health impact functions used in this modeling effort. These include: Within-study variability (the precision with which a given study estimates the relationship between air quality changes and health effects); across-study variation (different published studies of the same pollutant/health effect relationship typically do not report identical findings and in some instances the differences are substantial); the application of concentration-response functions nationwide (does not account for any relationship between region and health effect, to the extent that such a relationship exists); extrapolation of impact functions across population (we assumed that certain health impact functions applied to age ranges broader than that considered in the original epidemiological study); and various uncertainties in the concentration-response function, including causality and thresholds. These uncertainties may under- or over-estimate benefits.
- EPA has investigated methods to characterize uncertainty in the relationship between $PM_{2.5}$ exposure and premature mortality. EPA's final $PM_{2.5}$ NAAQS analysis provides a more complete picture about the overall uncertainty in $PM_{2.5}$ benefits estimates. For more information, please consult the $PM_{2.5}$ NAAQS RIA (Table 5.5).[561]
- 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

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[554] U.S. Environmental Protection Agency (U.S. EPA). 2008. 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*>.

[555] 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*>. Note that the cost-benefit analysis was prepared solely for purposes of fulfilling analysis requirements under Executive Order 12866 and was not considered, or otherwise played any part, in the decision to revise the Ozone NAAQS.

[556] 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.

[557] 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.*

[558] As we discuss in the emissions chapter of EPA's DRIA (Chapter 4), the rule would yield emission reductions from upstream refining and fuel distribution due to decreased petroleum consumption.

[559] The issue is discussed in more detail in the PM NAAQS RIA from 2006. See U.S. Environmental Protection Agency. 2006. Final Regulatory Impact Analysis (RIA) for the Proposed National Ambient Air Quality Standards for Particulate Matter. Prepared by: Office of Air and Radiation. October 2006. Available at *http://www.epa.gov/ttn/ecas/ria.html.*

[560] For more information about EPA's population projections, please refer to the following: *http://www.epa.gov/air/benmap/models/BenMAPManualAppendicesAugust2010.pdf* (See Appendix K).

[561] U.S. Environmental Protection Agency. October 2006. Final Regulatory Impact Analysis (RIA) for the Final National Ambient Air Quality Standards for Particulate Matter. Prepared by: Office of Air and Radiation.

context of the Expert Elicitation results, this estimate falls toward the lower end of the distribution. By contrast, the estimated $PM_{2.5}$ benefits using the coefficient reported by Laden in that author's reanalysis of the Harvard Six Cities cohort fall toward the upper end of the Expert Elicitation distribution results.

As mentioned above, emissions changes and benefits-per-ton estimates alone are not a good indication of local or regional air quality and health impacts, as there may be localized impacts associated with the proposed rulemaking. Additionally, the atmospheric chemistry related to ambient concentrations of $PM_{2.5}$, ozone and air toxics is very complex. Full-scale photochemical modeling is therefore necessary to provide the needed spatial and temporal detail to more completely and accurately estimate the changes in ambient levels of these pollutants and their associated health and welfare impacts. As discussed above, timing and resource constraints precluded EPA from conducting a full-scale photochemical air quality modeling analysis in time for the NPRM. For the final rule, however, a national-scale air quality modeling analysis will be performed to analyze the impacts of the standards on $PM_{2.5}$, ozone, and selected air toxics. The benefits analysis plan for the final rulemaking is discussed in the next section.

b. Human Health and Environmental Benefits for the Final Rule

i. Human Health and Environmental Impacts

To model the ozone and PM air quality benefits of the final rule, EPA will use the Community Multiscale Air Quality (CMAQ) model (see Section III.G.5. for a description of the CMAQ model). The modeled ambient air quality data will serve as an input to the Environmental Benefits Mapping and Analysis Program (BenMAP).[562] BenMAP is a computer program developed by EPA that integrates a number of the modeling elements used in previous RIAs (*e.g.,* interpolation functions, population projections, health impact functions, valuation functions, analysis and pooling methods) to translate modeled air concentration estimates into health effects incidence estimates and monetized benefits estimates.

Chapter 6.3 in the DRIA that accompanies this proposal lists the co-pollutant health effect concentration-response functions EPA will use to quantify the non-GHG incidence impacts associated with the final light-duty vehicles standard. These include PM- and ozone-related premature mortality, chronic bronchitis, nonfatal heart attacks, hospital admissions (respiratory and cardiovascular), emergency room visits, acute bronchitis, minor restricted activity days, and days of work and school lost.

ii. Monetized Impacts

To calculate the total monetized impacts associated with quantified health impacts, EPA applies values derived from a number of sources. For premature mortality, EPA applies a value of a statistical life (VSL) derived from the mortality valuation literature. For certain health impacts, such as chronic bronchitis and a number of respiratory-related ailments, EPA applies willingness-to-pay estimates derived from the valuation literature. For the remaining health impacts, EPA applies values derived from current cost-of-illness and/or wage estimates. Chapter 6.3 in the DRIA that accompanies this proposal presents the monetary values EPA will apply to changes in the incidence of health and welfare effects associated with reductions in non-GHG pollutants that will occur when these GHG control strategies are finalized.

iii. Other Unquantified Health and Environmental Impacts

In addition to the co-pollutant health and environmental impacts EPA will quantify for the analysis of the final standard, there are a number of other health and human welfare endpoints that EPA will not be able to quantify or monetize because of current limitations in the methods or available data. These impacts are associated with emissions of air toxics (including benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, and ethanol), ambient ozone, and ambient $PM_{2.5}$ exposures. Chapter 6.3 of the DRIA lists these unquantified health and environmental impacts.

While there will be impacts associated with air toxic pollutant emission changes that result from the final standard, EPA will not attempt to monetize those impacts. This is primarily because currently available tools and methods to assess air toxics risk from mobile sources at the national scale are not adequate for extrapolation to incidence estimations or benefits assessment. The best suite of tools and methods currently available for assessment at the national scale are those used in the National-Scale Air Toxics Assessment (NATA). The EPA Science Advisory Board specifically commented in their review of the 1996 NATA that these tools were not yet ready for use in a national-scale benefits analysis, because they did not consider the full distribution of exposure and risk, or address sub-chronic health effects.[563] While EPA has since improved the tools, there remain critical limitations for estimating incidence and assessing benefits of reducing mobile source air toxics. EPA continues to work to address these limitations; however, EPA does not anticipate having methods and tools available for national-scale application in time for the analysis of the final rules.[564]

7. Energy Security Impacts

The proposed GHG standards require improvements in light-duty vehicle fuel efficiency which, in turn, will reduce overall fuel consumption and help to reduce U.S. petroleum imports. Reducing U.S. petroleum imports lowers both the financial and strategic risks caused by potential sudden disruptions in the supply of imported petroleum to the U.S. The economic value of reductions in these risks provides a measure of improved U.S. energy security. This section summarizes EPA's estimates of U.S. oil import reductions and energy security benefits from this proposal. Additional discussion of this issue can be found in Chapter 4.2.8 of the Joint TSD.

a. Implications of Reduced Petroleum Use on U.S. Imports

In 2010, U.S. petroleum import expenditures represented 14 percent of total U.S. imports of all goods and services.[565] These expenditures rose to 18 percent by April of 2011.[566] In 2010, the United States imported 49 percent of the petroleum it consumed,[567] and the

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[562] Information on BenMAP, including downloads of the software, can be found at *http://www.epa.gov/ttn/ecas/benmodels.html*.

[563] 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*.

[564] In April, 2009, EPA hosted a workshop on estimating the benefits of reducing hazardous air pollutants. This workshop built upon the work accomplished in the June 2000 Science Advisory Board/EPA Workshop on the Benefits of Reductions in Exposure to Hazardous Air Pollutants, which generated thoughtful discussion on approaches to estimating human health benefits from reductions in air toxics exposure, but no consensus was reached on methods that could be implemented in the near term for a broad selection of air toxics. Please visit *http://epa.gov/air/toxicair/2009workshop.html* for more information about the workshop and its associated materials.

[565] *http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=WTTIMUS2&f=W.*

[566] *http://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbblpd_a.htm.*

[567] *http://www.eia.gov/dnav/pet/pet_pri_rac2_dcu_nus_m.htm.*

transportation sector accounted for 71 percent of total U.S. petroleum consumption. This compares to approximately 37 percent of total U.S. petroleum supplied by imports and 55 percent of U.S. petroleum consumption in the transportation sector in 1975.[568]

Requiring vehicle technology that reduces GHGs and fuel consumption in light-duty vehicles is expected to lower U.S. oil imports. EPA's estimates of reductions in fuel consumption resulting from the proposed standards are discussed in Section III.H.3 above, and in EPA's draft RIA.[569]

The agencies conducted a detailed analysis of future changes in U.S. transportation fuel consumption, petroleum imports, and domestic fuel refining projected to occur under alternative economic growth and oil price scenarios reported by the EIA in its Annual Energy Outlook 2011.[570] On the basis of this analysis, we estimate that approximately 50 percent of the reduction in fuel consumption resulting from adopting improved GHG emission and fuel efficiency standards is likely to be reflected in reduced U.S. imports of refined fuel, while the remaining 50 percent is expected to be reflected in reduced domestic fuel refining. Of this latter figure, 90 percent is anticipated to reduce U.S. imports of crude petroleum for use as a refinery feedstock, while the remaining 10 percent is expected to reduce U.S. domestic production of crude petroleum. Thus, on balance, each gallon of fuel saved as a consequence of the GHG and fuel efficiency standards is anticipated to reduce total U.S. imports of petroleum by 0.95 gallon.[571] Table III–74 below compares EPA's estimates of the reduction in imports of U.S. crude oil and petroleum-based products from this program to projected total U.S. imports for selected years.

Table III-74 Projected Import Reductions from this Proposal and Total U.S. Petroleum-Based Imports for Selected Years

(Millions of Barrels per Day, mmbd)

Year	U.S. Petroleum-Based Import Reductions from the Proposal (mmbd)	U.S. Total Petroleum-Based Imports without the Proposal (mmbb)
2020	0.141	9.26
2030	1.59	8.94
2040	2.50	NA
2050	2.97	NA

Note: NA –Not available, (forecasts reported in EIA's Annual Energy Outlook 2011 extend only to 2035)

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 proposal.[572] [573]

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[568] 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.

[569] Due to timing constraints, the energy security premiums ($/gallon) were derived using preliminary estimates of the gasoline consumption reductions projected from this proposal. The energy security benefits totals shown here were calculated with those $/gallon values along with the final quantities of gasoline consumption avoided. Relative to the preliminary gasoline consumption reductions, the reductions presented in this proposal are roughly 3% lower in total from 2017 through 2050.

[570] Energy Information Administration, Annual Energy Outlook 2011, Reference Case and other scenarios, available at *http://www.eia.gov/oiaf/aeo/tablebrowser/* (last accessed October 12, 2011).

[571] This figure is calculated as 0.50 + 0.50*0.9 = 0.50 + 0.45 = 0.95.

[572] Leiby, Paul N., *Estimating the Energy Security Benefits of Reduced U.S. Oil Imports,* Oak Ridge National Laboratory, ORNL/TM–2007/028, Final Report, 2008. (Docket EPA–HQ–OAR–2010–0162)

[573] The ORNL study *The Energy Security Benefits of Reduced Oil Use, 2006–2015,* completed in March 2008, is an updated version of the approach

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When conducting its analysis, ORNL considered the full economic cost of importing petroleum into the United States. 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 the market power of the Organization of the Petroleum Exporting Countries (*i.e.,* the ''demand'' or ''monopsony'' costs); and (2) the risk of reductions in U.S. economic output and disruption of the U.S. economy caused by sudden disruptions in the supply of imported petroleum to the U.S. (*i.e.,* ''macroeconomic disruption/adjustment costs''). In its analysis of energy security benefits from reducing U.S. petroleum imports, however, the agencies included only the latter component (discussed below).

ORNL's analysis of energy security benefits from reducing U.S. oil imports did not include an estimate of potential reductions in costs for maintaining a U.S. military presence to help secure stable oil supply from potentially vulnerable regions of the world because attributing military spending to particular missions or activities is difficult. Attempts to attribute some share of U.S. military costs to oil imports are further complicated by the need to estimate how those costs vary with incremental variations in U.S. oil imports. Several commenters for the 2012–2016 light-duty vehicle proposal recommended that the agencies attempt to estimate the avoided U.S. military costs associated with reductions in U.S. oil imports. The agencies request comment on this issue, including whether there are new studies that credibly estimate the military cost of securing stable oil supplies and, if so, how should these new estimates be factored into this proposal's energy security analysis. See Section 4.2.8 of the TSD for a more detailed discussion of the national security implications of this proposed rule.

For this action, ORNL estimated energy security premiums by incorporating the most recently available AEO 2011 Reference Case oil price forecasts and market trends. Energy security premiums for the years 2020, 2030, 2035, 2040 and 2050 are presented in Table III–75 as well as a breakdown of the components of the energy security premiums for each of these years.[574] The components of the energy security premium and their values are discussed in detail in the Joint TSD Chapter 4.2.8. The oil security premium rises over the future as a result of changing factors such as the world oil price, global supply/demand balances, U.S. oil imports and consumption, and U.S. GDP (the size of economy at risk to oil shocks). The principal factor is steadily rising oil prices.

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used for estimating the energy security benefits of U.S. oil import reductions developed in an ORNL 1997 Report by Leiby, Paul N., Donald W. Jones, T. Randall Curlee, and Russell Lee, entitled *Oil Imports: An Assessment of Benefits and Costs.* (Docket EPA–HQ–OAR–2010–0162).

[574] AEO 2011 forecasts energy market trends and values only to 2035. The energy security premium estimates post-2035 were assumed to be the 2035 estimate.

Table III-75 Energy Security Premiums in Selected Years (2009$/Barrel)

Year (range)	Monopsony	Macroeconomic Disruption/Adjustment Costs	Total Mid-Point
2020	$11.12 ($3.78 - $21.21)	$7.10 ($3.40 - $10.96)	$18.22 ($9.53 - $29.06)
2030	$10.91 ($3.74 - $20.47)	$8.32 ($4.09 – $13.34)	$19.23 ($10.51 - $29.02)
2035	$10.11 ($3.51 - $18.85)	$8.60 ($4.41 - $13.62)	$18.71 ($10.30 – $28.20)
2040	$10.11 ($3.51 - $18.85)	$8.60 ($4.41 - $13.62)	$18.71 ($10.30 – $28.20)
2050	$10.11 ($3.51 - $18.85)	$8.60 ($4.41 - $13.62)	$18.71 ($10.30 – $28.20)

Note: Values in parentheses represent a 90% confidence interval around the central value.

The literature on 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 social cost of carbon (SCC) value, the question arises: How should the energy security premium be determined when a global perspective is taken? Monopsony benefits represent avoided payments by the United States to oil producers in foreign countries that result from a decrease in the world oil price as the U.S. decreases its consumption of imported oil.

Although there is clearly a benefit to the U.S. when considered from a domestic perspective, the decrease in price due to decreased demand in the U.S. also represents a loss to other countries. Given the redistributive nature of this monopsony effect from a global perspective, it is excluded in the energy security benefits calculations for this proposal. In contrast, the other portion of the energy security premium, the U.S. macroeconomic disruption and adjustment cost that arises from U.S. petroleum imports, does not have offsetting impacts outside of the U.S., and, thus, is included in the energy security benefits estimated for this proposal. To summarize, EPA has included only the macroeconomic disruption portion of the energy security benefits to estimate the monetary value of the total energy security benefits of this program.

For this proposal, using EPA's fuel consumption analysis in conjunction with ORNL's energy security premium estimates,[575] [576] the agencies developed estimates of the total energy security benefits for the years 2017 through 2050 as shown in Table III–76.[577]

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[575] AEO 2011 forecasts energy market trends and values only to 2035. The energy security premium estimates post-2035 were assumed to be the 2035 estimate.

[576] Due to timing constraints, the energy security premiums ($/gallon) were derived using preliminary estimates of the gasoline consumption reductions projected from this proposal. The energy security benefits totals shown here were calculated with those $/gallon values along with the final quantities of gasoline consumption avoided. Relative to the preliminary gasoline consumption reductions, the reductions presented in this proposal are roughly 3% lower in total from 2017 through 2050.

[577] Estimated reductions in U.S. imports of finished petroleum products and crude oil are 95% of 54.2 million barrels (MMB) in 2020, 609 MMB

Continued

Table III-76. Undiscounted Annual Energy Security Benefits, & Proposed Program Benefits Discounted back to 2012 (2009$)

Year	Oil Imports Reduced (mmb)	Benefits ($Millions)
2017	4.4	$30
2018	14.5	$99
2019	30.0	$209
2020	51.5	$366
2021	83.1	$601
2022	123	$903
2023	170	$1,270
2024	224	$1,710
2025	286	$2,220
2030	579	$4,810
2040	914	$7,860
2050	1,083	$9,310
NPV, 3%		$81,500
NPV, 7%		$31,500

Note: Annual values represent undiscounted benefits; net present values represent annual costs discounted to 2012.

The energy security analysis conducted for this proposal 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, particularly outside the U.S. In addition, other fuels could be displaced from the increasing use of oil worldwide. For example, if a decline in the world oil price causes an increase in oil use in China, India, or another country's industrial sector, this increase in oil consumption may displace natural gas usage. Alternatively, the increased oil use could result in a decrease in coal used to produce electricity. An increase in the consumption of petroleum products, particularly outside the U.S., could lead to a modest increase in emissions of greenhouse gases, criteria air pollutants, and airborne toxics from their refining and use. However, lower usage of, for example, displaced coal would result in a decrease in greenhouse gas emissions. Therefore, any assessment of the impacts on GHG emissions from a potential increase in world oil demand would need to take into account the impacts on all portions of the global energy sector. The agencies' analyses have not attempted to estimate these effects.

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in 2030, 962 MMB in 2040, and 1,140 MMB in 2050.

Since EPA anticipates that more electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) will penetrate the U.S. automobile market over time as a result of this proposal, the Agency is considering analyzing the energy security implications of these vehicles and the fuels that they consume. These vehicles run on electricity either in whole (EVs), or in part (PHEVs), which displaces conventional transportation fuel such as gasoline and diesel. EPA does not have sufficient information for this proposal to conduct an analysis of the energy security implications of increased use of EVs/PHEVs, but is considering how to conduct this type of analysis in the future. The Agency recognizes that the fleet penetration of EV/PHEV's will be relatively small in the time period of these standards (fewer than 3% of new vehicles in 2025), but views establishing a framework for examining the energy security implications of these vehicles as important for longer-term analysis.

Key questions that arise with increased use of electricity in vehicles in the U.S. include whether there is the potential for disruptions in electricity supply in general, or more specifically, from increased electrification of the U.S. vehicle fleet. Also, if there is the potential for supply disruptions in electricity markets, how likely would the disruptions be associated with disruptions in the supply of oil? In addition, what is the overall expected impact, if any, of additional EV/PHEV use on the stability and flexibility of fuel and electricity markets? Finally, such analysis may also need to consider the source of electricity used to power EVs/PHEVs. EPA solicits comments on how to best conduct this type of analysis, including any studies or research that have been published on these issues.

8. Additional 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–77 summarizes the other economic impacts. Please refer to Preamble Section II.E and the Joint TSD that accompanies this rule for more information about these impacts and how EPA and NHTSA use them in their analyses.

Table III-77 Additional Impacts Associated with the Light-Duty Vehicle GHG Program

($Millions of 2007 dollars)

	2017	2020	2030	2040	2050	NPV, 3%	NPV, 7%
Accidents, Noise, Congestion Costs[a]	$66	$844	$9,960	$16,900	$22,000	$176,000	$67,700
Benefits of Increased Driving[b]	$89	$1,090	$12,900	$23,600	$33,600	$244,000	$92,100
Benefits of Less Frequent Refueling	$25	$301	$3,780	$6,650	$8,800	$68,700	$26,200

[a] Note that accidents, congestion and noise are costs, so the positive values shown represent increased costs which we treat as negative benefits.

[b] Calculated using post-tax fuel prices.

9. Summary of Costs and Benefits

In this section, the agencies present a summary of costs, benefits, and net benefits of the proposed program. Table III–78 shows the estimated annual monetized costs of the proposed program for the indicated calendar years. The table also shows the net present values of those costs for the calendar years 2012–2050 using both 3 percent and 7 percent discount rates.[578] Table III–79 shows the undiscounted annual monetized fuel savings of the proposed program. The table also shows the net present values of those fuel savings for the same calendar years using both 3 percent and 7 percent discount rates. In this table, the aggregate value of fuel savings is calculated using pre-tax fuel prices since savings in fuel taxes do not represent a reduction in the value of economic resources utilized in producing and consuming fuel. Note that the fuel savings shown here result from reductions in fleet-wide fuel use. Thus, fuel savings grow over time as an increasing fraction of the fleet meets the proposed standards.

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[578] For the estimation of the stream of costs and benefits, we assume that after implementation of the proposed MY 2017–2025 standards, the 2025 standards apply to each year thereafter.

Table III-78 Undiscounted Annual Costs & Costs of the Proposed Program Discounted Back to 2012 at 3% and 7% Discount Rates (Millions, 2009$)[a]

	2017	2020	2030	2040	2050	NPV, Years 2012-2050, 3% Discount Rate	NPV, Years 2012-2050, 7% Discount Rate
Technology Costs	$2,300	$8,470	$35,700	$39,800	$44,600	$551,000	$243,000

Note:

[a] Technology costs for separate light-duty vehicle segments can be found in Section III.H.2. Annual costs shown are undiscounted values.

Table III-79 Undiscounted Annual Fuel Savings & Proposed Program Fuel Savings Discounted Back to 2012 at 3% and 7% Discount Rates (Millions, 2009$)[a]

	2017	2020	2030	2040	2050	NPV, Years 2012-2050, 3% Discount Rate	NPV, Years 2012-2050, 7% Discount Rate
Fuel Savings (pre-tax)	$570	$7,060	$85,800	$144,000	$187,000	$1,510,000	$579,000

Note:

[a] Fuel savings for separate light-duty vehicle segments can be found in Section III.H.3. Annual costs shown are undiscounted values.

Table III–80 presents estimated annual monetized benefits for the indicated calendar years. The table also shows the net present values of those benefits for the calendar years 2012–2050 using both 3 percent and 7 percent discount rates. The table shows the benefits of reduced CO_2 emissions—and consequently the annual quantified benefits (*i.e.,* total benefits)—for each of the four social cost of carbon (SCC) values estimated by the interagency working group. As discussed in the RIA Chapter 7.2, there are some limitations to the SCC analysis, including the incomplete way in which the integrated assessment models capture catastrophic and non-catastrophic impacts, their incomplete treatment of adaptation and technological change, uncertainty in the extrapolation of damages to high temperatures, and assumptions regarding risk aversion.

In addition, these monetized GHG benefits exclude the value of net reductions in non-CO_2 GHG emissions (CH_4, N_2O, HFC) expected under this action. Although EPA has not monetized the benefits of reductions in non-CO_2 GHGs, the value of these reductions should not be interpreted as zero. Rather, the net reductions in non-CO_2 GHGs will contribute to this program's climate benefits, as explained in Section III.H.5.

Table III-80 Monetized Undiscounted Annual Benefits & Benefits of the Proposed Program Discounted Back to 2012 at 3% and 7% Discount Rates (Millions, 2009$)

	2017	2020	2030	2040	2050	NPV, Years 2012-2050, 3% Discount Rate[a]	NPV, Years 2012-2050, 7% Discount Rate[a]
Reduced CO$_2$ Emissions at each assumed SCC value [b]							
5% (avg SCC)	$13	$171	$2,690	$5,490	$8,050	$32,800	$32,800
3% (avg SCC)	$53	$662	$9,040	$17,000	$23,000	$172,000	$172,000
2.5% (avg SCC)	$85	$1,050	$13,800	$25,300	$33,300	$292,000	$292,000
3% (95th %ile)	$162	$2,030	$27,600	$51,600	$69,800	$522,000	$522,000
Energy Security Benefits (macro-disruption costs)	$30	$366	$4,810	$7,860	$9,310	$81,500	$31,500
Accidents, Congestion, Noise Costs[g]	$66	$844	$9,960	$16,900	$22,000	$176,000	$67,700
Increased Travel Benefits	$89	$1,090	$12,900	$23,600	$33,600	$244,000	$92,100
Refueling Time Savings	$25	$301	$3,780	$6,650	$8,800	$68,700	$26,200
PM$_{2.5}$ Related Impacts [c,d,e]	$11	$150	$1,360	$2,190	$2,970	$23,800	$9,280
Non-CO$_2$ GHG Impacts[f]		n/a	n/a	n/a	n/a	n/a	n/a
Total Annual Benefits at each assumed SCC value [b]							
5% (avg SCC)	$101	$1,240	$15,600	$29,000	$40,700	$275,000	$124,000
3% (avg SCC)	$141	$1,730	$22,000	$40,400	$55,600	$413,000	$263,000

2.5% (avg SCC)	$173	$2,120	$26,700	$48,700	$65,900	$534,000	$384,000
3% (95th %ile)	$250	$3,100	$40,500	$75,100	$102,000	$764,000	$614,000

Notes:

[a] Net present value of reduced CO_2 emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5, 3, 2.5 percent) is used to calculate net present value of SCC for internal consistency. Refer to the SCC TSD for more detail. Annual costs shown are undiscounted values.

[b] Section III.H.5 notes that SCC increases over time. For the years 2012-2050, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $23-$46; for Average SCC at 2.5%: $38-$67; and for 95th percentile SCC at 3%: $70-$140.

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

[d] 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 nearly two-and-a-half times larger.

[e] 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.

[f] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this program (*See* DRIA Chapter 7.1). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero. We seek comment on a method of quantifying non-CO_2 GHG benefits in Section III.H.5.

[g] Positive values for Accidents, Congestion, and Noise costs represent an increase in costs. Therefore, they are treated as negative values when calculating the total benefits.

Table III–81 presents estimated annual net benefits for the indicated calendar years. The table also shows the net present values of those net benefits for the calendar years 2012–2050 using both 3 percent and 7 percent discount rates. The table includes the benefits of reduced CO_2 emissions (and consequently the annual net benefits) for each of the four SCC values considered by EPA.

Table III-81 Undiscounted Annual Monetized Net Benefits & Net Benefits of the Proposed Program Discounted Back to 2012 at 3% and 7% Discount Rates (Millions, 2009$)

	2017	2020	2030	2040	2050	NPV, 3%[a]	NPV, 7%[a]
Technology Costs	$2,300	$8,470	$35,700	$39,800	$44,600	$551,000	$243,000
Fuel Savings	$570	$7,060	$85,800	$144,000	$187,000	$1,510,000	$579,000
Total Annual Benefits at each assumed SCC value[b]							
5% (avg SCC)	$101	$1,240	$15,600	$29,000	$40,700	$275,000	$124,000
3% (avg SCC)	$141	$1,730	$22,000	$40,400	$55,600	$413,000	$263,000
2.5% (avg SCC)	$173	$2,120	$26,700	$48,700	$65,900	$534,000	$384,000
3% (95th %ile)	$250	$3,100	$40,500	$75,100	$102,000	$764,000	$614,000
Monetized Net Benefits at each assumed SCC value[c]							
5% (avg SCC)	-$1,630	-$166	$65,600	$133,000	$183,000	$1,230,000	$460,000
3% (avg SCC)	-$1,590	$325	$72,000	$144,000	$198,000	$1,370,000	$599,000
2.5% (avg SCC)	-$1,560	$712	$76,800	$153,000	$208,000	$1,490,000	$719,000
3% (95th %ile)	-$1,480	$1,690	$90,500	$179,000	$244,000	$1,720,000	$950,000

Notes:

[a] Net present value of reduced CO_2 emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5, 3, 2.5 percent) is used to calculate net present value of SCC for internal consistency. Refer to the SCC TSD for more detail. Annual costs shown are undiscounted values.

[b] Section VIII.H.5 notes that SCC increases over time. For the years 2012-2050, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $23-$46; for Average SCC at 2.5%: $38-$67; and for 95th percentile SCC at 3%: $70-$140 Section VIII.H.5 also presents these SCC estimates.

[c] Net Benefits equal Fuel Savings minus Technology Costs plus Benefits.

EPA also conducted a separate analysis of the total benefits over the model year lifetimes of the 2017 through 2025 model year vehicles. In contrast to the calendar year analysis presented above in Table III–78 through Table III–81, the model year lifetime analysis below shows the impacts of the proposed program on vehicles produced during each of the model years 2017 through 2025 over the course of their expected lifetimes. The net societal benefits over the full lifetimes of vehicles produced during each of the nine model years from 2017 through 2025 are shown in Table III–82 and Table III–83 at both 3 percent and 7 percent discount rates, respectively.

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Table III-82 Monetized Technology Costs, Fuel Savings, Benefits, and Net Benefits Associated with the Lifetimes of 2017-2025 Model Year Light-Duty Vehicles (Millions, 2009$; 3% Discount Rate)[h]

	2017 MY	2018 MY	2019 MY	2020 MY	2021 MY	2022 MY	2023 MY	2024 MY	2025 MY	Sum
Technology Costs	$2,270	$4,590	$6,410	$8,340	$11,700	$19,100	$24,700	$30,300	$33,100	$140,000
Fuel Savings (pre-tax)	$6,060	$14,300	$22,400	$31,800	$47,300	$61,000	$73,700	$87,000	$100,000	$444,000
Energy Security Benefits (macro-disruption costs)	$322	$763	$1,200	$1,710	$2,550	$3,310	$4,030	$4,790	$5,560	$24,200
Accidents, Congestion, Noise Costs[f]	$721	$1,740	$2,740	$3,880	$5,600	$7,150	$8,560	$10,000	$11,500	$52,000
Increased Travel Benefits	$1,040	$2,480	$3,850	$5,380	$7,720	$9,770	$11,600	$13,600	$15,500	$70,900
Refueling Time Savings	$262	$618	$967	$1,370	$2,040	$2,650	$3,230	$3,840	$4,470	$19,500
$PM_{2.5}$ Related Impacts[c,d,e]	$117	$302	$481	$692	$1,090	$1,210	$1,300	$1,380	$1,450	$8,020
Non-CO_2 GHG Impacts[g]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reduced CO_2 Emissions at each assumed SCC value[a, b]										
5% (avg	$142	$344	$552	$802	$1,230	$1,610	$1,980	$2,390	$2,810	$11,900

SCC)										
3% (avg SCC)	$598	$1,430	$2,260	$3,240	$4,900	$6,350	$7,730	$9,200	$10,700	$46,400
2.5% (avg SCC)	$968	$2,310	$3,640	$5,190	$7,820	$10,100	$12,300	$14,600	$16,900	$73,800
3% (95th %ile)	$1,830	$4,380	$6,920	$9,910	$15,000	$19,400	$23,600	$28,100	$32,700	$142,000
Monetized Net Benefits at each assumed SCC value[a, b]										
5% (avg SCC)	$4,960	$12,500	$20,300	$29,500	$44,600	$53,300	$62,600	$72,600	$85,700	$386,000
3% (avg SCC)	$5,420	$13,600	$22,100	$32,000	$48,300	$58,100	$68,400	$79,400	$93,600	$421,000
2.5% (avg SCC)	$5,790	$14,500	$23,400	$33,900	$51,200	$61,800	$72,900	$84,800	$99,800	$448,000
3% (95th %ile)	$6,650	$16,600	$26,700	$38,600	$58,400	$71,100	$84,300	$98,300	$116,000	$516,000

Notes:

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

[b] Section III.H.5 notes that SCC increases over time. For the years 2012-2050, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $23-$46; for Average SCC at 2.5%: $38-$67; and for 95th percentile SCC at 3%: $70-$140. Section III.H.5 also presents these SCC estimates.

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

[d] 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 nearly two-and-a-half times larger.

[e] 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.[f] Positive values for Accidents, Congestion, and Noise costs represent an increase in costs. Therefore, they are treated as negative values when calculating the total benefits.[g] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this action (*See* DRIA Chapter 7.1). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero. We seek comment on a method of quantifying non-CO_2 GHG benefits in Section III.H.5.

[h] Model year values are discounted to the first year of each model year; the "Sum" represents those discounted values summed across model years.

Table III-83 Monetized Technology Costs, Fuel Savings, Benefits, and Net Benefits Associated with the Lifetimes of 2017-2025 Model Year Light-Duty Vehicles (Millions, 2009$; 7% Discount Rate)[h]

	2017 MY	2018 MY	2019 MY	2020 MY	2021 MY	2022 MY	2023 MY	2024 MY	2025 MY	Sum
Technology Costs	$2,220	$4,500	$6,290	$8,190	$11,500	$18,700	$24,200	$29,700	$32,500	$138,000
Fuel Savings (pre-tax)	$4,720	$11,200	$17,500	$24,900	$37,000	$47,700	$57,700	$68,100	$78,700	$347,000
Energy Security Benefits (macro-disruption costs)	$250	$593	$934	$1,330	$1,980	$2,580	$3,150	$3,750	$4,360	$18,900
Accidents, Congestion, Noise Costs[f]	$562	$1,360	$2,140	$3,040	$4,390	$5,600	$6,720	$7,880	$9,060	$40,800

Increased Travel Benefits	$808	$1,930	$3,000	$4,190	$6,010	$7,620	$9,080	$10,600	$12,100	$55,300
Refueling Time Savings	$203	$481	$754	$1,070	$1,590	$2,070	$2,520	$2,990	$3,480	$15,200
$PM_{2.5}$ Related Impacts[c,d,e]	$93	$240	$382	$551	$864	$964	$1,030	$1,100	$1,160	$6,390
Non-CO_2 GHG Impacts[g]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reduced CO_2 Emissions at each assumed SCC value[a, b]										
5% (avg SCC)	$142	$344	$552	$802	$1,230	$1,610	$1,980	$2,390	$2,810	$11,900
3% (avg SCC)	$598	$1,430	$2,260	$3,240	$4,900	$6,350	$7,730	$9,200	$10,700	$46,400
2.5% (avg SCC)	$968	$2,310	$3,640	$5,190	$7,820	$10,100	$12,300	$14,600	$16,900	$73,800
3% (95th %ile)	$1,830	$4,380	$6,920	$9,910	$15,000	$19,400	$23,600	$28,100	$32,700	$142,000
Monetized Net Benefits at each assumed SCC value[a, b]										
5% (avg SCC)	$3,420	$8,920	$14,700	$21,600	$32,800	$38,200	$44,500	$51,300	$61,100	$277,000
3% (avg SCC)	$3,880	$10,000	$16,400	$24,000	$36,400	$43,000	$50,200	$58,100	$69,000	$311,000
2.5% (avg SCC)	$4,250	$10,900	$17,800	$26,000	$39,400	$46,700	$54,800	$63,500	$75,200	$338,000
3% (95th %ile)	$5,110	$13,000	$21,100	$30,700	$46,500	$56,000	$66,100	$77,000	$91,000	$406,000

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Notes:

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

[b] Section III.H.5 notes that SCC increases over time. For the years 2012-2050, the SCC estimates range as follows: for Average SCC at 5%: $5-$16; for Average SCC at 3%: $23-$46; for Average SCC at 2.5%: $38-$67; and for 95th percentile SCC at 3%: $70-$140. Section III.H.5 also presents these SCC estimates.

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

[d] 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 nearly two-and-a-half times larger.

[e] 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

.[f] Positive values for Accidents, Congestion, and Noise costs represent an increase in costs. Therefore, they are treated as negative values when calculating the total benefits.

[g] The monetized GHG benefits presented in this analysis exclude the value of changes in non-CO_2 GHG emissions expected under this action (*See* DRIA Chapter 7.1). Although EPA has not monetized changes in non-CO_2 GHGs, the value of any increases or reductions should not be interpreted as zero. We seek comment on a method of quantifying non-CO_2 GHG benefits in Section III.H.5.

[h] Model year values are discounted to the first year of each model year; the “Sum” represents those discounted values summed across model years.

10. U.S. Vehicle Sales Impacts and Payback Period

a. Vehicle Sales Impacts and Payback Period

Predicting the effects of this rule on vehicles entails comparing two effects. On the one hand, the vehicles designed to meet the proposed standards will become more expensive, which would, by itself, be expected to discourage sales. On the other hand, the vehicles will have improved fuel economy and thus lower operating costs, producing lower total costs over the life of vehicles, which makes them more attractive to consumers. Which of these effects dominates for potential vehicle buyers when they are considering a purchase will determine the effect on sales. However, assessing the net effect of these two competing effects is complex and uncertain, as it rests on how consumers value fuel savings at the time of purchase and the extent to which manufacturers and dealers reflect them in the purchase price. The empirical literature does not provide clear evidence on whether consumers fully consider the value of fuel savings at the time of purchase. It also generally does not speak to the efficiency of manufacturing and dealer pricing decisions. Thus, for the proposal we do not provide quantified estimates of potential sales impacts. Rather, we solicit comment on the issues raised here and on methods for estimating the effect of this rule on vehicle sales.

For years, consumers have been gaining experience with the benefits that accrue to them from owning and operating vehicles with greater fuel efficiency. Many households already own vehicles with a fairly wide range of fuel economy, and thus already have an opportunity to learn about the value of fuel economy on their own. Among two-vehicle households, for example, the least fuel-efficient vehicle averages just over 22 mpg (EPA test rating), and the range between this and the fuel economy of their other vehicle averages nearly 7 mpg. Among households that own 3 or more vehicles, the typical range of the fuel economy they offer is much wider. Consumer demand may have shifted towards such vehicles, not only because of higher fuel prices but also if many consumers are learning about the value of purchases based not only on initial costs but also on the total cost of owning and operating a vehicle over its lifetime. This type of learning should continue before and during the model years affected by this rule, particularly given the new fuel economy labels that clarify potential economic effects and should therefore reinforce that learning.

Today's proposed rule, combined with the new and easier-to-understand fuel economy label required to be on all new vehicles beginning in 2012, may increase sales above baseline levels by hastening this very type of consumer learning. As more consumers experience, as a result of the rule, the savings in time and expense from owning more fuel efficient vehicles, demand may shift yet further in the direction of the vehicles mandated under the rule. This social learning can take place both within and across households, as consumers learn from one another.

First and most directly, the time and fuel savings associated with operating more fuel efficient vehicles may be more salient to individuals who own them, which might cause their subsequent purchase decisions to shift closer to minimizing the total cost of ownership over the lifetime of the vehicle.

Second, this appreciation may spread across households through word of mouth and other forms of communications.

Third, as more motorists experience the time and fuel savings associated with greater fuel efficiency, the price of used cars will better reflect such efficiency, further reducing the cost of owning more efficient vehicles for the buyers of new vehicles (since the resale price will increase).

If these induced learning effects are strong, the rule could potentially increase total vehicle sales over time. It is not possible to quantify these learning effects years in advance and that effect may be speeded or slowed by other factors that enter into a consumer's valuation of fuel efficiency in selecting vehicles.

The possibility that the rule will (after a lag for consumer learning) increase sales need not rest on the assumption that automobile manufacturers are failing to pursue profitable opportunities to supply the vehicles that consumers demand. In the absence of the rule, no individual automobile manufacturer would find it profitable to move toward the more efficient vehicles mandated under the rule. In particular, no individual company can fully internalize the future boost to demand resulting from the rule. If one company were to make more efficient vehicles, counting on consumer learning to enhance demand in the future, that company would capture only a fraction of the extra sales so generated, because the learning at issue is not specific to any one company's fleet. Many of the extra sales would accrue to that company's competitors.

In other words, consumer learning about the benefits of fuel efficient vehicles involves positive externalities (spillovers) from one company to the others.[579] These positive externalities may lead to benefits for manufacturers as a whole. We emphasize that this discussion has been tentative and qualified. To be sure, social learning of related kinds has been identified in a number of contexts.[580] Comments are invited on the discussion offered here, with particular reference to any relevant empirical findings.

In previous rulemakings, EPA and NHTSA conducted vehicle sales analyses by comparing the up-front costs of the vehicles with the present value of five years' worth of fuel savings. We assumed that the costs for the fuel-saving technologies would be passed along fully to vehicle buyers in the vehicle prices. The up-front vehicle costs were adjusted to take into account several factors that would affect consumer costs: The increased sales tax that consumers would pay, the increase in insurance premiums, the increase in loan payments that buyers would face, and a higher resale value, with all of these factors due to the higher up-front cost of the vehicle. Those calculations resulted in an adjusted increase in costs to consumers. We then assumed that consumers considered the present value of five years of fuel savings in their vehicle purchase, which is consistent with the length of a typical new light-duty vehicle loan, and is similar to the average time that a new vehicle purchaser holds onto the vehicle.[581] The present value of fuel savings was subtracted from technology costs to get a net effect on vehicle cost of ownership. We then used a short-run demand elasticity of -1 to convert a change in price into a change in

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[579] Industrywide positive spillovers of this type are hardly unique to this situation. In many industries, companies form trade associations to promote industry-wide public goods. For example, merchants in a given locale may band together to promote tourism in that locale. Antitrust law recognizes that this type of coordination can increase output.

[580] See Hunt Allcott, Social Norms and Energy Conservation, Journal of Public Economics (forthcoming 2011), available at *http://web.mit.edu/allcott/www/Allcott%202011%20JPubEc%20-%20Social%20Norms%20and%20Energy%20Conservation.pdf*; Christophe Chamley, Rational Herds: Economic Models of Social Learning (Cambridge, 2003).

[581] In this proposal, the 5-year payback assumption corresponds to an assumption that vehicle buyers take into account between 30 and 50 percent of the present value of lifetime vehicle fuel savings (with the variation depending on discount rate, model year, and car vs. truck).

quantity demanded of vehicles.[582] An elasticity of −1 means that a 1% increase in price leads to a 1% reduction in quantity sold. In the vehicle sales analyses, if five years of fuel savings outweighed the adjusted technology costs, then vehicle sales were predicted to increase; if the fuel savings were smaller than the adjusted technology costs, sales would decrease, compared to a world without the standards.

We do not here present a vehicle sales analysis using this approach. This rule takes effect for MY 2017–2025. In the intervening years, it is possible that the assumptions underlying this analysis, as well as market conditions, might change. Instead, we present a payback period analysis to estimate the number of years of fuel savings needed to recover the up-front costs of the new technologies. In other words, the payback period identifies the break-even point for new vehicle buyers.

A payback period analysis examines how long it would take for the expected fuel savings to outweigh the increased cost of a new vehicle. For example, a new 2025 MY vehicle is estimated to cost $1,946 more (on average, and relative to the reference case vehicle) due to the addition of new GHG reducing/fuel economy improving 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 costs?

The payback analysis 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 fuel savings associated with A/C controls. 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 private impacts, such as reduced refueling events, or other societal impacts, such as the potential rebound miles driven or the value of driving those rebound miles, 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. The costs take into account the effects of the increased costs on sales tax, insurance, resale value, and finance costs. More detail on this analysis can be found in Chapter 5 of EPA's draft RIA.

Table III–84 presents results for MY 2021 because it is the last year before the mid-term review impacts, if any, will take place, and MY 2025 because it is the last year of the program. The payback period in 2021 is shorter than that in 2025, because the technologies required to meet the proposed MY 2021 standards are more cost-effective than those for MY 2025. In all cases, the payback periods are less than 4 years.

Table III-84 Estimated Payback Period for Model Years 2021 and 2025 (Years)[a]

Model Year	Estimated Payback Period for Cash Purchase, 3% Discount Rate	Estimated Payback Period for Cash Purchase, 7% Discount Rate	Estimated Payback Period for Purchase on Credit, 3% Discount Rate	Estimated Payback Period for Purchase on Credit, 7% Discount Rate
2021	2.7	2.9	2.9	2.8
2025	3.7	3.9	3.9	3.9

[a] The value here includes nationwide average sales tax of 5.32% and increased insurance premiums of 1.85% in year one decreasing to 0% by year 9. Financing costs assume a 5 year loan at 5.52 percent. These percentages are discussed in Section 8.1.1 of EPA's DRIA.

Most people purchase a new vehicle using credit rather than paying cash up front. A common car loan today is a five year, 60 month loan. As of July, 2011, the national average interest rate for a 5 year new car loan was 5.52 percent.[583] If the increased vehicle cost is spread out over 5 years at 5.52 percent, the analysis for a MY 2025 vehicle would

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[582] For a durable good such as an auto, the elasticity may be smaller in the long run: Though people may be able to change the timing of their purchase when price changes in the short run, they must eventually make the investment. We request comment on whether or when a long-run elasticity should be used for a rule that phases in over time, as well as how to find good estimates for the long-run elasticity.

[583] "National Auto Loan Rates for July 21, 2011," *http://www.bankrate.com/finance/auto/national-auto-loan-rates-for-july-21-2011.aspx*, accessed 7/26/11 (Docket EPA–HQ–OAR–2010–0799).

look like that shown in Table III–85. As can be seen in this table, the fuel savings immediately outweigh the increased payments on the car loan, amounting to $145 in discounted net savings (3% discount rate) in the first year and similar savings for the next four years although savings decline somewhat due to reduced VMT as the average vehicle ages. 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 $12 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 less the increased insurance premiums (as would be the case for the remaining years of ownership).

Table III-85 Payback Period on a 2025 MY New Vehicle Purchase via Credit (2009 dollars)

Year of Ownership	Increased Vehicle Cost[a] (undiscounted)	Annual Fuel Savings[b] (undiscounted)	Annual Discounted Net Savings at 3%[c]	Annual Discounted Net Savings at 7%[c]
1	-$489	$643	$145	$133
2	-$488	$634	$133	$117
3	-$487	$630	$127	$107
4	-$485	$614	$109	$88
5	-$484	$601	$96	$74
6	-$11	$572	$477	$387
7	-$6	$543	$443	$346
8	-$1	$512	$409	$308

[a] This uses the same increased cost as Table III-12 but spreads it out over 5 years assuming a 5 year car loan at 5.52 percent.

[b] Calculated using AEO 2011 reference case fuel prices including taxes.

[c] Note that the cumulative discounted fuel savings are identical to those shown in Table III-12. Here we show discounted net savings.

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–86. In either case, the present value of the lifetime net savings is greater than $4,200 at a 3% discount rate, or $2,900 at a 7% discount rate.

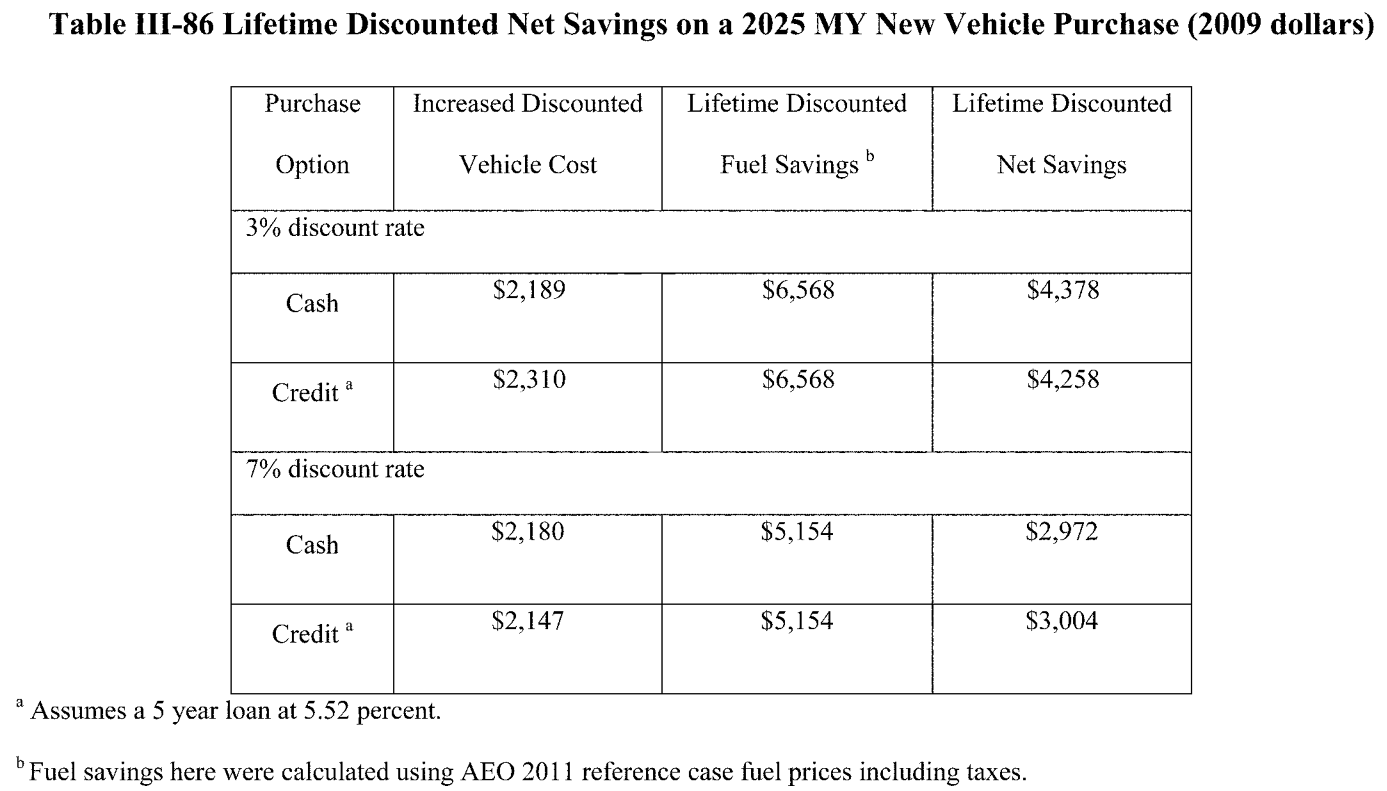

Table III-86 Lifetime Discounted Net Savings on a 2025 MY New Vehicle Purchase (2009 dollars)

Purchase Option	Increased Discounted Vehicle Cost	Lifetime Discounted Fuel Savings [b]	Lifetime Discounted Net Savings
3% discount rate			
Cash	$2,189	$6,568	$4,378
Credit [a]	$2,310	$6,568	$4,258
7% discount rate			
Cash	$2,180	$5,154	$2,972
Credit [a]	$2,147	$5,154	$3,004

[a] Assumes a 5 year loan at 5.52 percent.

[b] Fuel savings here were calculated using AEO 2011 reference case fuel prices including taxes.

Note that throughout this consumer payback discussion, the analysis reflects the average number of vehicle miles traveled per year. 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.

Another method to estimate effects on vehicle sales is to model 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. Helfand and Wolverton discuss the wide variation in the structure and results of these models.[584] 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 discussed in Section III.H.1 and in Chapter 8.1.2.8 of the DRIA, EPA is exploring development of a consumer vehicle choice model, but the model is not sufficiently developed for use in this NPRM.

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, the fuel efficiency of used vehicles, 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 could 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 reduce the anticipated effects of this rule on fuel use and emissions.

Because of the uncertainty regarding 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.

Chapter 5 of EPA's DRIA provides more information on the payback period analysis, and Chapter 8 of EPA's DRIA has further discussion of methods for examining the effects of this rule on vehicle sales. We welcome comments on all aspects of this discussion, including the full range of considerations and assumptions which influence market behavior and outcomes and associated uncertainties. We also welcome comments on all the parameters described here, as well as other quantitative estimates of the effects of this proposal on sales, accompanied by detailed descriptions of the methodologies used.

11. Employment Impacts

a. Introduction

Although analysis of employment impacts is not part of a cost-benefit analysis (except to the extent that labor costs contribute to costs), employment impacts of federal rules are of particular concern in the current economic climate

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[584] Helfand, Gloria, and Ann Wolverton. "Evaluating the Consumer Response to Fuel Economy: A Review of the Literature." *International Review of Environmental and Resource Economics* 5 (2011): 103–146 (Docket EPA–HQ–OAR–2010–0799).

of sizeable unemployment. When President Obama requested that the agencies develop this program, he sought a program that would ''strengthen the [auto] industry and enhance job creation in the United States.'' [585] The recently issued Executive Order 13563, ''Improving Regulation and Regulatory Review'' (January 18, 2011), states, ''Our regulatory system must protect public health, welfare, safety, and our *environment* while promoting economic growth, innovation, competitiveness, and *job creation''* (emphasis added). EPA is accordingly providing partial estimates of the effects of this proposal on domestic employment in the auto manufacturing and parts sectors, while qualitatively discussing how it may affect employment in other sectors more generally.

This proposal is expected to affect employment in the United States through the regulated sector—the auto manufacturing industry—and through several related sectors, specifically, industries that supply the auto manufacturing industry (*e.g.,* vehicle parts), auto dealers, the fuel refining and supply sectors, and the general retail sector. According to the U.S. Bureau of Labor Statistics, in 2010, about 677,000 people in the U.S. were employed in the Motor Vehicle and Parts Manufacturing Sector (NAICS 3361, 3362, and 3363). About 129,000 people in the U.S. were employed specifically in the Automobile and Light Truck Manufacturing Sector (NAICS 33611), the directly regulated sector, since it encompasses the auto manufacturers that are responsible for complying with the proposed standards.[586] The employment effects of this rule are expected to expand beyond the regulated sector. Though some of the parts used to achieve the proposed standards are likely to be built by auto manufacturers themselves, the auto parts manufacturing sector also plays a significant role in providing those parts, and will also be affected by changes in vehicle sales. Changes in light duty vehicle sales, discussed in Section III.H.10, could affect employment for auto dealers. As discussed in Chapter 5.4 of the DRIA, this proposal is expected to reduce the amount of fuel these vehicles use, and thus affect the petroleum refinery and supply industries. Finally, since the net reduction in cost associated with this proposal is expected to lead to lower household expenditures on fuel net of vehicle costs, consumers then will have additional discretionary income that can be spent on other goods and services.

When the economy is at full employment, an environmental regulation is unlikely to have much impact on net overall U.S. employment; instead, labor would primarily be shifted from one sector to another. These shifts in employment impose an opportunity cost on society, approximated by the wages of the employees, as regulation diverts workers from other activities in the economy. In this situation, any effects on net employment are likely to be transitory as workers change jobs (*e.g.,* some workers may need to be retrained or require time to search for new jobs, while shortages in some sectors or regions could bid up wages to attract workers).

On the other hand, if a regulation comes into effect during a period of high unemployment, a change in labor demand due to regulation may affect net overall U.S. employment because the labor market is not in equilibrium. In such a period, both positive and negative employment effects are possible.[587] Schmalansee and Stavins point out that net positive employment effects are possible in the near term when the economy is at less than full employment due to the potential hiring of idle labor resources by the regulated sector to meet new requirements (*e.g.,* to install new equipment) and new economic activity in sectors related to the regulated sector.[588] In the longer run, the net effect on employment is more difficult to predict and will depend on the way in which the related industries respond to the regulatory requirements. As Schmalansee and Stavins note, it is possible that the magnitude of the effect on employment could vary over time, region, and sector, and positive effects on employment in some regions or sectors could be offset by negative effects in other regions or sectors. For this reason, they urge caution in reporting partial employment effects since it can ''paint an inaccurate picture of net employment impacts if not placed in the broader economic context.''

It is assumed that the official unemployment rate will have declined to 5.3 percent by the time this rule takes effect and so the effect of the regulation on labor will be to shift workers from one sector to another.[589] Those shifts in employment impose an opportunity cost on society, approximated by the wages of the employees, as regulation diverts workers from other activities in the economy. In this situation, any effects on net employment are likely to be transitory as workers change jobs (*e.g.,* some workers may need to be retrained or require time to search for new jobs, while shortages in some sectors or regions could bid up wages to attract workers). It is also possible that the state of the economy will be such that positive or negative employment effects will occur.

A number of different approaches have been used in published literature to conduct employment analysis. All potential methods of estimating employment impacts of a rule have advantages and limitations. We seek comment on the analytical approach presented here, other appropriate methods for analyzing employment impacts for this rulemaking, and the inputs used here for employment analysis.

b. Approaches to Quantitative Employment Analysis

Measuring the employment impacts of a policy depend on a number of inputs and assumptions. For instance, as discussed, assumptions about the overall state of unemployment in the economy play a major role in measured job impacts. The inputs to the models commonly are the changes in quantities or expenditures in the affected sectors; model results may vary in different studies depending on the assumptions about the levels of those inputs, and which sectors receive those changes. Which sectors are included in the study can also affect the results. For instance, a study of this program that looks only at employment impacts in the refinery sector may find negative effects, because consumers will purchase less gasoline; a study that looks only at the auto parts sector, on the other hand, may find positive impacts, because the program will require redesigned or additional parts for vehicles. In both instances, these would only be partial perspectives

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[585] President Barack Obama. ''Presidential Memorandum Regarding Fuel Efficiency Standards. The White House, Office of the Press Secretary, May 21, 2010. *http://www.whitehouse.gov/the-press-office/presidential-memorandum-regarding-fuel-efficiency-standards.*

[586] U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages, as accessed on August 9, 2011.

[587] Masur and Posner, *http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1920441.*

[588] Schmalensee, Richard, and Robert N. Stavins. ''A Guide to Economic and Policy Analysis of EPA's Transport Rule.'' White paper commissioned by Excelon Corporation, March 2011 (Docket EPA–HQ–OAR–2010–0799).

[589] Office of Management and Budget, ''Fiscal Year 2012 Mid-Session Review: Budget of the U.S. Government.'' *http://www.whitehouse.gov/sites/default/files/omb/budget/fy2012/assets/12msr.pdf,* p. 10.

on the overall change in national employment due to Federal regulation.

i. Conceptual Framework for Employment Impacts in the Regulated Sector

One study by Morgenstern, Pizer, and Shih[590] provides a retrospective look at the impacts of regulation in employment in the regulated sectors by estimating the effects on employment of spending on pollution abatement for four highly polluting/regulated U.S. industries (pulp and paper, plastics, steel, and petroleum refining) using data for six years between 1979 and 1991. The paper provides a theoretical framework that can be useful for examining the impacts of a regulatory change on the regulated sector in the medium to longer term. In particular, it identifies three separate ways that employment levels may change in the regulated industry in response to a new (or more stringent) regulation.

- *Demand effect:* higher production costs due to the regulation will lead to higher market prices; higher prices in turn reduce demand for the good, reducing the demand for labor to make that good. In the authors' words, the ''extent of this effect depends on the cost increase passed on to consumers as well as the demand elasticity of industry output.''
- *Cost effect:* as costs go up, plants add more capital and labor (holding other factors constant), with potentially positive effects on employment. In the authors' words, as ''production costs rise, more inputs, including labor, are used to produce the same amount of output.''
- *Factor-shift effect:* post-regulation production technologies may be more or less labor-intensive (*i.e.,* more/less labor is required per dollar of output). In the authors' words, ''environmental activities may be more labor intensive than conventional production,'' meaning that ''the amount of labor per dollar of output will rise,'' though it is also possible that ''cleaner operations could involve automation and less employment, for example.''

According to the authors, the ''demand effect'' is expected to have a negative effect on employment,[591] the ''cost effect'' to have a positive effect on employment, and the ''factor-shift effect'' to have an ambiguous effect on employment. Without more information with respect to the magnitude of these competing effects, it is not possible to predict the total effect environmental regulation will have on employment levels in a regulated sector.

The authors conclude that increased abatement expenditures generally have not caused a significant change in employment in those sectors. More specifically, their results show that, on average across the industries studied, each additional $1 million spent on pollution abatement results in a (statistically insignificant) net increase of 1.5 jobs.

This approach to employment analysis has the advantage of carefully controlling for many possibly confounding effects in order to separate the effect of changes in regulatory costs on employment. It was, however, conducted for only four sectors. It could also be very difficult to update the study for other sectors, because one of the databases on which it relies, the Pollution Abatement Cost and Expenditure survey, has been conducted infrequently since 1994, with the last survey conducted in 2005. The empirical estimates provided by Morgenstern et al. are not relevant to the case of fuel economy standards, which are very different from the pollution control standards on industrial facilities that were considered in that study. In addition, it does not examine the effects of regulation on employment in sectors related to but outside of the regulated sector. Nevertheless, the theory that Morgenstern et al. developed continues to be useful in this context.

The following discussion of additional methodologies draws from Berck and Hoffmann's review of employment models.[592]

ii. Computable General Equilibrium (CGE) Models

Computable general equilibrium (CGE) models are often used to assess the impacts of policy. These models include a stylized representation of supply and demand curves for all major markets in the economy. The labor market is commonly included. CGE models are very useful for looking at interaction effects of markets: ''They allow for substitution among inputs in production and goods in consumption.'' Thus, if one market experiences a change, such as a new regulation, then the effects can be observed in all other markets. As a result, they can measure the employment changes in the economy due to a regulation. Because they usually assume equilibrium in all markets, though, they typically lack involuntary unemployment. If the total amount of labor changes, it is due to people voluntarily entering or leaving the workforce. As a result, these models may not be appropriate for measuring effects of a policy on unemployment, because of the assumption that there is no involuntary unemployment. In addition, because of the assumptions of equilibrium in all markets and forward-looking consumers and firms, they are designed for examining the long-run effects of a policy but may offer little insight into its short-run effects.

iii. Input-Output (IO) Models

Input-output models represent the economy through a matrix of coefficients that describe the connections between supplying and consuming sectors. In that sense, like CGE models, they describe the interconnections of the economy. These interconnections look at how changes in one sector ripple through the rest of the economy. For instance, a requirement for additional technology for vehicles requires additional steel, which requires more workers in both the auto and steel sectors; the additional workers in those sectors then have more money to spend, which leads to more employment in retail sectors. These are known as ''multiplier'' effects, because an initial impact in one sector gets multiplied through the economy. Unlike CGE models, input-output models have fixed, linear relationships among the sectors (*e.g.,* substitution among inputs or goods is not allowed), and quantity supplied need not equal quantity demanded. In particular, these models do not allow for price changes—an increase in the demand for labor or capital does not result in a change in its price to help reallocate it to its best use. As a result, these models cannot capture opportunity costs from using resources in one area of the economy over another. The multipliers take an initial impact and can increase it substantially.

IO models are commonly used for regional analysis of projects. In a regional analysis, the markets are commonly considered small enough that wages and prices are determined outside the region, and any excess

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[590] Morgenstern, Richard D., William A. Pizer, and Jhih-Shyang Shih. ''Jobs Versus the Environment: An Industry-Level Perspective.'' *Journal of Environmental Economics and Management* 43 (2002): 412–436 (Docket EPA–HQ–OAR–2010–0799).

[591] As will be discussed below, the demand effect in this proposal is potentially an exception to this rule. While the vehicles become more expensive, they also produce reduced fuel expenditures; the reduced fuel costs provide a countervailing impact on vehicle sales. As discussed in Preamble Section III.H.1, this possibility that vehicles may become more attractive to consumers after the program poses a conundrum: Why have interactions between vehicle buyers and producers not provided these benefits without government intervention?

[592] Berck, Peter, and Sandra Hoffmann. ''Assessing the Employment Impacts of Environmental and Natural Resource Policy.'' Environmental and Resource Economics 22 (2002): 133–156 (Docket EPA–HQ–OAR–2010–0799) (Docket EPA–HQ–OAR–2010–0799).

supply or demand is due to exports and imports (or, in the case of labor, emigration or immigration). For national-level employment analysis, the use of input-output models requires the assumption that workers flow into or out of the labor market perfectly freely. Wages do not adjust; instead, people join into or depart from the labor pool as production requires them. For other markets as well, there is no substitution of less expensive inputs for more expensive ones. As a result, IO models provide an upper bound on employment impacts. As Berck and Hoffmann note, ''For the same reason, they can be thought of as simulating very short-run adjustment,'' in contrast to the CGE's implicit assumption of long-run adjustment. Changes in production processes, introducing new technologies, or learning over time due to new regulatory requirements are also generally not captured by IO models, as they are calibrated to already established relationships between inputs and outputs.

iv. Hybrid Models

As Berck and Hoffmann note, input-output models and CGE models ''represent a continuum of closely related models.'' Though not separately discussed by Berck and Hoffmann, some hybrid models combine some of the features of CGE models (*e.g.,* prices that can change) with input-output relationships. For instance, a hybrid model may include the ability to examine disequilibrium phenomena, such as labor being at less than full employment. Hybrid models depend on assumptions about how adjustments in the economy occur. CGE models characterize equilibria but say little about the pathway between them, while IO models assume that adjustments are largely constrained by previously defined relationships; the effectiveness of hybrid models depends on their success in overcoming the limitations of each of these approaches. Hybrid models could potentially be used to model labor market impacts of various vehicle policy options, although a number of judgments need to be made about the appropriate assumptions underlying the model as well as the empirical basis for the modeling results.

v. Single Sectors

It is possible to conduct a bottom-up analysis of the partial effect of regulation on employment in a single sector by estimating the change in output or expenditures in a sector and multiplying it by an estimate of the number of workers per unit of output or expenditures, under the assumption that labor demand is proportional to output or expenditures. As Berck and Hoffmann note, though, ''Compliance with regulations may create additional jobs that are not accounted for.'' While such an analysis can approximate the effects in that one sector in a simple way, it also may miss important connections to related sectors.

vi. Ex-Post Econometric Studies

A number of ex-post econometric analyses examine the net effect of regulation on employment in regulated sectors. Morgenstern, Pizer, and Shih (2002), discussed above, and Berman and Bui (2001) are two notable examples that rely on highly disaggregated establishment-level time series data to estimate longer-run employment effects.[593] While often a sophisticated treatment of the issues analyzed, these studies commonly analyze specific scenarios or sectors in the past; care needs to be taken in extrapolating their results to other scenarios and to the future. For instance, neither of these two studies examines the auto industry and are therefore of limited applicability in this context.

vii. Summary

All methods of estimating employment impacts of a regulation have advantages and limitations. CGE models may be most appropriate for long-term impacts, but the usual assumption of equilibrium in the employment market means that it is not useful for looking at changes in overall employment: overall levels are likely to be premised on full employment. IO models, on the other hand, may be most appropriate for small-scale, short-term effects, because they assume fixed relationships across sectors and do not require market equilibria. Hybrid models, which combine some features of CGEs with IO models, depend upon key assumptions and economic relationships that are built into them. Single-sector models are simple and straightforward, but they are often based on the assumptions that labor demand is proportional to output, and that other sectors are not affected. Finally, econometric models have been developed to evaluate the longer-run net effects of regulation on sector employment, though these are ex-post analyses commonly of specific sectors or situations, and the results may not have direct bearing for the regulation being reviewed. We seek comment on the analytical approaches presented here, the inputs used below for employment analysis, and other appropriate methods for analyzing employment impacts for this rulemaking.

c. Employment analysis of this proposal

As mentioned above, this program is expected to affect employment in the regulated sector (auto manufacturing) and other sectors directly affected by the proposal: auto parts suppliers, auto dealers, the fuel supply market (which will face reduced petroleum production due to reduced fuel demand but which may see additional demand for electricity or other fuels), and consumers (who will face higher vehicle costs and lower fuel expenditures). In addition, as the discussion above suggests, each of these sectors could potentially have ripple effects in the rest of the economy. These ripple effects depend much more heavily on the state of the macroeconomy than do the direct effects. At the national level, employment may increase in one industry or region and decrease in another, with the net effect being smaller than either individual-sector effect. EPA does not attempt to quantify the net effects of the regulation on overall national employment.

The discussion that follows provides a partial, bottom-up quantitative estimate of the effects of this proposal on the regulated sector (the auto industry; for reasons discussed below, we include some quantitative assessment of effects on suppliers to the industry, although they are not regulated directly). It also includes qualitative discussion of the effects of the proposal on other sectors. Focusing quantification of employment impacts on the regulated sector has some advantages over quantifying all impacts. First, the analysis relies on data generated as part of the rulemaking process, which focuses on the regulated sector; as a result, what is presented here is based on internally consistent assumptions and estimates made in this proposal. Secondly, as discussed above, net effects on employment in the economy as a whole depend heavily on the overall state of the economy when this rule has its effects. Focusing on the regulated sector provides insight into employment effects in that sector without having to make assumptions about the state of the economy when this rule has its impacts. We include a qualitative discussion of employment effects other sectors to provide a broader perspective on the impacts of this rule.

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[593] Berman, Eli, and Linda T. Bui, (2001) ''Environmental Regulation and Labor Demand: Evidence from the South Coast Air Basin,'' *Journal of Public Economics,* 79, 265—295 (Docket EPA–HQ–OAR–2010–0799).

As noted above, in a full-employment economy, any changes in employment will result from people changing jobs or voluntarily entering or exiting the workforce. In a full-employment economy, employment impacts of this proposal will change employment in specific sectors, but it will have small, if any, effect on aggregate employment. This rule would take effect in 2017 through 2025; by then, the current high unemployment may be moderated or ended. For that reason, this analysis does not include multiplier effects, but instead focuses on employment impacts in the most directly affected industries. Those sectors are likely to face the most concentrated employment impacts. The agencies seek comment on other sectors that are likely to be significantly affected and thus warrant further analysis in the final rulemaking analysis.

i. Employment Impacts in the Auto Industry

Following the Morgenstern et al. conceptual framework for the impacts of regulation on employment in the regulated sector, we consider three effects for the auto sector: the demand effect, the cost effect, and the factor shift effect. However, we are only able to offer quantitative estimates for the cost effect. We note that these estimates, based on extrapolations from current data, become more uncertain as time goes on.

(1) The Demand Effect

The demand effect depends on the effects of this proposal on vehicle sales. If vehicle sales increase, then more people will be required to assemble vehicles and their components. If vehicle sales decrease, employment associated with these activities will unambiguously decrease. Unlike in Morgenstern et al.'s study, where the demand effect unambiguously decreased employment, there are countervailing effects in the vehicle market due to the fuel savings resulting from this program. On one hand, this proposal will increase vehicle costs; by itself, this effect would reduce vehicle sales. On the other hand, this proposal will reduce the fuel costs of operating the vehicle; by itself, this effect would increase vehicle sales, especially if potential buyers have an expectation of higher fuel prices. The sign of demand effect will depend on which of these effects dominates. Because, as described in Chapter 8.1, we have not quantified the impact on sales for this proposal, we do not quantify the demand effect.

(2) The Cost Effect

The demand effect, discussed above, measures employment changes due to new vehicle sales only. The cost effect measures employment impacts due to the new or additional technologies needed for vehicles to comply with the proposed standards. As DRIA Chapter 8.2.3.1.3 explains, we estimate the cost effect by multiplying the costs of rule compliance by ratios of workers to each $1 million of expenditures in that sector. The magnitude and relative size of these ratios depends on the sectors' labor intensity of the production process.

The use of these ratios has both advantages and limitations. It is often possible to estimate these ratios for quite specific sectors of the economy; as a result, it is not necessary to extrapolate employment ratios from possibly unrelated sectors. On the other hand, these estimates are averages for the sectors, covering all the activities in those sectors; they may not be representative of the labor required when expenditures are required on specific activities, as the factor shift effect (discussed below) indicates. In addition, these estimates do not include changes in sectors that supply these sectors, such as steel or electronics producers. They thus may best be viewed as the effects on employment in the auto sector due to the changes in expenditures in that sector, rather than as an assessment of all employment changes due to these changes in expenditures.

Some of the costs of this proposal will be spent directly in the auto manufacturing sector, but some of the costs will be spent in the auto parts manufacturing sector. Because we do not have information on the proportion of expenditures in each sector, we separately present the ratios for both the auto manufacturing sector and the auto parts manufacturing sector. These are not additive, but should instead be considered as a range of estimates for the cost effect, depending on which sector adds technologies to the vehicles to comply with the regulation.

We use several public sources for estimates of employment per $1 million expenditures: The U.S. Bureau of Labor Statistics' (BLS) Employment Requirements Matrix (ERM);[594] the Census Bureau's Annual Survey of Manufactures[595] (ASM); and the Census Bureau's Economic Census. DRIA Chapter 8.2.3.1.2 provides details on all these sources. The ASM and the Economic Census have more sectoral detail than the ERM; we provide estimates for both Motor Vehicle Manufacturing and Light Duty Vehicle Manufacturing sectors for comparison purposes. For all of these, we adjust for the ratio of domestic production to domestic sales. The maximum value for employment impacts per $1 million expenditures (after accounting for the share of domestic production) in 2009 was estimated to be 2.049 if all the additional costs are in the parts sector; the minimum value is 0.407, if all the additional costs are in the light-duty vehicle manufacturing sector: That is, the range of employment impacts is between 0.4 and 2 additional jobs per $1 million expenditures in the sector. The different data sources provide similar magnitudes for the estimates for the sectors. Parts manufacturing appears to be more labor-intensive than vehicle manufacturing; light-duty vehicle manufacturing appears to be slightly less labor-intensive than motor vehicle manufacturing as a whole. As discussed in the DRIA, trends in the BLS ERM are used to estimate productivity improvements over time that are used to adjust these ratios over time. Table III–87 shows the cost estimates developed for this rule, discussed in Section III.H.2. Multiplying those cost estimates by the maximum and minimum values for the cost effect (maximum using the ASM ratio if all additional costs are in the parts sector, and minimum using the Economic Census ratio for the light-duty sector if all additional costs are borne by auto manufacturers) provides the cost effect employment estimates. This is a simple way to examine the relationship between labor required and expenditure, and we seek comment on refining this method.

While we estimate employment impacts beginning with the first year of the standard (2017), some of these job gains may occur earlier as auto manufacturers and parts suppliers hire staff in anticipation of compliance with the standard.

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[594] *http://www.bls.gov/emp/ep_data_emp_requirements.htm.*

[595] *http://www.census.gov/manufacturing/asm/index.html.*

Table III-87 Employment Effects due to Increased Expenditures on Vehicles and Parts

Year	*Costs (before adjustment for domestic proportion of production) ($Millions)*	*Minimum employment effect if all expenditures are in light duty vehicle mfg sector*	*Maximum employment effect if all expenditures are in the parts sector*
2017	$ 2,300	600	3,600
2018	$ 4,656	1,200	7,000
2019	$ 6,507	1,600	9,400
2020	$ 8,467	1,900	11,800
2021	$ 11,878	2,600	15,900
2022	$ 19,340	4,100	25,000
2023	$ 25,036	5,000	31,200
2024	$ 30,738	5,900	37,000
2025	$ 33,561	6,200	39,000

(3) The Factor Shift Effect

The factor shift effect looks at the effects on employment due to changes in labor intensity associated with a regulation. As noted above, the estimates of the cost effect assume constant labor per $1 million in expenditures, though the new technologies may be either more or less labor-intensive than the existing ones. An estimate of the factor shift effect would either increase or decrease the estimate used for the cost effect.

We are not quantifying the factor shift effect here, for lack of data on the labor intensity of all the possible technologies that manufacturers could use to comply with the proposed standards. As discussed in DRIA Chapter 8.2.3.1.3, though, for a subset of the technologies, EPA-sponsored research (discussed in Chapter 3.2.1.1 of the Joint TSD), which compared new technologies to existing ones at the level of individual components, found that labor use for the new technologies increased: The new fuel-saving technologies use more labor than the baseline technologies. For instance, switching from a conventional mid-size vehicle to a hybrid version of that vehicle involves an additional $395.85 in labor costs, which we estimate to require an additional 8.6 hours per vehicle.[596] For a subset of the technologies likely to be used to meet the standards in this proposal, then, the factor shift effect increases labor demand, at least in the short run; in the long run, as with all technologies, the cost structure is likely to change due to learning, economies of scale, etc. The technologies examined in this research are, however, only a subset of the technologies that auto makers may use to comply with the standards proposed here. As a result, these results cannot be considered definitive evidence that the factor-shift effect increases employment for this rule. We therefore do not quantify the factor shift effect.

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[596] FEV, Inc. ‘‘Light Duty Technology Cost Analysis, Power-Split and P2 HEV Case Studies.’’ EPA Report EPA–420–R–11_015, November 2011 (Docket EPA–HQ–OAR–2010–0799).

(4) Summary of Employment Effects in the Auto Sector

While we are not able to quantify the demand or factor shift effects, the cost effect results show that the employment effects of the increased spending in the regulated sector (and, possibly, the parts sector) are expected to be positive and on the order of a few thousand in the initial years of the program. As noted above, the motor vehicle and parts manufacturing sectors employed about 677,000 people in 2010, with automobile and light truck manufacturing accounting for about 129,000 of that total.

ii. Effects on Employment for Auto Dealers

The effects of the proposed standards on employment for auto dealers depend principally on the effects of the standards on light duty vehicle sales. In addition, auto dealers may be affected by changes in maintenance and service costs. Increases in those costs are likely to increase labor demand in dealerships.

Although this proposal predicts very small penetration of advanced technology vehicles, the uncertainty on consumer acceptance of such technology vehicles is even greater. As discussed in Section III.H.1.b, consumers may find some characteristics of electric vehicles and plug-in hybrid electric vehicles, such as the ability to fuel with electricity rather than gasoline, attractive; they may find other characteristics, such as the limited range for electric vehicles, undesirable. As a result, some consumers will find that EVs will meet their needs, but other buyers will choose more conventional vehicles. Auto dealers may play a major role in explaining the merits and disadvantages of these new technologies to vehicle buyers. There may be a temporary need for increased employment to train sales staff in the new technologies as the new technologies become available.

iii. Effects on Employment in the Auto Parts Sector

As discussed in the context of employment in the auto industry, some vehicle parts are made in-house by auto manufacturers; others are made by independent suppliers who are not directly regulated, but who will be affected by the proposed standards as well. The additional expenditures on technologies are expected to have a positive effect on employment in the parts sector as well as the manufacturing sector; the breakdown in employment between the two sectors is difficult to predict. The effects on the parts sector also depend on the effects of the proposed standards on vehicle sales and on the labor intensity of the new technologies, qualitatively in the same ways as for the auto manufacturing sector.

iv. Effects on Employment for Fuel Suppliers

In addition to the effects on the auto manufacturing and parts sectors, these rules will result in changes in fuel use that lower GHG emissions. Fuel saving, principally reductions in liquid fuels such as gasoline and diesel, will affect employment in the fuel suppliers industry sectors throughout the supply chain, from refineries to gasoline stations. To the extent that the proposed standards result in increased use of electricity, natural gas, or other fuels, employment effects will result from providing these fuels and developing the infrastructure to supply them to consumers.

Expected petroleum fuel consumption reductions can be found in Section III.H.3. While those figures represent fuel savings for purchasers of fuel, it represents a loss in value of output for the petroleum refinery industry, fuel distribution, and gasoline stations. The loss of expenditures to petroleum fuel suppliers throughout the petroleum fuel supply chain, from the petroleum refiners to the gasoline stations, is likely to result in reduced employment in these sectors.

This rule is also expected to lead to increases in electricity consumption by vehicles, as discussed in Section III.H.4. This new fuel may require additional infrastructure, such as electricity charging locations. Providing this infrastructure will require some increased employment. In addition, the generation of electricity will also require some additional labor. We have insufficient information at this time to predict whether the increases in labor associated with increased infrastructure provision and fuel generation for these newer fuels will be greater or less than the employment reductions associated with reduced demand for petroleum fuels.

v. Effects on Employment Due to Impacts on Consumer Expenditures

As a result of these proposed standards, consumers will pay a higher up-front cost for the vehicles, but they will recover those costs in a fairly short payback period (see Section III.H.10.b); indeed, people who finance their vehicles are expected to find that their fuel savings per month exceed the increase in the loan cost (though this depends on the particular loan rate a consumer receives). As a result, consumers will have additional money to spend on other goods and services, though, for those who do not finance their vehicles, it will occur after the initial payback period. These increased expenditures will support employment in those sectors where consumers spend their savings.

These increased expenditures will occur in 2017 and beyond. If the economy returns to full employment by that time, any change in consumer expenditures would primarily represent a shift in employment among sectors. If, on the other hand, the economy still has substantial unemployment, these expenditures would contribute to employment through increased consumer demand.

d. Summary

The primary employment effects of this proposal are expected to be found throughout several key sectors: auto manufacturers, auto dealers, auto parts manufacturing, fuel production and supply, and consumers. This rule initially takes effect in model year 2017, a time period sufficiently far in the future that the current sustained high unemployment at the national level may be moderated or ended. In an economy with full employment, the primary employment effect of a rulemaking is likely to be to move employment from one sector to another, rather than to increase or decrease employment. For that reason, we focus our partial quantitative analysis on employment in the regulated sector, to examine the impacts on that sector directly. We discuss the likely direction of other impacts in the regulated sector as well as in other directly related sectors, but we do not quantify those impacts, because they are more difficult to quantify with reasonable accuracy, particularly so far into the future.

For the regulated sector, we have not quantified the demand effect. The cost effect is expected to increase employment by 600–3,600 workers in 2017 depending on the share of that employment that is in the auto manufacturing sector compared to the auto parts manufacturing sector. As mentioned above, some of these job gains may occur earlier as auto manufacturers and parts suppliers hire staff to prepare to comply with the standard. The demand effect is ambiguous and depends on changes in vehicle sales, which are not quantified for this proposal. Though we do not have estimates of the factor shift effect for all potential compliance technologies, the evidence which we do have for some technologies suggests that many of the technologies will have increased labor needs.

Effects in other sectors that are predicated on vehicle sales are also ambiguous. Changes in vehicle sales are expected to affect labor needs in auto dealerships and in parts manufacturing. Increased expenditures for auto parts are expected to require increased labor to build parts, though this effect also depends on any changes in the labor intensity of production; as noted, the subset of potential compliance technologies for which data are available show increased labor requirements. Reduced fuel production implies less employment in the petroleum sectors. Finally, consumer spending is expected to affect employment through changes in expenditures in general retail sectors; net fuel savings by consumers are expected to increase demand (and therefore employment) in other sectors.

I. Statutory and Executive Order Reviews

a. Executive Order 12866: ''Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review''

Under section 3(f)(1) of Executive Order 12866 (58 FR 51735, October 4, 1993), this action is an ''economically significant regulatory action'' because it is likely to have an annual effect on the economy of $100 million or more. Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for review under Executive Orders 12866 and 13563 (76 FR 3821, January 21, 2011) and any changes made in response to OMB recommendations have been documented in the docket for this action as required by CAA section 307(d)(4)(B)(ii).

In addition, EPA prepared an analysis of the potential costs and benefits associated with this action. This analysis is contained in the Draft Regulatory Impact Analysis, which is available in the docket for this rulemaking and at the docket internet address listed under **ADDRESSES** above.

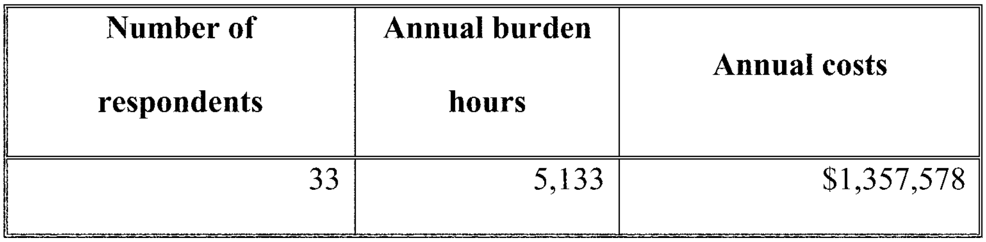
b. Paperwork Reduction Act

The information collection requirements in this proposed rule have been submitted for approval to the Office of Management and Budget (OMB) under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* The Information Collection Request (ICR) document prepared by EPA has been assigned EPA ICR number 0783.61.

The Agency proposes to collect information to ensure compliance with the provisions in this rule. This includes a variety of requirements for vehicle manufacturers. Section 208(a) of the Clean Air Act requires that vehicle manufacturers provide information the Administrator may reasonably require to determine compliance with the regulations; submission of the information is therefore mandatory. We will consider confidential all information meeting the requirements of section 208(c) of the Clean Air Act.

As shown in Table III–88, the total annual reporting burden associated with this proposal is about 5,100 hours and $1.36 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-88 Estimated Burden for Reporting and Recordkeeping Requirements



Number of respondents	Annual burden hours	Annual costs
33	5,133	$1,357,578

An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9.

To comment on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques, EPA has established a public docket for this rule, which includes this ICR, under Docket ID number EPA–HQ–OAR–2010–0799. Submit any comments related to the ICR for this proposed rule to EPA and OMB. See 'Addresses' section at the beginning of this notice for where to submit comments to EPA. Send comments to OMB at the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th Street NW., Washington, DC 20503, Attention: Desk Office for EPA. Since OMB is required to make a decision concerning the ICR between 30 and 60 days after December 1, 2011, a comment to OMB is best assured of having its full effect if OMB receives it by January 3, 2012. The final rule will respond to any OMB or public comments on the information collection requirements contained in this proposal.

c. Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of this rule on small entities, small entity is defined as: (1) A small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201 (see table below); (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.

Table III–89 provides an overview of the primary SBA small business categories included in the light-duty vehicle sector:

Table III-89 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]
Vehicle manufacturers (including small volume manufacturers)	1,000 employees	336111, 336112
Independent commercial importers	$7 million annual sales $23 million annual sales 100 employees	811111, 811112, 811198 441120 423110
Alternative Fuel Vehicle Converters	750 employees 1,000 employees $7 million annual sales	336312, 336322, 336399 335312 811198

[a] Light-duty vehicle entities that qualify as small businesses would not be subject to this proposed rule. We are proposing to exempt small business entities from the proposed standards.

[b] North American Industrial Classification System

After considering the economic impacts of today's proposal on small entities, EPA certifies that this action will not have a significant economic impact on a substantial number of small entities. As with the MY 2012–2016 GHG standards, EPA is proposing to exempt manufacturers meeting SBA's definition of small business as described in 13 CFR 121.201 due to unique issues involved with establishing appropriate GHG standards for these small businesses and the potential need to develop a program that would be structured differently for them (which would require more time), and the extremely small emissions contribution of these entities. EPA would instead consider appropriate GHG standards for these entities as part of a future regulatory action.

Potentially affected small entities fall into three distinct categories of businesses for light-duty vehicles: Small volume manufacturers (SVMs), independent commercial importers (ICIs), and alternative fuel vehicle converters. Based on our preliminary assessment, EPA has identified a total of about 21 entities that fit the Small Business Administration (SBA) criterion of a small business. There are about 4 small manufacturers, including three electric vehicle manufacturers, 8 ICIs, and 9 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 less than 0.1 percent of the total light-duty vehicle sales in the U.S., and therefore the proposed exemption will have a negligible impact on the GHG emissions reductions from the proposed standards.

As discussed in Section III.B.7, EPA is proposing to allow small businesses to waive their small entity exemption and optionally certify to the GHG standards. This would allow small entity manufacturers to earn CO_2 credits under the GHG program, if their actual fleetwide CO_2 performance was better than their fleetwide CO_2 target standard. EPA proposes to make the GHG program opt-in available starting in MY 2014, as the MY 2012, and potentially the MY 2013, certification process will have already occurred by the time this rulemaking is finalized. EPA is also proposing that manufacturers certifying to the GHG standards for MY 2014 would be eligible to generate early credits for vehicles sold in MY 2012 and MY 2013. Manufacturers waiving their small entity exemption would be required to meet all aspects of the GHG standards and program requirements across their entire product line. However, the exemption waiver would be optional for small entities and presumably manufacturers would only opt into the GHG program if it is economically advantageous for them to do so, for example through the generation and sale of CO_2 credits. Therefore, EPA believes adding this voluntary option does not affect EPA's determination that the proposed standards would impose no significant adverse impact on small entities.

Some commenters to the 2012–2016 light duty vehicle GHG rulemaking argued that EPA is obligated under the RFA to consider indirect impacts of the rules in assessing impacts on small businesses, in particular potential impacts on stationary sources that would not be directly regulated by the rule. EPA disagrees. When considering whether a rule should be certified, the RFA requires an agency to look only at the small entities to which the proposed rule will apply and which will be subject to the requirement of the specific rule in question. 5 U.S.C. 603, 605 (b); *Mid-Tex Elec. Coop.* v. *FERC,* 773 F.3d 327, 342 (DC Cir. 1985). Reading section 605 in light of section 603, we conclude that an agency may properly certify that no regulatory flexibility analysis is necessary when it determines that the rule will not have a significant economic impact on a substantial number of small entities that are subject to the requirements of the rule; see also *Cement Kiln Recycling Coalition,* v. *EPA,* 255 F.3d 855, 869 (DC Cir. 2001). DC Circuit has consistently rejected the contention that the RFA applies to small businesses indirectly affected by the regulation of other entities.[597]

Since the proposal would regulate exclusively large motor vehicle manufacturers and small vehicle manufacturers are exempted from the standards, EPA is properly certifying that the 2017–2025 standards would not have a significant economic impact on a substantial number of small entities directly subject to the rule or otherwise would have a positive economic effect on all of the small entities opting in to the rule.

We continue to be interested in the potential impacts of the proposed rule on small entities and welcome comments on issues related to such impacts.

d. Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), Public Law 104–4, establishes requirements for Federal agencies to assess the effects of their regulatory actions on State, local, and tribal governments and the private sector.

This proposal contains no Federal mandates (under the regulatory provisions of Title II of the UMRA) for State, local, or tribal governments. The rule imposes no enforceable duty on any State, local or tribal governments. This action is also not subject to the requirements of section 203 of UMRA because EPA has determined that this rule contains no regulatory requirements that might significantly or uniquely affect small governments. EPA has determined that this proposal contains a Federal mandate that may result in expenditures of $100 million or more for the private sector in any one year. EPA believes that the proposal represents the least costly, most cost-effective approach to revise the light duty vehicle standards as authorized by section 202(a)(1). See Section III.A.2.a above. The costs and benefits associated with the proposal are discussed above and in the Draft Regulatory Impact Analysis, as required by the UMRA.

e. Executive Order 13132: ''Federalism''

This proposed action would not have federalism implications. It will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. This rulemaking would apply to manufacturers of motor vehicles and not to state or local governments; state and local governments that purchase new model year 2017 and later vehicles will enjoy substantial fuel savings from these more fuel efficient vehicles. 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 and local governments in developing this action.

In the spirit of Executive Order 13132, and consistent with EPA policy to promote communications between EPA and State and local governments, EPA specifically solicits comment on this proposed action from State and local officials.

f. Executive Order 13175: ''Consultation and Coordination with Indian Tribal Governments''

This proposed rule does not have tribal implications, as specified in Executive Order 13175 (65 FR 67249, November 9, 2000). This rule will be implemented at the Federal level and impose compliance costs only on vehicle manufacturers. Tribal governments would be affected only to the extent they purchase and use regulated vehicles; tribal governments that purchase new model year 2017 and later vehicles will enjoy substantial fuel savings from these more fuel efficient vehicles. Thus, Executive Order 13175 does not apply to this rule. EPA specifically solicits additional comment on this proposed rule from tribal officials.

g. 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. Climate change impacts, and in particular the determinations of the Administrator in the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act (74 FR 66496, December 15, 2009), are summarized in Section III.F.2. In making those Findings, the Administrator placed weight on the fact that certain groups, including children, are particularly vulnerable to climate-related health effects. In those Findings, the Administrator determined that the health effects of climate change linked to observed and projected elevated concentrations of GHGs include the increased likelihood of more frequent and intense heat waves, increases in ozone concentrations over broad areas of the country, an increase of the severity of extreme weather events such as hurricanes and floods, and increasing severity of coastal storms due to rising sea levels. These effects can all increase mortality and morbidity, especially in

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[597] In any case, any impacts on stationary sources arise because of express statutory requirements in the CAA, not as a result of vehicle GHG regulation. Moreover, GHGs have become subject to regulation under the CAA by virtue of other regulatory actions taken by EPA before this proposal.

vulnerable populations such as children, the elderly, and the poor. In addition, the occurrence of wildfires in North America have increased and are likely to intensify in a warmer future. PM emissions from these wildfires can contribute to acute and chronic illnesses of the respiratory system, including pneumonia, upper respiratory diseases, asthma, and chronic obstructive pulmonary disease, especially in children.

EPA has estimated reductions in projected global mean surface temperature and sea level rise as a result of reductions in GHG emissions associated with the standards proposed in this action (Section III.F.3). Due to their vulnerability, children may receive disproportionate benefits from these reductions in temperature and the subsequent reduction of increased ozone and severity of weather events.

The public is invited to submit comments or identify peer-reviewed studies and data that assess effects of early life exposure to the pollutants addressed by this proposed rule.

h. Executive Order 13211: ''Energy Effects''

Executive Order 13211;[598] 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 proposed rule and explain why the proposed regulation is preferable to other potentially effective and reasonably feasible alternatives considered by us.

The proposed rule seeks to establish passenger car and light truck fuel economy standards that would significantly reduce the consumption of petroleum, would achieve energy security benefits, and would not have any adverse energy effects (Section III.H.7). 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. Accordingly, this proposed rulemaking action is not designated as a significant energy action as defined by E.O. 13211.

i. National Technology Transfer and 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.

For CO_2 emissions, EPA is proposing to collect data over the same tests that are used for the MY 2012–2016 CO_2 standards and for the CAFE program. This will minimize the amount of testing done by manufacturers, since manufacturers are already required to run these tests. For A/C credits, EPA is proposing to use a consensus methodology developed by the Society of Automotive Engineers (SAE) and also a new A/C test. EPA knows of no consensus standard available for the A/C test.

j. Executive Order 12898: ''Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations''

Executive Order (E.O.) 12898 (59 FR 7629 (Feb. 16, 1994)) establishes federal executive policy on environmental justice. Its main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

With respect to GHG emissions, EPA has determined that this proposed rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases the level of environmental protection for all affected populations without having any disproportionately high and adverse human health or environmental effects on any population, including any minority or low-income population. The reductions in CO_2 and other GHGs associated with the proposed standards will affect climate change projections, and EPA has estimated reductions in projected global mean surface temperatures and sea-level rise (Section III.F.3). Within settlements experiencing climate change, certain parts of the population may be especially vulnerable; these include the poor, the elderly, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or a few resources.[599] Therefore, these populations may receive disproportionate benefits from reductions in GHGs.

For non-GHG co-pollutants such as ozone, $PM_{2.5}$, and toxics, EPA has concluded that it is not practicable to determine whether there would be disproportionately high and adverse human health or environmental effects on minority and/or low income populations from this proposed rule.

J. Statutory Provisions and Legal Authority

Statutory authority for the vehicle controls proposed today is found in section 202(a) (which authorizes standards for emissions of pollutants from new motor vehicles which emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare), 202(d), 203–209, 216, and 301 of the Clean Air Act, 42 U.S.C. 7521(a), 7521(d), 7522, 7523, 7524, 7525, 7541, 7542, 7543, 7550, and 7601. Statutory authority for EPA to establish CAFE test procedures is found in section 32904(c) of the Energy Policy and Conservation Act, 49 U.S.C. section 32904(c).

IV. NHTSA Proposed Rule for Passenger Car and Light Truck CAFE Standards for Model Years 2017–2025

A. Executive Overview of NHTSA Proposed Rule

1. Introduction

The National Highway Traffic Safety Administration (NHTSA) is proposing Corporate Average Fuel Economy (CAFE) standards for passenger automobiles (passenger cars) and nonpassenger automobiles (light trucks) for model years (MY) 2017–2025. NHTSA's proposed CAFE standards would require passenger cars and light trucks to meet an estimated combined average of 49.6 mpg in MY 2025. This represents an average annual increase of

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[598] 66 FR 28355 (May 18, 2001).

[599] U.S. EPA. (2009). Technical Support Document for Endangerment or Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act. Washington, DC: U.S. EPA. Retrieved on April 21, 2009 from *http://epa.gov/climatechange/endangerment/downloads/TSD_Endangerment.pdf.*

4 percent from the estimated 34.4 mpg combined fuel economy level expected in MY 2016. Due to these proposed standards, we project total fuel savings of approximately 173 billion gallons over the lifetimes of the vehicles sold in model years 2017–2025, with corresponding net societal benefits of over $358 billion using a 3 percent discount rate,[600] or $262 billion using a 7 percent discount rate.

While NHTSA has been setting fuel economy standards since the 1970s, as discussed in Section I, NHTSA's proposed MYs 2017–2025 CAFE standards are part of a National Program made up of complementary regulations by NHTSA and the Environmental Protection Agency. Today's proposed standards build upon the success of the first phase of the National Program, finalized on May 7, 2010, in which NHTSA and EPA set coordinated CAFE and greenhouse gas (GHG) standards for MYs 2012–2016 passenger cars and light trucks. Because of the very close relationship between improving fuel economy and reducing carbon dioxide (CO_2) tailpipe emissions, a large majority of the projected benefits are achieved jointly with EPA's GHG rule, described in detail above in Section III of this preamble. These proposed CAFE standards are consistent with the President's National Fuel Efficiency Policy announcement of May 19, 2009, which 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 proposed CAFE standards and the analysis supporting them also respond to President's Obama's May 2010 memorandum requesting the agencies to develop, through notice and comment rulemaking, a coordinated National Program for passenger cars and light trucks for MYs 2017 to 2025.

2. Why does NHTSA set CAFE standards for passenger cars and light trucks?

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.[601] 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 due to the combustion of petroleum is one of the largest sources of U.S. CO_2 emissions.[602] Using vehicle technology to improve fuel economy, and thereby reducing tailpipe emissions of CO_2, is one of the three main measures for reducing those tailpipe emissions of CO_2.[603] 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.

Reducing Petroleum Consumption To Improve Energy Security and Save the U.S. Money

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. The need to reduce energy consumption is even more crucial today than it was when EPCA was enacted. U.S. energy consumption has been outstripping U.S. energy production at an increasing rate. Improving our energy and national 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 accounted for approximately 51 percent of U.S. petroleum consumption in 2009.[604] World crude oil production is highly concentrated, exacerbating the risks of supply disruptions and price shocks as the recent unrest in North Africa and the Persian Gulf highlights. The export of U.S. assets for oil imports continues to be an important component of U.S. trade deficits. Transportation accounted for about 71 percent of U.S. petroleum consumption in 2009.[605] 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.

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. Recent tight

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[600] 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 2011 Reference Case, a 3 percent and a 7 percent discount rate, a 10 percent rebound effect, a value for the social cost of carbon (SCC) of $22/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.

[601] 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 Sept. 24, 2011).

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 Sept. 24, 2011).

Alliance to Save Energy *et al.,* ''Reducing the Cost of Addressing Climate Change Through Energy Efficiency'' (2009), available at: *http://www.aceee.org/files/pdf/white-paper/ReducingtheCostofAddressingClimateChange_synopsis.pdf* (last accessed Sept. 24, 2011).

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/sites/default/files/5301_Globalwarmingontheroad_0.pdf* (last accessed Sept. 24, 2011).

''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 Sept. 24, 2011);

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 Sept. 24, 2011).

[602] EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2008 (April 2010), pp. ES–5, ES–8, and 2–17. Available at *http://www.epa.gov/climatechange/emissions/usgginv_archive.html* (last accessed Sept. 25, 2011).

[603] 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 Sept. 24, 2011).

[604] Energy Information Administration, ''How dependent are we on foreign oil?'' *Available at http://www.eia.gov/energy_in_brief/foreign_oil_dependence.cfm* (last accessed August 28, 2011).

[605] Energy Information Administration, Annual Energy Outlook 2011, ''Oil/Liquids.'' *Available at http://www.eia.gov/forecasts/aeo/MT_liquid fuels.cfm* (last accessed August 28, 2011).

global oil markets led to prices over $100 per barrel, with gasoline reaching as high as $4 per gallon in many parts of the U.S., causing financial hardship for many families and businesses. This fiscal distress can, in some cases, have macroeconomic consequences for the economy at large.

Additionally, since U.S. oil production is only affected by fluctuations in prices over a period of years, any changes in petroleum consumption (as through increased fuel economy levels for the on-road fleet) largely flow into changes in the quantity of imports. Since petroleum imports account for about 2 percent of GDP, increases in oil imports can create a discernible fiscal drag. As a consequence, measures that reduce petroleum consumption, like fuel economy standards, will directly benefit the balance-of-payments account, and strengthen the U.S. economy to some degree. And finally, U.S. foreign policy has been affected by decades by rising U.S. and world dependency on crude oil as the basis for modern transportation systems, although fuel economy standards have at best an indirect impact on U.S. foreign policy.

Reducing Petroleum Consumption To Reduce Climate Change Impacts

CO_2 is the natural by-product of the combustion of fuel to power motor vehicles. The more fuel-efficient a vehicle is, the less fuel it needs to burn to travel a given distance. The less fuel it burns, the less CO_2 it emits in traveling that distance.[606] 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 closely related to the amount of CO_2 emissions per mile. Motor vehicles are the second largest GHG-emitting sector in the U.S. after electricity generation, and accounted for 27 percent of total U.S. GHG emissions in 2008.[607] 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, and in NHTSA's draft Environmental Impact Statement (DEIS) accompanying these proposed standards.

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 of CO_2 emissions. In December 2007, Congress enacted the Energy Independence and Security Act (EISA), amending EPCA to require substantial, continuing increases in fuel economy. NHTSA thus sets CAFE standards today under EPCA, as amended by EISA, in order to help the U.S. passenger car and light truck fleet save fuel to promote energy independence, energy security, and a low carbon economy.

3. Why is NHTSA proposing CAFE standards for MYs 2017–2025 now?

a. President's Memorandum

During the public comment period for the MY 2012–2016 proposed rulemaking, many stakeholders encouraged NHTSA and EPA to begin working toward standards for MY 2017 and beyond in order to maintain a single nationwide program. After the publication of the final rule establishing MYs 2012–2016 CAFE and GHG standards, President Obama issued a Memorandum on May 21, 2010 requesting that NHTSA, on behalf of the Department of Transportation, and EPA work together to develop a national program for model years 2017–2025.[608] Specifically, he requested that the agencies develop *''* * * a coordinated national program under the CAA [Clean Air Act] and the EISA [Energy Independence and Security Act of 2007] to improve fuel efficiency and to reduce greenhouse gas emissions of passenger cars and light-duty trucks of model years 2017–2025.''* The President recognized that our country could take a leadership role in addressing the global challenges of improving energy security and reducing greenhouse gas pollution, stating that *''America has the opportunity to lead the world in the development of a new generation of clean cars and trucks through innovative technologies and manufacturing that will spur economic growth and create high-quality domestic jobs, enhance our energy security, and improve our environment.''*

The Presidential Memorandum stated *''The program should also seek to achieve substantial annual progress in reducing transportation sector greenhouse gas emissions and fossil fuel consumption, consistent with my Administration's overall energy and climate security goals, through the increased domestic production and use of existing, advanced, and emerging technologies, and should strengthen the industry and enhance job creation in the United States.''* Among other things, the agencies were tasked with researching and then developing standards for MYs 2017 through 2025 that would be appropriate and consistent with EPA's and NHTSA's respective statutory authorities, in order to continue to guide the automotive sector along the road to reducing its fuel consumption and GHG emissions, thereby ensuring corresponding energy security and environmental benefits. Several major automobile manufacturers and CARB sent letters to EPA and NHTSA in support of a MYs 2017 to 2025 rulemaking initiative as outlined in the President's May 21, 2010 announcement.[609] The agencies began working immediately on the next phase of the National Program, work which has culminated in the standards proposed in this notice for MYs 2017–2025.

b. Benefits of Continuing 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 close one. In the real world, there is a single pool of technologies for reducing fuel consumption and CO_2 emissions. Using these 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 that are produced by imperfect combustion of fuel (*e.g.,* carbon monoxide), there are at present no such technologies for CO_2. In fact, the only way at present to reduce tailpipe emissions of CO_2 is by reducing

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[606] 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. *Available at http://www.nap.edu/catalog.php?record_id=1605* (last accessed Sept. 25, 2011).

[607] EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2008 (April 2010), p. 2–17. Available at *http://www.epa.gov/climatechange/emissions/usgginv_archive.html* (last accessed Sept. 25, 2011).

[608] The Presidential Memorandum is found at: *http://www.whitehouse.gov/the-press-office/presidential-memorandum-regarding-fuel-efficiency-standards.* For the reader's reference, the President also requested the Administrators of EPA and NHTSA to issue joint rules under the CAA and EISA to establish fuel efficiency and greenhouse gas emissions standards for commercial medium-and heavy-duty on-highway vehicles and work trucks beginning with the 2014 model year. The agencies recently promulgated final GHG and fuel efficiency standards for heavy duty vehicles and engines for MYs 2014–2018. 76 FR 57106 (September 15, 2011).

[609] These commitment letters in response to the May 21, 2010 Presidential Memorandum are available at *http://www.epa.gov/otaq/climate/proposedregs.htm#cl*; and *http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/Stakeholder+Commitment+Letters* (last accessed August 28, 2011).

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.

Additionally, by setting harmonized Federal standards to regulate both fuel economy and greenhouse gas emissions, the agencies are able to provide a predictable regulatory framework for the automotive industry while preserving the legal authorities of NHTSA, EPA, and the State of California. Consistent, harmonized, and streamlined requirements under the National Program, both for MYs 2012–2016 and for MYs 2017–2025, hold out the promise of continuing to deliver energy and environmental 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 ''Section 177'' states to act in a unified fashion in providing these benefits. A harmonized approach to regulating passenger car and light truck fuel economy and GHG emissions is critically important given the interdependent goals of addressing climate change and ensuring energy independence and security. Additionally, a harmonized approach would help to mitigate the cost to manufacturers of having to comply with multiple sets of Federal and State standards.

One aspect of this phase of the National Program that is unique for NHTSA, however, is that the passenger car and light truck CAFE standards for MYs 2022–2025 must be conditional, while EPA's standards for those model years will be legally binding when adopted in this round. EISA requires NHTSA to issue CAFE standards for ''at least 1, but not more than 5, model years.'' [610] To maintain the harmonization benefits of the National Program, NHTSA will therefore propose and adopt standards for all 9 model years from 2017–2025, but the last 4 years of standards will not be legally binding as part of this rulemaking. The passenger car and light truck CAFE standards for MYs 2022–2025 will be determined with finality in a subsequent, *de novo* notice and comment rulemaking conducted in full compliance with EPCA/EISA and other applicable law—beyond simply reviewing the analysis and findings in the present rulemaking to see whether they are still accurate and applicable, and taking a fresh look at all relevant factors based on the best and most current information available at that future time.

To facilitate that future effort, NHTSA and EPA will conduct a comprehensive mid-term evaluation. Up to date information will be developed and compiled for the evaluation, through a collaborative, robust, and transparent process, including notice and comment. The agencies fully expect to conduct the mid-term evaluation in close coordination with the California Air Resources Board (CARB), consistent with the agencies' commitment to maintaining a single national framework for regulation of fuel economy and GHG emissions.[611] Prior to beginning NHTSA's rulemaking process and EPA's mid-term evaluation, the agencies will jointly prepare a draft Technical Assessment Report (TAR) to examine afresh the issues and, in doing so, conduct similar analyses and projections as those considered in the current rulemaking, including technical and other analyses and projections relevant to each agency's authority to set standards as well as any relevant new issues that may present themselves. The agencies will provide an opportunity for public comment on the draft TAR, and appropriate peer review will be performed of underlying analyses in the TAR. The assumptions and modeling underlying the TAR will be available to the public, to the extent consistent with law. The draft TAR is expected to be issued no later than November 15, 2017. After the draft TAR and public comment, the agencies will consult and coordinate as NHTSA develops its NPRM. NHTSA will ensure that the subsequent final rule will be timed to provide sufficient lead time for industry to make whatever changes to their products that the rulemaking analysis deems maximum feasible based on the new information available. At the very latest, NHTSA will complete its subsequent rulemaking on the standards with at least 18 months lead time as required by EPCA,[612] but additional lead time may be provided.

B. Background

1. Chronology of Events Since the MY 2012–2016 Final Rule Was Issued

Section I above covers the chronology of events in considerable detail, and we refer the reader there.

2. How has NHTSA developed the proposed CAFE standards since the President's announcement?

The CAFE standards proposed in this NPRM are based on much more analysis conducted by the agencies since July 29, including in-depth modeling analysis by DOT/NHTSA to support the proposed CAFE standards, and further refinement of a number of our baseline, technology, and economic assumptions used to evaluate the proposed standards and their impacts. This NPRM, the draft joint TSD, and NHTSA's PRIA and EPA's DRIA contain much more information about the analysis underlying these proposed standards. The following sections provide the basis for NHTSA's proposed passenger car and light truck CAFE standards for MYs 2017–2025, the standards themselves, the estimated impacts of the proposed standards, and much more information about the CAFE program relevant to the 2017–2025 timeframe.

C. Development and Feasibility of the Proposed Standards

1. How was the baseline 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. The agencies then developed a ''reference'' fleet, projecting the baseline fleet sales into MYs 2017–2025 and accounting for the effect that the MY 2012–2016 CAFE standards have on the baseline fleet.[613] This

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[610] 49 U.S.C. 32902(b)(3)(B).

[611] The agencies also fully expect that any adjustments to the standards as a result of the mid-term evaluation process from the levels enumerated in the current rulemaking will be made with the participation of CARB and in a manner that continues the harmonization of state and Federal vehicle standards.

[612] 49 U.S.C. 32902(a).

[613] In order to calculate the impacts of the proposed future GHG and CAFE standards, it is necessary to estimate the composition of the future vehicle fleet absent those proposed standards in order to conduct comparisons. The first step in this process was to develop a fleet based on model year 2008 data. This 2008-based fleet includes vehicle sales volumes, GHG/fuel economy performance, and contains a listing of the base technologies on every 2008 vehicle sold. The second step was to

reference fleet is then used for comparisons of technologies' incremental cost and effectiveness, as well as for other relevant comparisons in the rule.

b. What data did the agencies use to construct the baseline, and how did they do so?

As explained in the draft joint TSD, 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 compliance ratings, engine sizes, numbers of cylinders, and transmission types.

For this NPRM, NHTSA and EPA chose again to use MY 2008 vehicle data as the basis of the baseline fleet. MY 2008 is now the most recent model year for which the industry had what the agencies would consider to be ''normal'' sales. Complete MY 2009 data is now available for the industry, but the agencies believe that the model year was disrupted by the economic downturn and the bankruptcies of both General Motors and Chrysler. CAFE compliance data shows that there was a significant reduction in the number of vehicles sold by both companies and by the industry as a whole. These abnormalities led the agencies to conclude that MY 2009 data was likely not representative for projecting the future fleet for purposes of this analysis. While MY 2010 data is likely more representative for projecting the future fleet, it was not complete and available in time for it to be used for the NPRM analysis. Therefore, for purposes of the NPRM analysis, NHTSA and EPA chose to use MY 2008 CAFE compliance data for the baseline since it was the latest, most representative transparent data set that we had available. However, the agencies plan to use the MY 2010 data, if available, to develop an updated market forecast for use in the final rule. If and when the MY 2010 data becomes available, NHTSA will place a copy of this data into its rulemaking docket.

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. NHTSA also reviewed information from manufacturers' confidential product plans submitted to the agency, but did not rely on that information for developing the baseline or reference fleets.

After the baseline was created the next step was to project the sales volumes for 2017–2025 model years. EPA used projected car and truck volumes for this period from Energy Information Administration's (EIA's) 2011 Interim Annual Energy Outlook (AEO).[614] 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 2017–2025.[615] This provided the year-by-year percentages of cars and trucks sold by each manufacturer as well as the percentages of each vehicle segment. 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 2017–2025 baseline vehicle fleet are presented in detail in Chapter 1 of the Joint Technical Support Document accompanying today's proposed rule.

The agencies assume that without adoption of the proposed rule, that during the 2017–2025 period, manufacturers will not improve fuel economy levels beyond the levels required in the MY 2016 standards. However, it is possible that manufacturers may be driven by market forces to raise the fuel economy of their fleets. The recently-adopted fuel economy and environment labels (''window stickers''), for example, may make consumers more aware of the benefits of higher fuel economy, and may cause them to demand more fuel-efficient vehicles during that timeframe. Moreover, the agencies' analysis indicates that some fuel-saving technologies may save money for manufacturers. In Chapter X of the PRIA, NHTSA examines the impact of an alternative ''market-driven'' baseline, which allows for some increases in fuel economy due to ''voluntary overcompliance'' beyond the MY 2016 levels. NHTSA seeks comment on what assumptions about fuel economy increases are most likely to accurately predict what would happen in the absence of the proposed rule.

NHTSA invites comment on the process used to develop the market forecast, and on whether the agencies should consider alternative approaches to producing a forecast at the level of detail we need for modeling. If commenters wish to offer alternatives, we ask that they address how manufacturers' future fleets would be

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project that 2008-based fleet volume into MYs 2017–2025. This is called the reference fleet, and it represents the fleet volumes (but, until later steps, not levels of technology) that the NHTSA and EPA expect would exist in MYs 2017–2025 absent any change due to regulation in 2017–2025.

After determining the reference fleet, a third step is needed to account for technologies (and corresponding increases in cost and reductions in fuel consumption and CO_2 emissions) that could be added to MY 2008-technology vehicles in the future, taking into previously-promulgated standards, and assuming MY 2016 standards are extended through MY2025. NHTSA accomplished this by using the CAFE model to add technologies to that MY 2008-based market forecast such that each manufacturer's car and truck CAFE and average CO_2 levels reflect baseline standards. The model's output, the reference case (or adjusted baseline, or no-action alternative), is the light-duty fleet estimated to exist in MYs 2017–2025 without new GHG/CAFE standards covering MYs 2017–2025.

[614] Department of Energy, Energy Information Administration, Annual Energy Outlook (AEO) 2011, Early Release. *Available at http://www.eia.gov/forecasts/aeo/.* 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. The agencies used the early release version of AEO 2011 and confirmed later that changes reflected in the final version were insignificant with respect to the relative volumes of passenger cars and light trucks.

[615] The agencies explain in Chapter I of the draft Joint TSD why data from CSM was chosen for creating the baseline for this rulemaking.

defined in terms of specific products, and the sales volumes and technical characteristics (*e.g.,* fuel economy, technology content, vehicle weight, and other engineering characteristics) of those products. The agency also invites comment regarding what sensitivity analyses—if any—we should do related to the market forecast. For example, should the agency evaluate the extent to which its analysis is sensitive to projections of the size of the market, manufacturers' respective market shares, the relative growth of different market segments, and or the relative growth of the passenger car and light truck markets? If so, how would commenters suggest that we do that?

c. How is the development of the baseline fleet for this rule different from the baseline fleet that NHTSA used for the MY 2012–2016 (May 2010) final rule?

The development of the baseline fleet for this rulemaking utilizes the same procedures used in the development of the baseline fleet for the MY 2012–2016 rulemaking. Compared to that rulemaking, the change in the baseline is much less dramatic—the MY 2012–2016 rulemaking was the first rulemaking in which NHTSA did not use manufacturer product plan data to develop the baseline fleet,[616] so evaluating the difference between the baseline fleet used in the MY 2011 final rule and in the MY 2012–2016 rulemaking was informative at that time regarding some of the major impacts of that switch. In this proposal, we are using basically the same MY 2008 based file as the starting point in the MY 2012–2016 analysis, and simply using an updated AEO forecast and an updated CSM forecast. Of those, most differences are in input assumptions rather than the basic approach and methodology. These include changes in various macroeconomic assumptions underlying the AEO and CSM forecasts and the use of results obtained by using DOE's National Energy Modeling System (NEMS) to repeat the AEO 2011 analysis without forcing increased passenger car volumes, and without assuming post-MY 2016 increases in the stringency of CAFE standards.[617]

Another change in the baseline fleet from the last rulemaking involved our redefinition of the list of manufacturers to account for realignment and ownership changes taking place within the industry. The reported results supporting this rulemaking recognize that Volvo vehicles are no longer a part of Ford, but are reported as a separate company, Geely; that Saab vehicles are no longer part of GM, but are reported as part of Spyker which purchased Saab from GM in 2010; and that Chrysler, along with Ferrari and Maserati, are reported as Fiat.

In addition, low volume specialty manufacturers omitted from the analysis supporting the MY 2012–2016 rulemaking have been included in the analysis supporting this rulemaking. These include Aston Martin, Lotus, and Tesla.

d. How is this baseline different quantitatively from the baseline that NHTSA used for the MY 2012–2016 (May 2010) final rule?

As discussed above, the current baseline was developed from adjusted MY 2008 compliance data and covers MY 2017–2025. This section describes, for the reader's comparison, some of the differences between the current baseline and the MY 2012–2016 CAFE rule baseline. This comparison provides a basis for understanding general characteristics and measures of the difference between the two baselines. The current baseline, while developed using the same methods as the baseline used for MY 2012–2016 rulemaking, reflects updates to the underlying commercially-available forecast of manufacturer and market segment shares of the future passenger car and light truck market. Again, the differences are in input assumptions rather than the basic approach and methodology. It also includes changes in various macroeconomic assumptions underlying the AEO forecasts and the use of the AEO Unforced Reference Case. Another change in the market input data from the last rulemaking involved our redefinition of the list of manufacturers to account for realignment taking place within the industry.

Estimated vehicle sales:

The sales forecasts, based on the Energy Information Administration's (EIA's) Early Annual Energy Outlook for 2011 (Interim AEO 2011), used in the current baseline indicate that the total number of light vehicles expected to be sold during MYs 2012–2016 is 79 million, or about 15.8 million vehicles annually. NHTSA's MY 2012–2016 final rule forecast, based on AEO 2010, of the total number of light vehicles likely to be sold during MY 2012 through MY 2016 was 80 million, or about 16 million vehicles annually. Light trucks are expected to make up 37 percent of the MY 2016 baseline market forecast in the current baseline, compared to 34 percent of the baseline market forecast in the MY 2012–2016 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, changes in AEO's forecast of future fuel prices, and use of the Unforced Reference Case.

Estimated manufacturer market shares:

These changes are reflected below in Table IV–1, which shows the agency's sales forecasts for passenger cars and light trucks under the current baseline and the MY 2012–2016 final rule. There has been a general decrease in MY 2016 forecast overall sales (from AEO) and for all manufacturers (reflecting CSM's forecast of manufacturers' market shares), with the exception of Chrysler, when the current baseline is compared to that used in the MY 2012–2016 rulemaking. There were no significant shifts in manufacturers' market shares between the two baselines. The effect of including the low volume specialty manufacturers and accounting for known corporate realignments in the current baseline appear to be negligible. For individual manufacturers, there have been shifts in the shares of passenger car and light trucks, as would

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[616] The agencies' reasons for not relying on product plan data for the development of the baseline fleet were discussed in the Regulatory Impact Analysis for the MYs 2012–2016 rulemaking and at 74 FR 49487–89. 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 currently concludes, as it did in the course of that prior rulemaking, that the advantages outweigh the disadvantages. Commenters generally supported the more transparent approach employed in the MYs 2012–2016 rulemaking.

[617] Similar to the analyses supporting the MYs 2012–2016 rulemaking, the agencies have used the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) to estimate the future relative market shares of passenger cars and light trucks. However, NEMS methodology includes shifting vehicle sales volume, starting after 2007, away from fleets with lower fuel economy (the light-truck fleet) towards vehicles with higher fuel economies (the passenger car fleet) in order to facilitate compliance with CAFE and GHG MYs 2012–2016 standards. Because we use our market projection as a baseline relative to which we measure the effects of new standards, and we attempt to estimate the industry's ability to comply with new standards without changing product mix, the Interim AEO 2011-projected shift in passenger car market share as a result of required fuel economy improvements creates a circularity. Therefore, for the current analysis, the agencies developed a new projection of passenger car and light truck sales shares by running scenarios from the Interim AEO 2011 reference case that first deactivate the above-mentioned sales-volume shifting methodology and then hold post-2017 CAFE standards constant at MY 2016 levels. Incorporating these changes reduced the projected passenger car share of the light vehicle market by an average of about 5 percent during 2017–2025. NHTSA and EPA refer to this as the ''Unforced Reference Case.''

be expected given that the agency is relying on different underlying assumptions as discussed above and in Chapter 1 of the joint TSD.

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[618] Again, Aston Martin, Alfa Romeo, Ferrari, Maserati, Lotus and Tesla were not included in the baseline of the MY 2012–2016 rulemaking; Volvo vehicles were reported under Ford and Saab vehicles were reported under GM; and Chrysler was reported as a separate company whereas now it is reported as part of Fiat and includes Alfa Romeo, Ferrari, and Maserati.

Table IV-1. Sales Forecasts [Production for U.S. sale in MY 2016, thousand units]

Manufacturer	MY 2012-2016 Final Rule[618]		Current Baseline	
	Passenger	Nonpassenger	Passenger	Nonpassenger
Aston Martin			1	
BMW	423	171	383	184
Daimler	271	126	245	136
Fiat/Chrysler	400	462	392	498
Ford	1,559	911	1,393	930
Geely/Volvo			94	50
General Motors	1,514	1,342	1,391	1,444
Honda	930	545	862	588
Hyundai	518	92	489	99
Kia	548	115	512	124
Lotus			0.3	
Mazda	420	72	393	78
Mitsubishi	83	55	80	60
Nissan	946	381	869	410
Porsche	33	17	30	18
Spyker/Saab			18	2
Subaru	207	117	236	74
Suzuki	103	20	94	21
Tata	65	42	59	46
Tesla			27	
Toyota	2,226	1,077	2,043	1,159
Volkswagen	583	124	528	134
Total	10,832	5,669	10,139	6,055

Estimated achieved fuel economy levels:

The current baseline market forecast shows industry-wide average fuel economy levels somewhat lower in MY 2016 than shown in the baseline market forecast for the MY 2012–2016 rulemaking. Under the current baseline, average fuel economy for MY 2016 is 27.0 mpg, versus 27.3 mpg under the baseline in the MY 2012–2016 rulemaking. The 0.3 mpg change relative to the MY 2012–2016 rulemaking's baseline is the result of changes in the shares of passenger car and light trucks in the MY 2016 market as noted above—more light trucks generally equals lower average fuel economy—and not the result of changes in the capabilities of the car and truck fleets.

These differences are shown in greater detail below in Table IV–2, which shows manufacturer-specific CAFE levels (not counting FFV credits that some manufacturers expect to earn) from the current baseline versus the MY 2012–2016 rulemaking baseline for passenger cars and light trucks. Table IV–3 shows the combined averages of these planned CAFE levels in the respective baseline fleets. These tables demonstrate that there are no significant differences in CAFE for either passenger cars or light trucks at the manufacturer level between the current baseline and the MY 2012–2016 rulemaking baseline. The differences become more significant at the manufacturer level when combined CAFE levels are considered. Here we see a general decline in CAFE at the manufacturer level due to the increased share of light trucks. Because the agencies have, as for the MY 2012–2016 rulemaking, based this market forecast on vehicles in the MY 2008 fleet, these changes in CAFE levels reflect changes in vehicle mix, not changes in the fuel economy achieved by individual vehicle models.

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Table IV-2. Current Baseline CAFE Levels in MY 2016 versus MY 2012-2016 Rulemaking CAFE Levels

Manufacturer	MY 2012-2016 Final Rule[619]		Current Baseline	
	Passenger	Non passenger	Passenger	Non passenger
Aston Martin			18.83	
BMW	27.19	23.04	27.19	23.03
Daimler	25.25	21.12	25.50	21.13
Fiat/Chrysler	28.69	22.19	27.74	22.19
Ford	28.14	21.31	28.24	21.32
Geely/Volvo			25.89	21.08
General Motors	28.42	21.45	28.38	21.45
Honda	33.98	25.05	33.83	25.02
Hyundai	32.02	24.30	31.74	24.29
Kia	32.98	23.74	32.70	23.74
Lotus			29.66	
Mazda	30.94	26.41	30.77	26.40
Mitsubishi	28.94	23.59	28.86	23.57
Nissan	32.04	22.11	31.98	22.10
Porsche	26.22	19.98	26.22	19.98
Spyker/Saab			26.54	19.79
Subaru	29.44	26.91	29.59	27.37
Suzuki	30.84	23.29	30.77	23.29
Tata	24.58	19.74	24.58	19.71
Tesla			244.00	
Toyota	35.33	24.25	35.22	24.26
Volkswagen	28.99	20.23	28.90	20.24
Total/Average	30.73	22.59	30.65	22.56

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[619] Again, Aston Martin, Alfa Romeo, Ferrari, Maserati, Lotus and Tesla were not included in the baseline of the MY 2012–2016 rulemaking; Volvo vehicles were reported under Ford and Saab vehicles were reported under GM; and Chrysler was reported as a separate company whereas now it is reported as part of Fiat and includes Alfa Romeo, Ferrari, and Maserati.

Table IV-3. Current Baseline CAFE Levels in MY 2016 versus MY 2012-2016 Rulemaking

CAFE Levels (Combined)

Manufacturer	MY 2012-2016 Final Rule[620]	Current Baseline
Aston Martin		18.83
BMW	25.85	25.68
Daimler	23.77	23.75
Fiat/Chrysler	24.79	24.33
Ford	25.17	24.99
Geely/Volvo		23.99
General Motors	24.66	24.37
Honda	30.03	29.61
Hyundai	30.56	30.18
Kia	30.89	30.46
Lotus		29.66
Mazda	30.18	29.95
Mitsubishi	26.53	26.33
Nissan	28.38	27.97
Porsche	23.74	23.48
Spyker/Saab		25.70
Subaru	28.47	29.03
Suzuki	29.30	29.04
Tata	22.42	22.19
Tesla		244.00
Toyota	30.75	30.27
Volkswagen	26.94	26.60
Total/Average	27.34	27.03

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e. How does manufacturer product plan data factor into the baseline used in this rule?

In December 2010, NHTSA requested that manufacturers provide information regarding future product plans, as well as information regarding the context for those plans (*e.g.,* estimates of future fuel prices), and estimates of the future availability, cost, and efficacy of fuel-saving technologies.[621] The purpose of this request was to acquire updated information regarding vehicle manufacturers' future product plans to assist the agency in assessing what corporate CAFE standards should be established for passenger cars and light trucks manufactured in model years 2017 and beyond. The request was being issued in preparation for today's joint NPRM.

NHTSA indicated that it requested information for MYs 2010–2025 primarily as a basis for subsequent discussions with individual manufacturers regarding their capabilities for the MYs 2017–2025 time frame as it worked to develop today's NPRM. NHTSA indicated that the information received would supplement other information to be used by NHTSA to develop a realistic forecast of the vehicle market in MY 2017 and beyond, and to evaluate what technologies may feasibly be applied by manufacturers to

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[620] Again, Aston Martin, Alfa Romeo, Ferrari, Maserati, Lotus and Tesla were not included in the baseline of the MY 2012–2016 rulemaking; Volvo vehicles were reported under Ford and Saab vehicles were reported under GM; and Chrysler was reported as a separate company whereas now it is reported as part of Fiat and includes Alfa Romeo, Ferrari, and Maserati.

[621] 75 FR 80430.

achieve compliance with potential future standards. NHTSA further indicated that information regarding later model years could help the agency gain a better understanding of how manufacturers' plans through MY 2025 relate to their longer-term expectations regarding foreseeable regulatory requirements, market trends, and prospects for more advanced technologies.

NHTSA also indicated that it would consider information regarding the model years requested when considering manufacturers' planned schedules for redesigning and freshening their products, in order to examine how manufacturers anticipate tying technology introduction to product design schedules. In addition, the agency requested information regarding manufacturers' estimates of the future vehicle population, and fuel economy improvements and incremental costs attributed to technologies reflected in those plans.

Given the importance that responses to this request for comment may have in informing NHTSA's proposed CAFE rulemaking, whether as part of the basis for the standards or as an independent check on them, NHTSA requested that commenters fully respond to each question, particularly by providing information regarding the basis for technology costs and effectiveness estimates.

We have already noted that in past CAFE rulemakings, NHTSA used manufacturers' product plans—and other information—to build market forecasts providing the foundation for the agency's rulemaking analysis. This issue has been the subject of much debate over the past several rulemakings since NHTSA began actively working on CAFE again following the lifting of the appropriations riders in 2001. The agency continues to believe that these market forecasts reflected the most technically sound forecasts the agency could have then developed for this purpose. Because the agency could not disclose confidential business information in manufacturers' product plans, NHTSA provided summarized information, such as planned CAFE levels and technology application rates, rather than the fuel economy levels and technology content of specific vehicle model types.

In preparing the MY 2012–2016 rule jointly with EPA, however, NHTSA revisited this practice, and concluded that for that rulemaking, it was important that all reviewers have equal access to all details of NHTSA's analysis. NHTSA provided this level of transparency by releasing not only the agency's CAFE modeling system, but also by releasing all model inputs and outputs for the agency's analysis, all of which are available on NHTSA's Web site at *http://www.nhtsa.gov/fuel-economy*. Therefore, NHTSA worked with EPA, as it did in preparing for analysis supporting today's proposal, to build a market forecast based on publicly- and commercially-available sources. NHTSA continues to believe that the potential technical benefits of relying on manufacturers' plans for future products are outweighed by the transparency gained in building a market forecast that does not rely on confidential business information, but also continues to find product plan information to be an important point of reference for meetings with individual manufacturers. We seek comment on what value manufacturer product plan might have in the future, and whether it continues to be useful to request manufacturer product plans to inform rulemaking analyses, specifically the baseline forecast used in rulemaking analyses.

f. What sensitivity analyses is NHTSA conducting on the baseline?

As discussed below in Section IV.G, when evaluating the potential impacts of new CAFE standards, NHTSA considered the potential that, depending on how the cost and effectiveness of available technologies compare to the price of fuel, manufacturers would add more fuel-saving technology than might be required solely for purposes of complying with CAFE standards. This reflects that agency's consideration that there could, in the future, be at least *some* market for fuel economy improvements beyond the required MY 2016 CAFE levels. In this sensitivity analysis, this causes some additional technology to be applied, more so under baseline standards than under the more stringent standards proposed today by the agency. Results of this sensitivity analysis are summarized in Section IV.G and in NHTSA's PRIA accompanying today's notice.

g. How else is NHTSA considering looking at the baseline for the final rule?

Beyond the sensitivity analysis discussed above, NHTSA is also considering developing and using a vehicle choice model to estimate the extent to which sales volumes would shift in response to changes in vehicle prices and fuel economy levels. As discussed IV.C.4, the agency is currently sponsoring research directed toward developing such a model. If that effort is successful, the agency will consider integrating the model into the CAFE modeling system and using the integrated system for future analysis of potential CAFE standards. If the agency does so, we expect that the vehicle choice model would impact estimated fleet composition not just under new CAFE standards, but also under baseline CAFE standards.

2. How were the technology inputs developed?

As discussed above in Section II.E, for developing the technology inputs for these proposed MYs 2017–2025 CAFE and GHG standards, the agencies primarily began with the technology inputs used in the MYs 2012–2016 CAFE final rule and in the 2010 TAR. The agencies have also updated information based on newly completed FEV tear down studies and new vehicle simulation work conducted by Ricardo Engineering, both of which were contracted by EPA. Additionally, the agencies relied on a model developed by Argonne National Laboratory to estimate hybrid, plug-in hybrid and electric vehicle battery costs. More detail is available regarding how the agencies developed the technology inputs for this proposal above in Section II.E, in Chapter 3 of the Joint TSD, and in Section V of NHTSA's PRIA.

a. What technologies does NHTSA consider?

Section *II.E.*1 above describes the fuel-saving technologies considered by the agencies that manufacturers could use to improve the fuel economy of their vehicles during MYs 2017–2025. Many 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, added for this rulemaking analysis, are considered that are not currently in production, but are beyond the initial research phase, under development and are expected to be in production in the next 5–10 years. As discussed, the technologies considered fall into five broad categories: engine technologies, transmission technologies, vehicle technologies, electrification/accessory technologies, and hybrid technologies. Table IV–4 below lists all the technologies considered and provides the abbreviations used for them in the CAFE model,[622] as well as their year of availability, which for purposes of NHTSA's analysis means the first model year in the rulemaking

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[622] 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–2010–0131 and on NHTSA's Web site.

period that the CAFE model is allowed to apply a technology to a manufacturer's fleet.[623] ''Year of availability'' recognizes that technologies must achieve a level of technical viability before they can be implemented in the CAFE model, and are thus a means of constraining technology use until such time as it is considered to be technologically feasible. For a more detailed description of each technology and their costs and effectiveness, we refer the reader to Chapter 3 of the Joint TSD and Section V of NHTSA's PRIA.

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[622] 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–2010–0131 and on NHTSA's Web site.

Table IV-4. List of Technologies in NHTSA's Analysis

Technology	Model abbreviation	Year available
Low Friction Lubricants - Level 1	LUB1	2007
Engine Friction Reduction - Level 1	EFR1	2007
Low Friction Lubricants and Engine Friction Reduction - Level 2	LUB2_EFR2	2017
Variable Valve Timing (VVT) - Coupled Cam Phasing (CCP) on SOHC	CCPS	2007
Discrete Variable Valve Lift (DVVL) on SOHC	DVVLS	2007
Cylinder Deactivation on SOHC	DEACS	2007
Variable Valve Timing (VVT) - Intake Cam Phasing (ICP)	ICP	2007
Variable Valve Timing (VVT) - Dual Cam Phasing (DCP)	DCP	2007
Discrete Variable Valve Lift (DVVL) on DOHC	DVVLD	2007
Continuously Variable Valve Lift (CVVL)	CVVL	2007
Cylinder Deactivation on DOHC	DEACD	2007
Stoichiometric Gasoline Direct Injection (GDI)	SGDI	2007
Cylinder Deactivation on OHV	DEACO	2007
Variable Valve Actuation - CCP and DVVL on OHV	VVA	2007
Stoichiometric Gasoline Direct Injection (GDI) on OHV	SGDIO	2007

Turbocharging and Downsizing - Level 1 (18 bar BMEP) - Small Displacement	TRBDS1_SD	2007
Turbocharging and Downsizing - Level 1 (18 bar BMEP) - Medium Displacement	TRBDS1_MD	2007
Turbocharging and Downsizing - Level 1 (18 bar BMEP) - Large Displacement	TRBDS1_LD	2007
Turbocharging and Downsizing - Level 2 (24 bar BMEP) - Small Displacement	TRBDS2_SD	2012
Turbocharging and Downsizing - Level 2 (24 bar BMEP) - Medium Displacement	TRBDS2_MD	2012
Turbocharging and Downsizing - Level 2 (24 bar BMEP) - Large Displacement	TRBDS2_LD	2012
Cooled Exhaust Gas Recirculation (EGR) - Level 1 (24 bar BMEP) - Small Displacement	CEGR1_SD	2012
Cooled Exhaust Gas Recirculation (EGR) - Level 1 (24 bar BMEP) - Medium Displacement	CEGR1_MD	2012
Cooled Exhaust Gas Recirculation (EGR) - Level 1 (24 bar BMEP) - Large Displacement	CEGR1_LD	2012
Cooled Exhaust Gas Recirculation (EGR) - Level 2 (27 bar BMEP) - Small Displacement	CEGR2_SD	2017
Cooled Exhaust Gas Recirculation (EGR) - Level 2 (27 bar BMEP) - Medium Displacement	CEGR2_MD	2017

Cooled Exhaust Gas Recirculation (EGR) - Level 2 (27 bar BMEP) - Large Displacement	CEGR2_LD	2017
Advanced Diesel - Small Displacement	ADSL_SD	2017
Advanced Diesel - Medium Displacement	ADSL_MD	2017
Advanced Diesel - Large Displacement	ADSL_LD	2017
6-Speed Manual/Improved Internals	6MAN	2007
High Efficiency Gearbox (Manual)	HETRANSM	2017
Improved Auto. Trans. Controls/Externals	IATC	2007
6-Speed Trans with Improved Internals (Auto)	NAUTO	2007
6-speed DCT	DCT	2007
8-Speed Trans (Auto or DCT)	8SPD	2014
High Efficiency Gearbox (Auto or DCT)	HETRANS	2017
Shift Optimizer	SHFTOPT	2017
Electric Power Steering	EPS	2007
Improved Accessories - Level 1	IACC1	2007
Improved Accessories - Level 2 (w/ Alternator Regen and 70% efficient alternator)	IACC2	2014
12V Micro-Hybrid (Stop-Start)	MHEV	2007
Strong Hybrid - Level 1	SHEV1	2012
Strong Hybrid - Level 2	SHEV2	2017
Plug-in Hybrid - 30 mi range	PHEV1	2020
Electric Vehicle (Early Adopter) - 75 mile range	EV1	2017
Electric Vehicle (Broad Market) - 150 mile range	EV4	2017

Mass Reduction - Level 1	MR1	2007
Mass Reduction - Level 2	MR2	2007
Mass Reduction - Level 3	MR3	2007
Mass Reduction - Level 4	MR4	2011
Mass Reduction - Level 5	MR5	2016
Low Rolling Resistance Tires - Level 1	ROLL1	2007
Low Rolling Resistance Tires - Level 2	ROLL2	2017
Low Drag Brakes	LDB	2007
Secondary Axle Disconnect	SAX	2007
Aero Drag Reduction, Level 1	AERO1	2007
Aero Drag Reduction, Level 2	AERO2	2011

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For purposes of this proposal and as discussed in greater detail in the Joint TSD, NHTSA and EPA built upon the list of technologies used by agencies for the MYs 2017–2025 CAFE and GHG standards. NHTSA and EPA had additional technologies to the list that that the agencies expect to be in production during the MYs 2017–2025 timeframe. These new technologies included higher BMEP turbocharged and downsized engines, advanced diesel engines, higher efficiency transmissions, additional mass reduction levels, PHEVs, EVs, etc.

b. How did NHTSA determine the costs and effectiveness of each of these technologies for use in its modeling analysis?

Building on cost estimates developed for the MYs 2012–2016 CAFE and GHG final rule and the 2010 TAR, the agencies incorporated new cost and effectiveness estimates for the new technologies being considered and some of the technologies carried over from the MYs 2012–2016 final rule and 2010 TAR. 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 PRIA.

For this proposal the FEV tear down work was expanded to include an 8-speed DCT, a power-split hybrid, which was used to determine a P2 hybrid cost, and a mild hybrid with stop-start technology. Additionally, battery costs have been revised using Argonne National Laboratory's battery cost model. The model developed by ANL allows users to estimate unique battery pack cost using user customized input sets for different hybridization applications, such as strong hybrid, PHEV and EV. Based on staff input and public feedback EPA and NHTSA have modified how the indirect costs, using ICMs, were derived and applied. The updates are discussed at length in Chapter 3 of the Joint TSD and in Chapter 5 of NHTSA's PRIA.

Some of the effectiveness estimates for technologies applied in MYs 2012–2016 and 2010 TAR have remained the same. However, nearly all of the effectiveness estimates for carryover technologies have been updated based on a newer version of EPA's lumped parameter model, which was calibrated by the vehicle simulation work performed by Ricardo Engineering. The Ricardo simulation study was also used to estimate the effectiveness for the technologies newly considered for this proposal like higher BMEP turbocharged and downsized engine, advanced transmission technologies and P2 Hybrids. While NHTSA and EPA apply technologies differently, the agencies have sought to ensure that the resultant effectiveness of applying technologies is consistent between the two agencies.

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, drivability, durability, noise, vibration and harshness (NVH) 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 nonperformance passenger cars. NHTSA seeks comment on the extent to which commenters believe that the agencies have been successful in holding constant these elements of vehicle performance and utility in developing the technology cost and effectiveness estimates.

The agency notes that the technology costs included in this proposal take into account only those associated with the initial build of the vehicle. Although comments were received to the MYs

2012–2016 rulemaking 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 have not explicitly incorporated maintenance costs (or potential savings) as a separate element in this analysis. The agency requests comments on this topic and will undertake a more detailed review of these potential costs for the final rule.

For some of the technologies, NHTSA's inputs, which are designed to be as consistent as practicable with EPA's, indicate negative incremental costs. In other words, the agency is estimating that some technologies, if applied in a manner that holds performance and utility constant, will, following initial investment (for, *e.g.,* R&D and tooling) by the manufacturer and its suppliers, incrementally improve fuel savings and reduce vehicle costs. Nonetheless, in the agency's central analysis, these and other technologies are applied only insofar as is necessary to achieve compliance with standards defining any given regulatory alternative (where the baseline no action alternative assumes CAFE standards are held constant after MY 2016). The agency has also performed a sensitivity analysis involving market-based application of technology—that is, the application of technology beyond the point needed to achieve compliance, if the cost of the technology is estimated to be sufficiently attractive relative to the accompanying fuel savings. NHTSA has invited comment on all of its technology estimates, and specifically requests comment on the likelihood that each technology will, if applied in a manner that holds vehicle performance and utility constant, be able to both deliver the estimated fuel savings *and* reduce vehicle cost. The agency also invites comment on whether, for the final rule, its central analysis should be revised to include estimated market-driven application of technology.

The tables below provide examples of the incremental cost and effectiveness estimates employed by the agency in developing this proposal, according to the decision trees used in the CAFE 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.

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Table IV-5. Technology Effectiveness Estimates Employed in the CAFE 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 (level 1)	0.5	0.5	0.7	0.8	0.5	0.5	0.7	0.8	0.7	0.6	0.7	0.7
Engine friction reduction (level 1)	2.0	2.0	2.6	2.7	2.0	2.0	2.6	2.7	2.6	2.0	2.6	2.4
VVT—Dual cam phasing (DCP)	2.0	2.0	2.5	2.7	2.0	2.0	2.5	2.7	2.6	2.0	2.6	2.4
Discrete variable valve lift (DVVL) on DOHC	2.8	2.8	3.6	3.9	2.8	2.8	3.6	3.9	3.5	2.8	3.5	3.4

Cylinder deactivation on OHV	4.7	4.7	5.9	6.3	4.7	4.7	5.9	6.3	5.9	4.7	5.9	5.5
Stoichiometric gasoline direct injection	1.6	1.6	1.5	1.5	1.6	1.6	1.5	1.5	1.5	1.6	1.5	1.5
Turbocharging and downsizing (level 1)	7.2	7.2	8.3	7.8	7.2	6.7	7.5	7.8	7.9	7.1	7.9	7.3
Turbocharging and downsizing (level 2)	2.9	2.9	3.5	3.7	2.9	2.9	3.5	3.7	3.4	2.9	3.4	3.4
Cooled exhaust gas recirculation (EGR) – (level 1)	3.6	3.6	3.5	3.5	3.6	3.6	3.5	3.5	3.6	3.6	3.6	3.6

Cooled exhaust gas recirculation (EGR) – (level 2)	1.0	1.0	1.4	1.4	1.0	1.0	1.4	1.4	1.1	1.0	1.1	1.2
Advanced Diesel	5.5	5.5	2.8	2.9	5.5	5.5	2.8	2.9	3.4	5.3	3.4	3.5
6-speed auto. trans. with improved internals	1.9	1.9	2.0	2.0	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.1
6-speed DCT	4.0	4.0	4.1	3.8	4.0	3.4	4.1	3.8	n/a	3.8	n/a	n/a
High Efficiency Gearbox	2.2	2.2	2.7	2.6	2.2	2.2	2.7	2.6	3.1	2.5	3.1	3.7
Shift Optimizer	3.3	3.3	4.1	4.3	3.3	3.3	4.1	4.3	4.1	3.3	4.1	3.9
Electric power steering	1.5	1.5	1.3	1.1	1.5	1.5	1.3	1.1	1.0	1.2	1.0	0.8

12V micro-hybrid	1.7	1.7	2.1	2.2	1.7	1.7	2.1	2.2	2.09	1.8	2.1	2.1
Strong Hybrid (level 2)	10.1	10.1	6.5	6.9	10.1	9.7	6.5	6.8	5.2	10.0	8.2	7.3
Plug-in Hybrid	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7
Electric Vehicle (Early Adopter)	68.5	68.5	68.5	68.5	68.5	68.5	68.5	68.5	68.5	68.5	68.5	68.5
Low Rolling Resistance Tires (level 1)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Low Rolling Resistance Tires (level 2)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Aero Drag Reduction (level 1)	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Aero Drag Reduction (level 2)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Table IV-6. Technology Cost Estimates Employed in the CAFE 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 purposes)	Inline 4	Inline 4	Inline 4	V6	Inline 4	V6	V6	V8	V6	Inline 4	V6	V8
Low friction lubricants (level 1)	16	16	16	24	16	24	24	32	24	16	24	32
Engine friction reduction (level 1)	60	60	60	90	60	90	90	120	90	60	90	120
VVT—Dual cam phasing (DCP)	44	44	44	88	44	88	88	88	88	44	88	88

Discrete variable valve lift (DVVL) on DOHC	160	160	160	240	160	240	240	320	240	160	240	320
Cylinder deactivation on OHV	204	204	204	204	204	204	204	204	204	204	204	204
Stoichiometric gasoline direct injection	268	268	268	402	268	402	5402	536	402	268	402	536
Turbocharging and downsizing (level 1)	490	490	490	20	490	20	20	639	20	490	20	639
Turbocharging and downsizing (level 2)	26	26	26	260	26	260	260	439	260	26	260	439

Cooled exhaust gas recirculation (EGR) – (level 1)	303	303	303	303	303	303	303	303	303	303	303	303
Cooled exhaust gas recirculation (EGR) – (level 2)	520	520	520	(296)	520	(296)	(296)	(296)	(296)	520	(296)	(296)
Advanced Diesel	873	873	873	844	873	844	844	1693	844	873	844	1693
6-speed auto. trans. with improved internals	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)

6-speed DCT	(107)	(107)	(107)	(73)	(107)	(73)	(73)	(73)	n/a	(107)	n/a	n/a
High Efficiency Gearbox	248	248	248	248	248	248	248	248	248	248	248	248
Shift Optimizer	2	2	2	2	2	2	2	2	2	2	2	2
Electric power steering	108	108	108	108	108	108	108	108	108	108	108	108
12V micro-hybrid	322	322	382	411	322	322	382	411	410	363	421	476
Strong Hybrid (level 2)	3526	3526	3705	4261	3526	3526	3705	4261	4677	4057	4332	4464
Plug-in Hybrid	10,686	10,686	11,864	15,514	10,686	10,686	11,864	15,514	n/a	14,055	n/a	n/a
Electric Vehicle (Early Adopter)	3,001	3,001	3.719	3,998	3,001	3,001	3.719	3,998	n/a	4,580	n/a	n/a
Low Rolling Resistance Tires (level 1)	7	7	7	7	7	7	7	7	7	7	7	7

Low Rolling Resistance Tires (level 2)	72	72	72	72	72	72	72	72	72	72	72	72
Aero Drag Reduction (level 1)	48	48	48	48	48	48	48	48	48	48	48	48
Aero Drag Reduction (level 2)	162	162	162	162	162	162	162	162	162	162	162	162

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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 CAFE model, as discussed further below and in Chapter 5 of the PRIA. For the purposes of applying technologies, the CAFE model primarily uses three data files, one that contains data on the vehicles expected to be manufactured in the model years covered by the rulemaking and identifies the appropriate stage within the vehicle's life-cycle for the technology to be applied, one that contains data/parameters regarding the available technologies the model can apply, and one that contains economic assumption inputs for calculating the costs and benefits of the standards. The inputs for the first two data files are discussed below.

As discussed above, the CAFE model begins with an initial state of the domestic vehicle market, which in this case is the market for passenger cars and light trucks to be sold during the period covered by the proposed standards. The vehicle market is defined on a year-by-year, 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. Comparatively, EPA's OMEGA model defines the vehicle market using representative vehicles at the vehicle platform level, which are binned into 5 year timeframes instead of year-by-year.

For the current standards, which cover MYs 2017–2025, 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 prior CAFE analyses—previous analyses would count a vehicle as ''new'' in any year when significant technology differences are made, such as at a redesign.[624] However, within the limitations of information that can be made available to the public, it provides the foundation for a reasonable 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.[625]

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 a refresh or 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 or engineering constraints) 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. 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 CAFE 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 CAFE model only applies technologies in an appropriate manner, since before any application of a technology can occur, the model checks the market forecast to see if it is either already present or unavailable. NHTSA seeks comment on the continued appropriateness of the engineering constraints used by the model, and specifically whether many of the technical constraints will be resolved (and therefore the engineering constraints should be changed) given the increased focus of engineering resources that will be working to solve these technical challenges.

Whether a vehicle can be equipped with a particular technology could also theoretically depend on certain technical considerations related to incorporating the technology into particular vehicles. For example, GM commented on the MY 2012–2016 NPRM that there are certain issues in implementing turbocharging and downsizing technologies on full-size trucks, like 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 stated in response that we believed that such technical considerations 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. The cost and effectiveness estimates used in the final rule for MYs 2012–2016, as well as the cost and effectiveness estimates employed in this NPRM, are based on analysis that assumes each of these factors is addressed prior to production implementation of the technologies. NHTSA continues to believe that these issues are accounted for by industry, but we seek comment on whether the engineering constraints should be used to address concerns like these (and if so, how), or alternatively, whether some of the things that the agency currently treats as engineering constraints should be (or actually are) accounted for in the cost and effectiveness estimates through assumptions like those described above, and whether the agency might be double-constraining the application of technology.

Is a vehicle being redesigned or refreshed?

Manufacturers typically plan vehicle changes to coincide with certain stages

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[639] *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.

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. To be clear, this is a general description of how manufacturers manage their product lines and refresh and redesign cycles but in some cases the timeframes could be shorter and others longer depending on market factors, regulations, etc. 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.[626]

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 low rolling resistance tires can be applied either when the vehicle is expected to be refreshed or when it is expected to be redesigned, while 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 how we assume manufacturers will apply technologies in the future based on how they have historically implemented new technologies. For each technology under consideration, NHTSA specifies whether it can be applied any time, at refresh/redesign, or only at redesign. The data forms another input to the CAFE 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 using a 5 to 8-year redesign and a 2–3 year refresh cycle, and this data is also stored in the market forecast file. While most vehicles are projected to follow a 5-year redesign a few of the niche market or small-volume manufacturer vehicles (*i.e.* luxury and performance vehicles) and large trucks are assumed to have 6- to 8-year redesigns based on historic redesign schedules and the agency's understanding of manufacturers' intentions moving forward. This approach is used because of the nature of the current 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. We note that this approach is different from what 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. Vehicle redesign/refresh assumptions are discussed in more detail in Chapter 5 of the PRIA and in Chapter 3 of the TSD.

NHTSA has previously received comments stating that manufacturers do not necessarily adhere to strict five-year redesign cycles, and may add significant technologies by redesigning vehicles at more frequent intervals, albeit at higher costs. Conversely, other comments received stated that as compared to full-line manufacturers, small-volume manufacturers in fact may have 7 to 8-year redesign cycles.[627] The agency believes that 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 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 and short- vs. long-term ICMs, 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 passenger car 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 year-by-year cost estimates and effectiveness (fuel consumption reduction) estimates, its applicability and the consumer value

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[626] 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.

[627] 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 NPRM 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 October 11, 2011).

loss. The phase-in values and the potential stranded capital costs are common for all vehicle subclasses and are thus listed in a separate input sheet that is referenced for all vehicle subclasses.

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 2010 NAS Report differentiated technology application using eight vehicle ''classes'' (4 car classes and 4 truck classes).[628] 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. NAS also used these vehicle classes along with powertrain configurations (*e.g.*.4 cylinder, 6 cylinder or 8 cylinder engines) to determine unique cost and effectiveness estimates for each class of vehicles.

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. The agency seeks comment on the appropriateness of these 12 subclasses for the MYs 2017–2025 timeframe. The agency is also seeking comment on the continued appropriateness of maintaining separate ''performance'' vehicle classes or if as fuel economy stringency increases the market for performance vehicles will decrease.

For this 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. The model's estimates of the cost to improve the fuel economy of each vehicle model thus 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 CAFE 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 for the MYs 2012–2016 rulemaking, and concluded that the same methodology would be appropriate for this NPRM for MYs 2017–2025. Vehicle subclasses are discussed in more detail in Chapter 5 of the PRIA and in Chapter 3 of the TSD.

For the reader's reference, the subclasses and example vehicles from the market forecast file are provided in the tables below.

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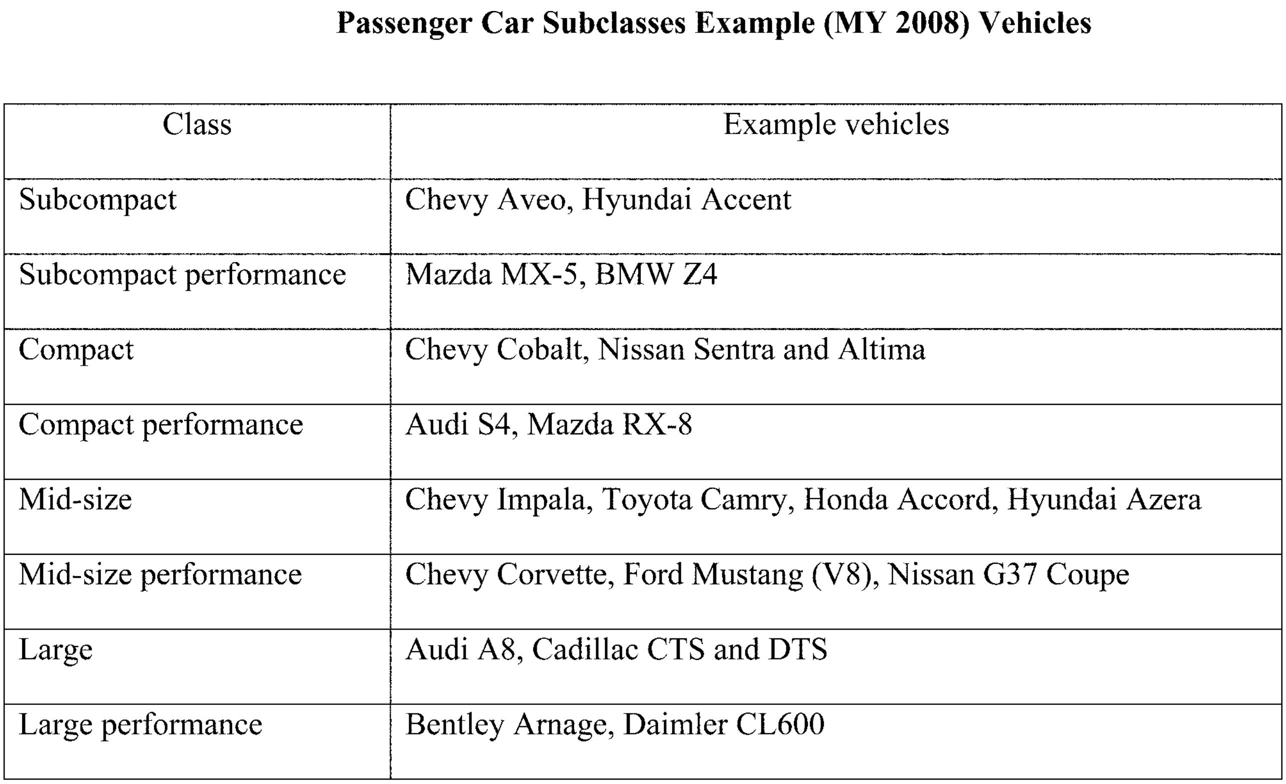
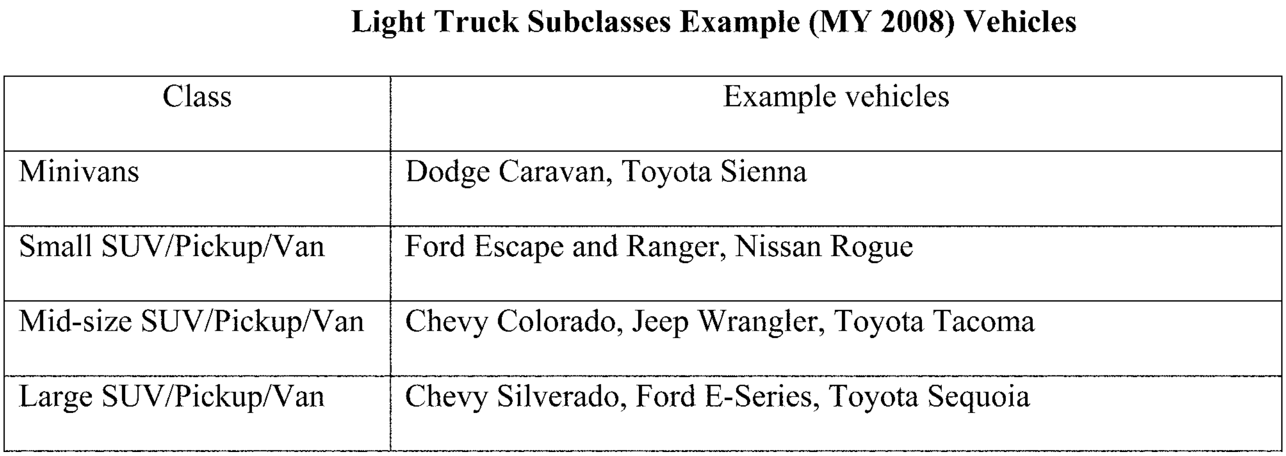
[628] The NAS classes included two-seater convertibles and coupes; small cars; intermediate and large cars; high-performance sedans; unit-body standard trucks; unit-body high-performance trucks; body-on-frame small and midsize trucks; and body.



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
Mid-size	Chevy Impala, Toyota Camry, Honda Accord, Hyundai Azera
Mid-size 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 and Ranger, Nissan Rogue
Mid-size 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 analysis evaluates the application of individual technologies and their incremental costs and effectiveness. Individual technologies are assessed 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 and explicitly accounting for any synergies that exist between technologies which are already present on the vehicle and new technologies being applied.

To keep track of incremental costs and effectiveness and to know which technology to apply and in which order, the CAFE model's architecture uses a logical sequence, which NHTSA refers to as "decision trees," for applying fuel economy-improving technologies to individual vehicles. For purposes of this proposal, NHTSA reviewed the MYs 2012–2016 final rule's technology sequencing architecture, which was based on the MY 2011 final rule's decision trees that were jointly developed by NHTSA and Ricardo, and, as appropriate, updated the decision trees to include new technologies that have been defined for the MYs 2017–2025 timeframe.

In general, and as described in great detail in Chapter 5 of the current PRIA,[629] 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

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[629] Additional details about technologies are categorized can be found in the MY 2011 final rule.

vehicle. Each of these categories has its own decision tree that the CAFE model uses to apply technologies sequentially during the compliance analysis. The decision trees were designed and configured to allow the CAFE 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 and integration intensive 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 5 of the PRIA. Expanded decision trees are available in the docket for this NPRM.

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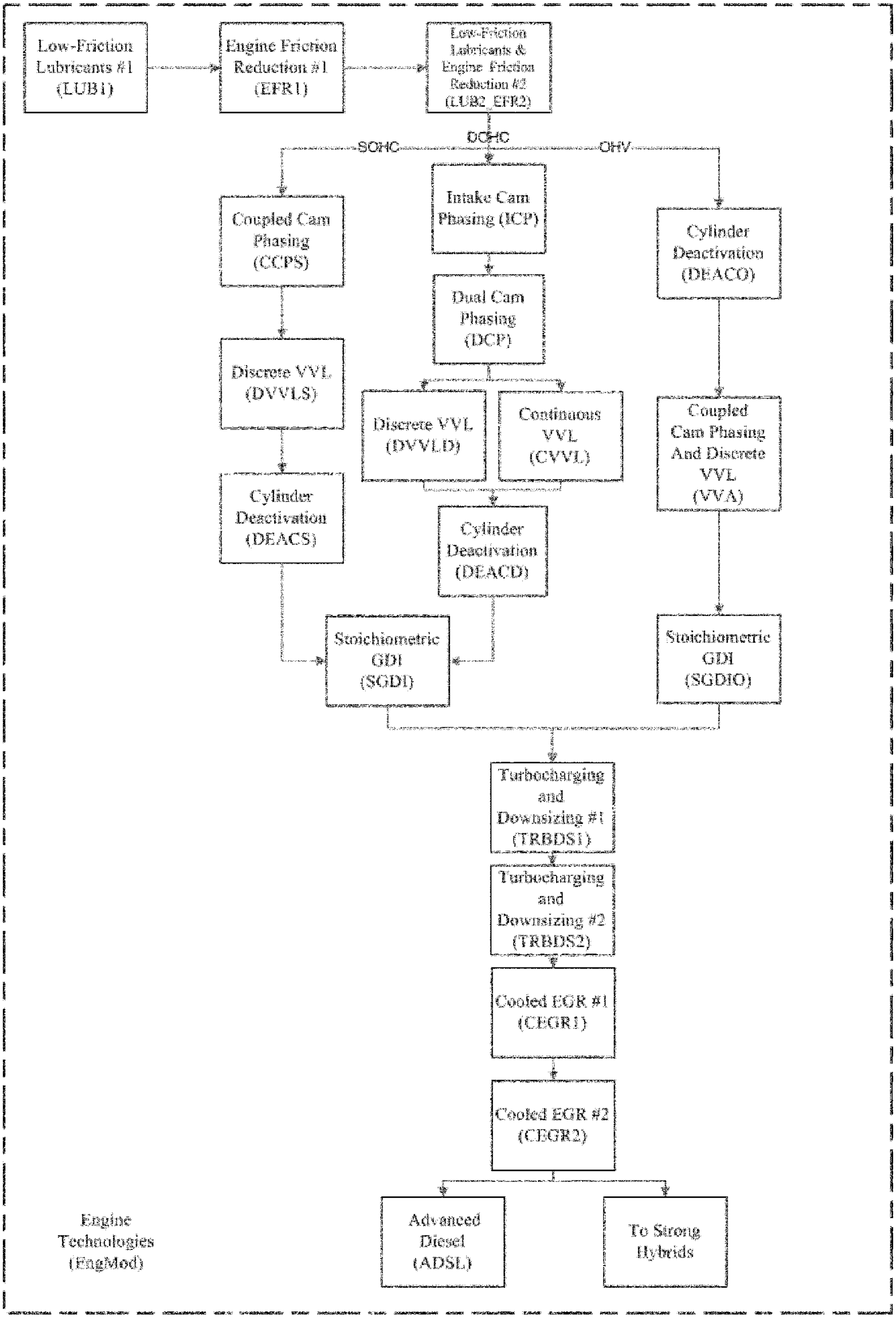

Simplified Engine Decision Tree Used in the CAFE Model

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 Chapter 5 of the PRIA).

Each technology's incremental estimate takes into account its position in the decision tree path. If a technology is located further down the decision tree, the estimates for the costs and effectiveness values attributed to that technology are influenced by the incremental estimates of costs and effectiveness values for prior technology applications. In essence, this approach accounts for ''in-path'' effectiveness synergies, as well as cost effects that occur between the technologies in the same path. When comparing cost and effectiveness estimates from various sources and those provided by commenters in 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 (or will be) offered for the agencies' consideration can be evaluated in an ''apples-to-apples'' comparison with those used by the CAFE 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 CAFE model and decision trees during that rulemaking process, including the improved handling and accuracy of valve train technology application and the development and implementation of a method for accounting path-dependent correction factors in order to ensure that technologies are evaluated within the proper context. The reader should consult the MY 2011 final rule documents for further information on these modeling techniques, all of which continued to be utilized in developing this proposal.[630] To the extent that the decision trees have changed for purposes of the MYs 2012–2016 final rule and this NPRM, it was due not to revisions in the order of technology application, but rather to redefinitions of technologies or addition or subtraction of technologies.

Is the next technology available in this model year?

Some of technologies considered are available on vehicles today, and thus will be available for application (albeit in varying degrees) in the model starting in MY 2017. Other 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–4.

The agency has received comments previously stating that if a technology is currently available or available prior to the rulemaking timeframe that it should be immediately made available in the model. 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 2025 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. NHTSA seeks comment on the appropriateness of the assumed years of availability.

Has the technology reached the phase-in cap for this model year?

Besides the refresh/redesign cycles used in the CAFE 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.[631] 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 and the years leading up to the rulemaking time frame, especially in years where many models may be scheduled for refresh or redesign. Even though this rulemaking is being proposed 5 years before it takes effect, OEM's will still be utilizing their limited resources to meet the MYs 2012–2016 CAFE standards. 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,[632] in the MY 2012–2016 final rule and in Chapter 5 of the PRIA and Chapter 3 of the Joint TSD. The MYs 2012–2016 final rule like 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 previously received comments on technology deployment.

For purposes of this NPRM for MYs 2017–2025, as in the MY 2011 and MYs 2012–2016 final rules, 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

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[630] *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.

[631] 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 CAFE 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 CAFE 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.

[632] NEED A FOOTNOTE HERE

application of either or both to any manufacturer's fleet is limited to the value of the cap.[633]

In developing phase-in cap values for purposes of this NPRM, NHTSA reviewed the MYs 2012–2016 final rule's phase-in caps, which for the majority of technologies were 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. The phase-in caps used in the MYs 2012–2016 final were developed to harmonize with EPA's proposal and consider the fact that manufacturers, as part of the information shared during the discussions that occurred during summer 2011, appeared to be anticipating higher technology application rates than assumed in prior rules. NHTSA determined that these phase-in caps for MY 2016 were still reasonable and thus used those caps as the starting point for the MYs 2017–2025 phase-in caps. For many of the carryover technologies this means that for MYs 2017–2025 the phase-in caps are assumed to be 100 percent. NHTSA along with EPA used confidential OEM submissions, trade press articles, company publications and press releases to estimate the phase-in caps for the newly defined technologies that will be entering the market just before or during the MYs 2017–2025 time frame. For example, advanced cooled EGR engines have a phase-in cap of 3 percent per year through MY 2021 and then 10 percent per year through 2025. The agency seeks comment on the appropriateness of both the carryover phase-in caps and the newly defined ones proposed in this NPRM.

Is the technology less expensive due to learning effects?

In the past two rulemakings NHTSA has explicitly accounted for the cost reductions a manufacturer might realize through learning achieved from experience in actually applying a technology. These cost reductions, due to learning effects, were taken into account through two kinds of mutually exclusive learning, ''volume-based'' and ''time-based.'' NHTSA and EPA included a detailed description of the learning effect in the MYs 2012–2016 final rule and the more recent heavy-duty rule.[634]

Most studies of the effect of experience or learning on production costs appear to assume that cost reductions begin only after some initial volume threshold has been reached, but not all of these studies specify this threshold volume. The rate at which costs decline beyond the initial threshold is usually expressed as the percent reduction in average unit cost that results from each successive doubling of cumulative production volume, sometimes referred to as the learning rate. Many estimates of experience curves do not specify a cumulative production volume beyond which cost reductions would no longer occur, instead depending on the asymptotic behavior of the effect for learning rates below 100 percent to establish a floor on costs.

In past rulemaking analyses, as noted above, both agencies have used a learning curve algorithm that applied a learning factor of 20 percent for each doubling of production volume. NHTSA has used this approach in analyses supporting recent CAFE rules. In its analyses, EPA has simplified the approach by using an ''every two years'' based learning progression rather than a pure production volume progression (*i.e.,* after two years of production it was assumed that production volumes would have doubled and, therefore, costs would be reduced by 20 percent).[635]

In the MYs 2012–2016 light-duty rule, the agencies employed an additional learning algorithm to reflect the volume-based learning cost reductions that occur further along on the learning curve. This additional learning algorithm was termed ''time-based'' learning simply as a means of distinguishing this algorithm from the volume-based algorithm mentioned above, although both of the algorithms reflect the volume-based learning curve supported in the literature. To avoid confusion, we are now referring to this learning algorithm as the ''flat portion'' of the learning curve. This way, we maintain the clarity that all learning is, in fact, volume-based learning, and that the level of cost reductions depend only on where on the learning curve a technology's learning progression is. We distinguish the flat portion of the curve from the ''steep portion'' of the curve to indicate the level of learning taking place in the years following implementation of the technology. The agencies have applied the steep portion learning algorithm for those technologies considered to be newer technologies likely to experience rapid cost reductions through manufacturer learning, and the flat portion learning algorithm for those technologies considered to be mature technologies likely to experience only minor cost reductions through manufacturer learning. As noted above, the steep portion learning algorithm results in 20 percent lower costs after two full years of implementation (*i.e.,* the MY 2016 costs are 20 percent lower than the MYs 2014 and 2015 costs). Once two steep portion learning steps have occurred (for technologies having the steep portion learning algorithm applied while flat portion learning would begin in year 2 for technologies having the flat portion learning algorithm applied), flat portion learning at 3 percent per year becomes effective for 5 years. Beyond 5 years of learning at 3 percent per year, 5 years of learning at 2 percent per year, then 5 at 1 percent per year become effective.

Technologies assumed to be on the steep portion of the learning curve are hybrids and electric vehicles, while no learning is applied to technologies likely to be affected by commodity costs (LUB, ROLL) or that have loosely-defined BOMs (EFR, LDB), as was the case in the MY 2012–2016 final rule. Chapter 3 of the Joint TSD and the PRIA shows the specific learning factors that NHTSA has applied in this analysis for each technology, and discusses learning factors and each agency's use of them further. EPA and NHTSA included discussion of learning cost assumptions in the RIAs and TSD Chapter 3. Since the agencies had to project how learning will occur with new technologies over a long period of time, we request comments on the assumptions of learning costs and methodology. In particular, we are interested in input on the assumptions for advanced 27-bar BMEP cooled EGR engines, which are currently still in the experimental stage and not expected to be available in

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[633] *See* 74 FR at 14270 (Mar. 30, 2009) for further discussion and examples.

[634] 76 FR 57106, 57320 (Sept. 15, 2011).

[635] To clarify, EPA has simplified the steep portion of the volume learning curve by assuming that production volumes of a given technology will have doubled within two years time. This has been done largely to allow for a presentation of estimated costs during the years of implementation, without the need to conduct a feedback loop that ensures that production volumes have indeed doubled. If EPA was to attempt such a feedback loop, it would need to estimate first year costs, feed those into OMEGA, review the resultant technology penetration rate and volume increase, calculate the learned costs, feed those into OMEGA (since lower costs would result in higher penetration rates, review the resultant technology penetration rate and volume increase, etc., until an equilibrium was reached. To do this for the dozens of technologies considered in the analysis for this rulemaking was deemed not feasible. Instead, EPA estimated the effects of learning on costs, fed those costs into OMEGA, and reviewed the resultant penetration rates. The assumption that volumes have doubled after two years is based solely on the assumption that year two sales are of equal or greater number than year one sales and, therefore, have resulted in a doubling of production. This could be done on a daily basis, a monthly basis, or a yearly basis as was done for this analysis.

volume production until 2017. For our analysis, we have based estimates of the costs of high-BMEP engines on current (or soon to be current) production engines, and assumed that learning (and the associated cost reductions) begins as early as 2012. We seek comment on the appropriateness of these pre-production applications of learning.

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.[636] 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 proposed rule using EPA's ''lumped parameter'' analysis tool, which EPA describes at length in Chapter 3 of the TSD. 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 2-cycle CAFE drive cycle. Results of this analysis were generally consistent with those of full-scale vehicle simulation modeling performed in 2010–2011 for EPA by Ricardo, Inc.

For the current rulemaking, NHTSA is using an updated version of lumped parameter tool that incorporates results from simulation modeling performed in 2010–2011 by Ricardo, Inc. 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).[637] Inputs to the CAFE model incorporate NEMS-identified pairs, as well as additional pairs from the set of technologies considered in the CAFE 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 CAFE model.

For applying incremental synergy factors in separate path technologies, the CAFE model uses an input table (see the tables in Chapter 3 of the TSD and in the PRIA) that 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 CAFE 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 CAFE model) are summed and applied to the fuel consumption improvement factor of the technology being applied. Many of the 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 all available electrification, engine and transmission technologies before applying strong hybrid technologies.

The U.S. DOT Volpe Center has entered into a contract with Argonne National Laboratory (ANL) to provide full vehicle simulation modeling support for this MYs 2017–2025 rulemaking. While this modeling was not completed in time for use in this NPRM, NHTSA intends to use this modeling to validate/update technology effectiveness estimates and synergy factors for the final rulemaking analysis. This simulation modeling will be accomplished using ANL's full vehicle simulation tool called ''Autonomie,'' which is the successor to ANL's Powertrain System Analysis Toolkit (PSAT) simulation tool, and ANL's expertise with advanced vehicle technologies.

d. Where can readers find more detailed information about NHTSA's technology analysis?

Much more detailed information is provided in Chapter 5 of the PRIA, and a discussion of how NHTSA and EPA jointly reviewed and updated technology assumptions for purposes of this NPRM is available in Chapter 3 of the TSD. Additionally, all of NHTSA's model input and output files are now public and available for the reader's review and consideration. The technology input files can be found in the docket for this NPRM, Docket No. NHTSA–2010–0131, and on NHTSA's Web site. And finally, because much of NHTSA's technology analysis for

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[636] 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.

[637] 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 Sept. 25, 2011).

purposes of this proposal builds on the work that was done for the MY 2011 and MYs 2012–2016 final rules, we refer readers to those documents 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.[638]

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, and the following discussion places more emphasis on these inputs.

In reviewing these variables and the agency's estimates of their values for purposes of this proposed rule, NHTSA reconsidered comments it had previously received on the NPRM for MYs 2012–16 CAFE standards and to the NOI/Interim Joint TAR, and also reviewed newly available literature. The agency elected to revise some of its economic assumptions and parameter estimates for this rulemaking, while retaining others. For the reader's reference, Table IV–7 below summarizes the values used to calculate the economic benefits from each alternative.

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[638] 74 FR 14233–308 (Mar. 30, 2009).

Table IV-7. Economic Values for Estimating Benefits (2009$)

Fuel Economy Rebound Effect	10%
"Gap" between test and on-road MPG for liquid-fueled vehicles	20%
“Gap” between test and on-road wall electricity consumption for electric and plug-in hybrid electric vehicles	30%
Value of refueling time per ($ per vehicle-hour)	$21.43
Average tank volume refilled during refueling stop	65%
Annual annual growth in average vehicle use	2001-30: 1.1% 2031-50: 0.5%
Fuel Prices (2017-50 average, $/gallon)	
Retail gasoline price	$3.71
Pre-tax gasoline price	$3.35
Economic Benefits from Reducing Oil Imports ($/gallon)	
"Monopsony" Component	$ 0.00
Price Shock Component	$ 0.185 in 2025
Military Security Component	$ 0.00
Total Economic Costs ($/gallon)	$ 0.185 in 2025
Emission Damage Costs (2020, $/short ton)	
Carbon monoxide	$ 0
Volatile organic compounds (VOC)	$ 1,300
Nitrogen oxides (NO_X) – vehicle use	$ 5,500
Nitrogen oxides (NO_X) – fuel production and distribution	$ 5,300
Particulate matter ($PM_{2.5}$) – vehicle use	$ 300,000

Particulate matter ($PM_{2.5}$) – fuel production and distribution	$ 250,000
Sulfur dioxide (SO_2)	$ 32,000
Annual CO_2 Damage Cost (per metric ton)	variable depending on discount rate and year (see Table II-9 above for 2017 estimates)
External Costs from Additional Automobile Use ($/vehicle-mile)	
Congestion	$ 0.056
Accidents	$ 0.024
Noise	$ 0.001
Total External Costs	$ 0.080
External Costs from Additional Light Truck Use ($/vehicle-mile)	
Congestion	$0.049
Accidents	$0.027
Noise	$0.001
Total External Costs	$0.077
Discount Rates Applied to Future Benefits	3%, 7%

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a. Costs of Fuel Economy-Improving Technologies

Building on cost estimates developed for the MYs 2012–2016 CAFE and GHG final rule and the 2010 TAR, the agencies incorporated new cost estimates for the new technologies being considered and some of the technologies carried over from the MYs 2012–2016 final rule and 2010 TAR. 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 cost of fuel-saving technologies, please refer to Chapter 3 of the Joint TSD and Chapter V of NHTSA's PRIA.

The technology cost estimates used in this analysis are intended to represent manufacturers' direct costs for high-volume production of vehicles with these technologies. NHTSA explicitly accounts for the cost reductions a manufacturer might realize through learning achieved from experience in actually applying a technology, which means that technologies become cheaper over the rulemaking time frame; learning effects are described above and in Chapter 3 of the draft joint TSD and Chapters V and VII of NHTSA's PRIA. NHTSA notes that, in developing technology cost 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, drivability, durability, noise, vibration and harshness (NVH) and towing and hauling capacity. For example, NHTSA includes in its analysis technology cost estimates that are specific to performance passenger cars (*i.e.,* sports cars), as compared to nonperformance passenger cars. NHTSA seeks comment on the extent to which commenters believe that the agencies have been successful in holding constant these elements of vehicle performance and utility in developing the technology cost estimates. Additionally, the agency notes that the technology costs included in this proposal take into account only those associated with the initial build of the vehicle. Although comments were received to the MYs 2012–2016 rulemaking 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 agency requests comments on this topic and will undertake a more detailed review of these potential costs for the final rule.

Additionally, 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. These indirect costs have been accounted for in this rulemaking through use of ICMs, which have been revised for this rulemaking as discussed above, in Chapter 3 of the draft joint TSD, and in Chapters V and VII of NHTSA's PRIA.

b. Potential Opportunity Costs of Improved Fuel Economy

An important concern is whether achieving the fuel economy improvements required by the proposed CAFE standards will require manufacturers to modify the performance, carrying capacity, safety, or comfort of some vehicle models. To the extent that it does so, the resulting sacrifice in the value of those models 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 that potential buyers attach to specific vehicle attributes 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 they offer to potential buyers.[639]

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 followed this precedent in its efforts to refine the technology costs it uses to analyze alternative passenger car and light truck CAFE standards for MYs 2017–2025. Although the agency has reduced its estimates of manufacturers' costs for most technologies 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.

While we believe that our cost estimates for fuel economy-improving technologies include adequate provisions for accompanying costs that are necessary to prevent any degradation in other vehicle attributes, it is possible that they do not include adequate allowance 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 accompanying reductions 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.

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 other vehicle attributes. The net change in buyer's welfare that results from the combination of these changes would provide a more accurate estimate of the true economic costs for improving fuel economy. The agency is in the process of developing a model of potential vehicle buyers' decisions about whether to purchase a new car or light truck and their choices from among the available models, which will allow it to conduct such an analysis. This process is expected to be completed for use in analyzing final CAFE standards for MY 2017–25; in the meantime, 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 proposed in this NPRM.

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.[640]

In its Final Rule, however, EPA estimated that actual on-road fuel

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[639] *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.

[640] 71 FR 77871 (Dec. 27, 2006).

economy for light-duty vehicles averages approximately 20 percent lower than published fuel economy levels, somewhat larger than the 15 percent shortfall it had previously assumed. For example, if the overall EPA fuel economy rating of a light truck is 20 mpg, EPA estimated that the on-road fuel economy actually achieved by a typical driver of that vehicle is expected to be only 80 percent of that figure, or 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.

In the course of developing its CAFE standards for MY 2012–16, 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.

Table IV–8 compares NHTSA's estimates of fleet-wide average fuel economy under test conditions for 2000 through 2006 to the Federal Highway Administration's (FHWA) published estimates of actual on-road fuel economy achieved by passenger cars and light trucks during each of those years.[641] As it shows, FHWA's estimates of actual fuel economy for passenger cars ranged from 21–23 percent lower than NHTSA's estimates of its fleet-wide average value under test conditions over this period, and FHWA's estimates of actual fuel economy for light trucks ranged from 16–18 percent lower than NHTSA's estimates of its fleet-wide average value under test conditions. Thus, these results appear to confirm that the 20 percent on-road fuel economy gap represents a reasonable estimate for use in evaluating the fuel savings likely to result from more stringent fuel economy and CO_2 standards in MYs 2017–2025.

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[641] 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).

Table IV-8. Estimated Fleet-Wide Fuel Economy of Passenger Cars and Light Trucks Compared to Reported Fuel Economy

YEAR	PASSENGER CARS			LIGHT-DUTY TRUCKS		
	NHTSA Estimated Test MPG	FHWA Reported Actual MPG	Percent Difference	NHTSA Estimated Test MPG	FHWA Reported Actual MPG	Percent Difference
2000	28.2	21.9	-22.2%	20.8	17.4	-16.3%
2001	28.2	22.1	-21.7%	20.8	17.6	-15.5%
2002	28.3	22.0	-22.3%	20.9	17.5	-16.2%
2003	28.4	22.2	-21.9%	21.0	17.2	-18.0%
2004	28.5	22.5	-21.1%	21.0	17.2	-18.3%
2005	28.6	22.1	-22.8%	21.1	17.7	-16.3%
2006	28.8	22.5	-21.8%	21.2	17.8	-16.2%
Avg., 2000-2006	28.4	22.2	-22.0%	21.0	17.5	-16.7%

The comparisons reported in this table must be interpreted with some caution, however, because the estimates of annual car and truck use used to develop these estimates are submitted to FHWA by individual states, which use differing definitions of passenger cars and light trucks. (For example, some states classify minivans as cars, while others define them as light trucks.) At the same time, while total gasoline consumption can be reasonably estimated from excise tax receipts, separate estimates of gasoline consumption by cars and trucks are not available. For these reasons, NHTSA has chosen not to rely on its separate estimates of the on-road fuel economy gap for cars and light trucks. However, the agency does believe that these results confirm that the 20 percent on-road fuel economy discount represents a reasonable estimate for use in evaluating the fuel savings likely to result from CAFE standards for both cars and light trucks. NHTSA employs this value for vehicles operating on liquid fuels (gasoline, diesel, and gasoline/alcohol blends), and uses it to analyze the impacts of proposed CAFE standards for model years 2017–25 on the use of these fuels.

In the recent TAR, EPA and NHTSA assumed that the overall energy shortfall for the vehicles employing electric drivetrains, including plug-in hybrid and battery-powered electric vehicles, is 30 percent. This value was derived from the agencies' engineering judgment based on the limited available information. During the stakeholder meetings conducted prior to the technical assessment, confidential business information (CBI) was supplied by several manufacturers which indicated that electrically powered vehicles had greater variability in their on-road energy consumption than vehicles powered by internal combustion engines, although other manufacturers suggested that the on-road/laboratory differential attributable to electric operation should approach that of liquid fuel operation in the future. Second, data from EPA's 2006 analysis of the ''five cycle'' fuel economy label as part of the rulemaking discussed above supported a larger on-road shortfall for vehicles with hybrid-electric drivetrains, partly because real-world driving tends to have higher acceleration/deceleration rates than are employed on the 2-cycle test. This diminishes the fuel economy benefits of regenerative braking, which can result in a higher test fuel economy for hybrids than is achieved under normal on-road conditions.[642] Finally, heavy accessory load, extremely high or low temperatures, and aggressive driving have deleterious impacts of unknown magnitudes on battery performance. Consequently, the agencies judged that 30 percent was a reasonable estimate for use in the TAR, and NHTSA believes that it continues to represent the most reliable estimate for use in the current analysis.

One of the most significant factors responsible for the difference between test and on-road fuel economy is the use of air conditioning. While the air conditioner is turned off during the FTP and HFET tests, drivers often use air conditioning under warm, humid conditions. The air conditioning compressor can also be engaged during ''defrost'' operation of the heating system.[643] In the MYs 2012–2016 rulemaking, EPA estimated the impact of an air conditioning system at approximately 14.3 grams CO_2/mile for an average vehicle without any of the improved air conditioning technologies discussed in that rulemaking. For a 27 mpg (330 g CO_2/mile) vehicle, this would account for is approximately 20 percent of the total estimated on-road gap (or about 4 percent of total fuel consumption).

In the MY 2012–2016 rule, EPA estimated that 85 percent of MY 2016 vehicles would reduce their tailpipe CO_2 emissions attributable to air conditioner efficiency by 40 percent through the use of advanced air conditioning technologies, and that incorporating this change would reduce the average on-road gap by about 2 percent.[644] However, air conditioning-related fuel consumption does not decrease proportionally as engine efficiency improves, because the engine load due attributable to air conditioner operation is approximately constant across engine efficiency and technology. As a consequence, air conditioning operation represents an increasing percentage of vehicular fuel consumption as engine efficiency increases.[645] Because these two effects are expected approximately to counterbalance each other, NHTSA has elected not to adjust its estimate of the on-road gap for use in this proposal.

d. Fuel Prices and the Value of Saving Fuel

Future fuel prices are the single most important input into the economic analysis of the benefits of alternative CAFE standards because they determine the value of future fuel savings, which account for approximately 90% of total economic benefits from requiring higher fuel economy. NHTSA relies on the most recent fuel price projections from the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2011 Reference Case to estimate the economic value of fuel savings projected to result from alternative CAFE standards for MY 2017–25. The AEO 2011 Reference Case forecasts of gasoline and diesel fuel prices represents EIA's most up-to-date estimate of the most likely course of future prices for petroleum products. EIA is widely recognized as an impartial and authoritative source of analysis and forecasts of U.S. energy production, consumption, and prices, and its forecasts are widely relied upon by federal agencies for use in regulatory analysis and for other purposes. Its forecasts are derived using EIA's National Energy Modeling System (NEMS), which includes detailed representations of supply pathways, sources of demand, and their interaction to determine prices for different forms of energy.

As compared to the gasoline prices used in NHTSA's Final Rule establishing CAFE standards for MY 2012–2016 (which relied on forecasts from AEO 2010), the AEO 2011 Reference Case fuel prices are slightly higher through the year 2020, but slightly lower for most years thereafter. Expressed in constant 2009 dollars, the AEO 2011 Reference Case forecast of retail gasoline prices (which include federal, state, and local taxes) during 2017 is $3.25 per gallon, rising gradually to $3.71 by the year 2035. However, valuing fuel savings over the full lifetimes of passenger cars and light trucks affected by the standards proposed for MYs 2017–25 requires fuel price forecasts that extend through 2060, approximately the last year during which a significant number of MY 2025 vehicles will remain in service.[646] To obtain fuel price forecasts for the years 2036 through 2060, the agency assumes that retail fuel prices will continue to increase after 2035 at the average annual rate (0.7%) projected for 2017–2035 in the AEO 2011 Reference Case. This assumption results in a projected retail price of gasoline that reaches $4.16 in 2050. Over the entire period from 2017–2050, retail gasoline prices are projected to average $3.67, as Table IV–7 reported previously.

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. 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 value of fuel savings resulting from more stringent CAFE standards to the U.S. economy.

NHTSA follows the assumptions used by EIA in AEO 2011 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. Subtracting fuel taxes from the retail prices forecast in AEO 2011 results in projected values for saving gasoline of $3.29 per gallon during 2017, rising to $3.48 per gallon by the year 2035, and to $3.65 by the year 2050. Over this entire period, pre-tax gasoline prices are projected to average $3.32 per gallon.

EIA also includes forecasts reflecting high and low global oil prices in each year's complete AEO, which reflect uncertainties regarding OPEC behavior as well as future levels of oil production and demand. These alternative scenarios project retail gasoline prices that range from a low of $2.30 to a high

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[642] EPA, Fuel Economy Labeling of Motor Vehicles: Revisions To Improve Calculation of Fuel Economy Estimates; Final Rule, 40 CFR parts 86 and 600, 71 FR 77872, 77879 (Dec. 27, 2006). *Available at http://www.epa.gov/fedrgstr/EPA-AIR/2006/December/Day-27/a9749.pdf.*

[643] EPA, *Final Technical Support Document: Fuel Economy Labeling of Motor Vehicle Revisions to Improve Calculation of Fuel Economy Estimates,* at 70. Office of Transportation and Air Quality EPA420–R–06–017 December 2006, Chapter II, *http://www.epa.gov/fueleconomy/420r06017.pdf.*

[644] 4% of the on-road gap x 40% reduction in air conditioning fuel consumption x 85% of the fleet = ~2%.

[645] As an example, the air conditioning load of 14.3 g/mile of CO_2 is a smaller percentage (4.3%) of 330 g/mile than 260 (5.4%).

[646] The agency defines the maximum lifetime of vehicles as the highest age at which more than 2 percent of those originally produced during a model year remain in service. In the case of light trucks, for example, this age has typically been 36 years for recent model years.

of $4.85 per gallon during 2020, and from $2.12 to $5.36 per gallon during 2035 (all figures in 2009 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 $1.91 to $4.46 per gallon during 2020, and from $1.77 to $5.01 per gallon in 2035 (again, all figures are in constant 2009 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 results and discussion of this sensitivity analysis can be found in the agency's PRIA. Generally, this analysis confirms that the primary economic benefit resulting from the rule—the value of fuel savings—is extremely sensitive to alternative forecasts of future fuel prices.

e. Consumer Valuation of Fuel Economy and Payback Period

The agency uses slightly different assumptions about the length of time over which potential vehicle buyers consider fuel savings from higher fuel economy, and about how they discount those future fuel savings, in different aspects of its analysis. For most purposes, the agency assumes that buyers value fuel savings over the first five years of a new vehicle's lifetime; the five-year figure represents approximately the current average term of consumer loans to finance the purchase of new vehicles.

To simulate manufacturers' assessment of the net change in the value of an individual vehicle model to prospective buyers from improving its fuel economy, NHTSA discounts fuel savings over the first five years of its lifetime using a 7 percent rate. The resulting value is deducted from the technology costs that would be incurred by its manufacturer to improve that model's fuel economy, in order to determine the change in its value to potential buyers. Since this is also the additional amount its manufacturer could expect to receive when selling the vehicle after improving its fuel economy, this can also be viewed as the ''effective cost'' of the improvement from its manufacturers' perspective. The CAFE model uses these estimates of effective costs to identify the sequence in which manufacturers are likely to select individual models for improvements in fuel economy, as well as to identify the most cost-effective technologies for doing so.

The average of effective cost to its manufacturer for increasing the fuel economy of a model also represents the change in its value from the perspective of potential buyers. Under the assumption that manufacturers change the selling price of each model by this amount, its average value also represents the average change in its net or effective price to would-be buyers. As part of our sensitivity case analyzing the potential for manufacturers to over-comply with CAFE standards—that is, to produce a lineup of vehicle models whose sales-weighted average fuel economy exceeds that required by prevailing standards—NHTSA used the extreme assumption that potential buyers value fuel savings only during the first year they expect to own a new vehicle.

The agency notes that these varying assumptions about future time horizons and discount rates for valuing fuel savings are used only to analyze manufacturers' responses to requiring higher fuel economy and buyers' behavior in response to manufacturers' compliance strategies. When estimating the aggregate value to the U.S. economy of fuel savings resulting from alternative increases in CAFE standards—or the ''social'' value of fuel savings—the agency includes fuel savings over the entire expected lifetimes of vehicles that would be subject to higher standards, rather than over the shorter periods we assume manufacturers employ to represent the preferences of vehicle buyers, or that buyers use to assess changes in the net price or new vehicles.

Valuing fuel savings over vehicles' entire lifetimes recognizes the savings in fuel costs that subsequent owners of vehicles will experience from higher fuel economy, even if their initial purchasers do not expect to recover the remaining value of fuel savings when they re-sell those vehicles, or for other reasons do not value fuel savings beyond the assumed five-year time horizon. The agency acknowledges that it has not accounted for any effects of increased costs for financing, insuring, or maintaining vehicles with higher fuel economy, over either this limited payback period or the full lifetimes of vehicles.

The procedure the agency uses for calculating lifetime fuel savings is discussed in detail in the following section, while discussion about the time horizon over which potential buyers may consider fuel savings in their vehicle purchasing decisions is provided in more detail in Section IV.G.6 below.

f. Vehicle Survival and Use Assumptions

NHTSA's analysis of fuel savings and related benefits from adopting more stringent fuel economy standards for MYs 2017–2025 passenger cars and light trucks begins by estimating the resulting changes in fuel use over the entire lifetimes of the affected vehicles. The change in total fuel consumption by vehicles produced during each model year is calculated as the difference between their total fuel use over their lifetimes with a higher CAFE standard in effect, and their total lifetime fuel consumption under a baseline in which CAFE standards remained at their 2016 levels. The 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.[647] 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) 2011 in the NPRM analysis.[648] However,

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[647] 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 Sept. 26, 2011).

[648] *Available at http://www.eia.gov/forecasts/aeo/index.cfm* (last accessed Sept. 26, 2011). 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.

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.[649]

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.[650] 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 total car and light truck sales volumes projected for 2017 through 2025 in AEO 2011 provided manufacturer-specific market share and model-specific sales estimates for those model years. The volumes were then scaled to AEO 2011 total volume for each year.

To estimate the number of passenger cars and light trucks originally produced during model years 2017 through 2025 that will remain in use during subsequent years, the agency applied age-specific survival rates for cars and light trucks to its forecasts of passenger car and light truck sales for each of those model years. 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.[651] However, the agency does not attempt to forecast changes in those survival rates over the future.

The next step in estimating fuel use is to calculate the total number of miles that cars and light trucks remaining in use will be driven each year. To estimate the total number of miles driven by cars or light trucks produced in a model year during each subsequent year, the number projected to remain in use during that year is multiplied by the average number of miles those vehicles are expected to be driven at the age they will have reached 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 Travel Survey (NHTS).[652] 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 the higher fuel prices projected over the lifetimes of model year 2017–25 cars and light trucks. Details of this adjustment are provided in Chapter VIII of the PRIA and Chapter 4 of the draft Joint TSD.

The estimates of annual miles driven at different vehicle ages derived from the 2001 NHTS were also adjusted to reflect projected future growth in average use for vehicles at every age over their lifetimes. Increases in average annual use of cars and light trucks, which have averaged approximately 1 percent annually over the past two decades, 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 that would be necessary for total car and light truck travel to increase at the rate forecast in the AEO 2011 Reference Case.[653] 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 is approximately 1.1 percent from 2017 through 2030, and declines to 0.5 percent per year thereafter. [654] While the adjustment for future fuel prices reduces average annual mileage at each age from the values derived using 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 for MY 2017–25 passenger cars and light trucks by about 22 percent from the estimates originally derived from the 2001 NHTS.

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 over its life span. In turn, the savings in lifetime fuel use by cars or light trucks produced during each model year affected by this proposed rule 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.[655]

g. Accounting for the Fuel Economy Rebound Effect

The fuel economy rebound effect refers to the fact that some of the fuel

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[649] Because AEO 2011'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 non-passenger (*i.e.,* light truck) fleet to the passenger car fleet, EPA staff made adjustments to account for such vehicles in the baseline.

[650] 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.

[651] 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.gov/Pubs/809952.pdf* (last accessed Sept. 26, 2011). These updated survival rates suggest that the expected lifetimes of recent-model passenger cars and light trucks are 13.8 and 14.5 years.

[652] For a description of the Survey, see *http://nhts.ornl.gov/introduction.shtml#2001* (last accessed September 26, 2011).

[653] 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.

[654] 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.

[655] 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).

savings expected to result from higher fuel economy, such as an increase in fuel economy required by the adoption of higher CAFE standards, may be offset by additional vehicle use. The increase in vehicle use occurs because higher fuel economy reduces the fuel cost of driving, which is typically the largest single component of the monetary cost of operating a vehicle, and vehicle owners respond to this reduction in operating costs by driving more. Even with their higher fuel economy, this additional driving consumes some fuel, so this effect reduces the fuel savings that result when raising CAFE standards requires manufacturers to improve fuel economy. The rebound effect refers to the fraction of fuel savings expected to result from increased fuel economy that is offset by additional driving.[656]

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 significant rebound effect occurs when vehicle fuel efficiency improves.[657] The most common approach to estimating its magnitude has been to analyze survey data on household vehicle use, fuel consumption, fuel prices, and other factors affecting household travel behavior to estimate the response of vehicle use to differences in the fuel efficiency of individual vehicles. Because this approach most closely matches the definition of the rebound effect, which is the response of vehicle use to differences in fuel economy, the agency regards these studies as likely to produce the most reliable estimates of the rebound effect. Other studies have relied on econometric analysis of annual U.S. data on vehicle use, fuel efficiency, fuel prices, and other variables to estimate the response of total or average vehicle use to changes in fleet-wide average fuel economy and its effect on fuel cost per mile driven. More recent studies have analyzed yearly variation in vehicle ownership and use, fuel prices, and fuel economy among states over an extended time period in order to measure the response of vehicle use to changing fuel costs per mile.[658]

Another important distinction among studies of the rebound effect is whether they assume that the effect is constant, or allow it to vary in response to changes in fuel costs, personal income, or vehicle ownership. Most studies using aggregate annual data for the U.S. assume a constant rebound effect, although some of these studies test whether the effect varies as changes in retail fuel prices or average fuel efficiency alter fuel cost per mile driven. Studies using household survey data estimate significantly different rebound effects for households owning varying numbers of vehicles, with most concluding that the rebound effect is larger among households that own more vehicles. Finally, recent studies using state-level data conclude that the rebound effect varies directly in response to changes in personal income, the degree of urbanization of U.S. cities, and differences in traffic congestion levels, as well as fuel costs. Some studies conclude that the long-run rebound effect is significantly larger than the immediate response of vehicle use to increased fuel efficiency. Although their estimates of the time required for the rebound effect to reach its long-run magnitude vary, this long-run effect is probably more appropriate for evaluating the fuel savings likely to result from adopting stricter CAFE standards for future model years.

In order to provide a more comprehensive overview of previous estimates of the rebound effect, NHTSA has updated its previous review of published studies of the rebound effect to include those conducted as recently as 2010. The agency performed a detailed analysis of several dozen separate estimates of the long-run rebound effect reported in these studies, which is summarized in Table IV–9 below.[659] As the table indicates, these estimates range from as low as 7 percent to as high as 75 percent, with a mean value of 23 percent. Both the type of data used and authors' assumption about whether the rebound effect varies over time have important effects on its estimated magnitude. The 34 estimates derived from analysis of U.S. annual time-series data produce a mean estimate of 18 percent for the long-run rebound effect, while the mean of 23 estimates based on household survey data is considerably larger (31 percent), and the mean of 15 estimates based on pooled state data (23 percent) is close to that for the entire sample. The 37 estimates assuming a constant rebound effect produce a mean of 23 percent, identical to the mean of the 29 estimates reported in studies that allowed the rebound effect to vary in response to fuel prices and fuel economy levels, vehicle ownership, or household income. Updated to reflect the most recent available information on these variables, the mean of these estimates is 19 percent, as Table IV–9 reports.

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[656] Formally, the rebound effect is often expressed as the elasticity of vehicle use with respect to the cost per mile driven. Additionally, it is consistently expressed as a positive percentage (rather than as a negative decimal fraction, as this elasticity is normally expressed).

[657] 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 probably more appropriate for evaluating the fuel savings and emissions reductions resulting from stricter standards that would apply to future model years.

[658] In effect, these studies treat U.S. states as a data ''panel'' by applying appropriate estimation procedures to data consisting of each year's average values of these variables for the separate states.

[659] In some cases, NHTSA derived estimates of the overall rebound effect from more detailed results reported in the studies. For example, where studies estimated different rebound effects for households owning different numbers of vehicles but did not report an overall value, the agency computed a weighted average of the reported values using the distribution of households among vehicle ownership categories.

Table IV-9. Summary of Published Estimates of the Rebound Effect

Category of Estimates	Number of Studies	Number of Estimates	Range		Distribution		
			Low	High	Median	Mean	Std. Dev.
All Estimates	23	72	7%	75%	21%	23%	13%
Published Estimates	17	50	7%	75%	22%	24%	14%
Authors' Preferred Estimates	17	17	9%	75%	22%	22%	15%
U.S. Time-Series Estimates	7	34	7%	45%	14%	18%	9%
Household Survey Estimates	13	23	9%	75%	31%	31%	16%
Pooled U.S. State Estimates	3	15	8%	58%	22%	23%	12%
Constant Rebound Effect (1)	15	37	7%	75%	20%	23%	16%
Variable Rebound Effect (1) Reported Estimates	10	29	10%	45%	23%	23%	10%
Updated to 2010 (2)	11	33	6%	56%	15%	19%	13%

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Table IV-10. Social Cost of CO_2 Emissions for Selected Future Years (2009$ per metric ton)

Discount Rate	5%	3%	2.5%	3%
Source	Average of estimates			95th percentile estimate
2012	$5.28	$23.06	$37.53	$70.14
2015	$5.93	$24. 58	$39.57	$74.03
2020	$7.01	$27.10	$42.98	$83.17
2025	$8. 53	$30.43	$47.28	$93.11
2030	$10.05	$33.75	$51.58	$103.06
2035	$11.57	$37.08	$55.88	$113.00
2040	$13.09	$40.40	$60.19	$122.95
2045	$14.63	$43. 34	$63.59	$131.66
2050	$16.18	$46.27	$66.99	$140.37

Some recent studies provide evidence that the rebound effect has been declining over time. This result appears plausible for two reasons: First, the responsiveness of vehicle use to variation in fuel costs would be expected to decline as they account for a smaller proportion of the total monetary cost of driving, which has been the case until recently. Second, 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. At the same time, however, rising incomes are strongly associated with higher auto ownership levels, which increase households' opportunities to substitute among vehicles in response to varying fuel prices and differences in their fuel economy levels. This is likely to increase the sensitivity of households' overall vehicle use to differences in the fuel economy levels of individual vehicles.

Small and Van Dender combined time series data for states to estimate the rebound effect, allowing its magnitude to vary in response to fuel prices, fleet-wide average fuel economy, the degree of urbanization of U.S. cities, and personal income levels.[660] The authors employ a model that allows the effect of fuel cost per mile on vehicle use to vary in response to changes in personal income levels and increasing urbanization of U.S. cities. For the time period 1966–2001, their analysis implied a long-run rebound effect of 22 percent, which is consistent with previously published studies. Continued growth in personal incomes over this period reduces their estimate of the long-run rebound effect during its last five years (1997–2001) to 11 percent, and an unpublished update through 2004 prepared by the authors reduced their estimate of the long-run rebound effect for the period 2000–2004 to 6 percent.[661]

More recently, Hymel, Small and Van Dender extended the previous analysis to include traffic congestion levels in urbanized areas.[662] Although controlling for the effect of congestion on vehicle use increased their estimates of the rebound effect, these authors also found that the rebound effect appeared to be declining over time. For the time period 1966–2004, their estimate of the long-run rebound effect was 24 percent, while for the last year of that period their estimate was 13 percent, significantly above the previous Small and Van Dender estimate of a 6 percent

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[660] 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.

[661] Small, K. and K. Van Dender, 2007b. "Long Run Trends in Transport Demand, Fuel Price Elasticities and Implications of the Oil Outlook for Transport Policy," OECD/ITF Joint Transport Research Centre Discussion Papers 2007/16, OECD, International Transport Forum.

[662] Hymel, Kent M., Kenneth A. Small, and Kurt Van Dender, "Induced demand and rebound effects in road transport," Transportation Research Part B: Methodological, Volume 44, Issue 10, December 2010, Pages 1220–1241, ISSN 0191–2615, DOI: 10.1016/j.trb.2010.02.007.

rebound effect for the period 2000–2004.

Recent research by Greene (under contract to EPA) using U.S. national time-series data for the period 1966–2007 lends further support to the hypothesis that the rebound effect is declining over time.[663] Greene found that fuel prices had a statistically significant impact on VMT, yet fuel efficiency did not, and statistical testing rejected the hypothesis of equal elasticities of vehicle use with respect to gasoline prices and fuel efficiency. Greene also tested model formulations that allowed the effect of fuel cost per mile on vehicle use to decline with rising per capita income; his preferred form of this model produced estimates of the rebound effect that declined to 12 percent in 2007.

In light of findings from recent research, 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 many 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 2017 until 2060, a value that is at the low end of historical estimates appears to be appropriate. Thus as it elected to do in its previous analysis of the effects of raising CAFE standards for MY 2012–16 cars and light trucks, NHTSA uses a 10 percent rebound effect in its analysis of fuel savings and other benefits from higher CAFE standards for MY 2017–25 vehicles. Recognizing the wide range of uncertainty surrounding its correct value, however, the agency also employs estimates of the rebound effect ranging from 5 to 20 percent in its sensitivity testing. The 10 percent figure is at the low end of 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—suggests that the magnitude of the rebound effect has declined over time, and is likely to continue to do so. As a consequence, NHTSA concluded that a value at the low end of 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 lies between the 10–30 percent range of estimates for the historical rebound effect reported in most previous research, and is at the upper end of the 5–10 percent range of estimates for the future rebound effect reported in recent studies. In summary, the 10 percent value was not derived from a single estimate or particular study, but instead represents a compromise between historical estimates and projected future estimates. Chapter 4.2.5 of the Joint TSD reviews the relevant literature and discusses in more depth the reasoning for the rebound value used here.

h. Benefits From Increased Vehicle Use

The increase in vehicle use from the rebound effect provides additional benefits to their users, who 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 traveling these additional distances.

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.[664] NHTSA estimates the value of the consumer surplus provided by added travel 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, a standard approximation for changes in consumer surplus resulting from small changes in prices. 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.

i. The Value of Increased Driving Range

Improving vehicles' fuel economy may also increase their driving range before they require refueling. By extending the upper limit of the range vehicles can travel before refueling is needed, the per-vehicle average number of refueling trips per year is expected to decline. This reduction in refueling frequency provides a time savings benefit to owners.[665]

NHTSA estimated a number of parameters regarding consumers' refueling habits using newly-available observational and interview data from a 2010–2011 NASS study conducted at fueling stations throughout the nation. A (non-exhaustive) list of key parameters derived from this study is as follows: Average number of gallons of fuel purchased, length of time to refuel and pay, length of time to drive to the fueling station, primary reason for refueling, and number of adult vehicle occupants.

Using these and other parameters (detailed explanation of parameters and methodology provided in Chapter VIII of NHTSA's PRIA), NHTSA estimated the decrease in number of refueling cycles for each model year's fleet attributable to improvements in actual on-road MPG resulting from the proposed CAFE standards. NHTSA acknowledges—and adjusts for—the fact that many refueling trips occur for reasons other than a low reading on the gas gauge (for example, many consumers refuel on a fixed schedule). NHTSA separately estimated the value of vehicle-hour refueling time and applied this to the projected decrease in number of refueling cycles to estimate the aggregate fleet-wide value of refueling time savings for each year that a given model year's vehicles are expected to remain in service.

As noted in the PRIA, NHTSA assumed a constant fuel tank size in estimating the impact of higher CAFE requirements on the frequency of refueling. NHTSA seeks comment regarding this assumption. Specifically, NHTSA seeks comment from manufacturers regarding their intention to retain fuel tank size or driving range in their redesigned vehicles. Will fuel economy improvements translate into increased driving range, or will fuel tanks be reduced in size to maintain current driving range?

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. To estimate the economic costs associated with these consequences of added driving, NHTSA applies estimates of per-mile congestion, accident, and noise costs caused by

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[663] Greene, David, "Rebound 2007: Analysis of National Light-Duty Vehicle Travel Statistics," February 9, 2010. This paper has been accepted for an upcoming special issue of Energy Policy, although the publication date has not yet been determined.

[664] 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.

[665] 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.

increased use of automobiles and light trucks developed previously by the Federal Highway Administration.[666] These values are intended to measure the increased costs resulting from added congestion and the delays it causes to other drivers and passengers, property damages and injuries in traffic accidents, and noise levels contributed by automobiles and light trucks. NHTSA previously employed these estimates in its analysis accompanying the MY 2011 final CAFE rule, as well as in its analysis of the effects of higher CAFE standards for MY 2012–16. After reviewing the procedures used by FHWA to develop them and considering other available estimates of these values, the agency continues to find them appropriate for use in this proposal. The agency multiplies FHWA's estimates of per-mile costs by the annual increases in automobile and light truck use from the rebound effect to yield the estimated increases in congestion, accident, and noise externality costs during each future year.

k. Petroleum Consumption and Import Externalities

i. Changes in Petroleum Imports

Based on a detailed analysis of differences in fuel consumption, petroleum imports, and imports of refined petroleum products among alternative scenarios presented in AEO 2011, NHTSA estimates that approximately 50 percent of the reduction in fuel consumption resulting from adopting higher CAFE standards is likely to be reflected in reduced U.S. imports of refined fuel, while the remaining 50 percent would reduce domestic fuel refining.[667] 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.[668] 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.[669]

ii. Benefits From Reducing U.S. Petroleum Imports

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. petroleum 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.[670] Reducing these costs by lowering U.S. petroleum imports represents another source of benefits from stricter CAFE standards and the savings in consumption of petroleum-based fuels that would result from higher fuel economy. 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.

The first component of the external costs imposed by U.S. petroleum consumption and imports (often termed the ''monopsony cost'' of U.S. oil imports), measures the increase in payments from domestic oil consumers 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.[671] However, this monopsony cost or premium represents a financial transfer from consumers of petroleum products to oil producers, and does not entail the consumption of real economic resources. Thus the decline in its value that occurs when reduced U.S. demand for petroleum products causes a decline in global petroleum prices produces no savings in 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 2017–2025 cars and light trucks excludes the reduced value of monopsony payments by U.S. oil consumers that would result from lower fuel consumption.

The second component of external costs imposed by U.S. petroleum consumption and imports reflects the potential costs to the U.S. economy from disruptions in the supply of imported petroleum. These costs arise because interruptions in the supply of petroleum products reduces U.S. economic output, as well as because firms are unable to adjust prices, output levels, and their use of energy, labor and other inputs smoothly and rapidly in response to the sudden changes in prices for petroleum products that are caused by interruptions in their supply. Reducing U.S. petroleum consumption and imports lowers these potential costs, and the amount by which it does so represents an economic benefit in addition to the savings in fuel costs that result from higher fuel economy. NHTSA estimates and includes this value in its analysis of the economic benefits from adopting higher CAFE standards for MY 2017–2025 cars and light trucks.

The third component of external costs imposed by U.S. petroleum consumption and imports includes 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. NHTSA recognizes that potential national and energy security risks exist due to the possibility of tension over oil supplies. Much of the world's oil and gas supplies are located in countries facing social, economic, and demographic challenges,

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[666] 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).

[667] Differences in forecast annual U.S. imports of crude petroleum and refined products among the Reference, High Oil Price, and Low Oil Price scenarios analyzed in EIA's Annual Energy Outlook 2011 range from 35–74 percent of differences in projected annual gasoline and diesel fuel consumption in the U.S. These differences average 53 percent over the forecast period spanned by AEO 2011.

[668] Differences in forecast annual U.S. imports of crude petroleum among the Reference, High Oil Price, and Low Oil Price scenarios analyzed in EIA's Annual Energy Outlook 2011 range from 67–104 percent of differences in total U.S. refining of crude petroleum, and average 90 percent over the forecast period spanned by AEO 2011.

[669] This figure is calculated as 50 gallons + 50 gallons * 90% = 50 gallons + 45 gallons = 95 gallons.

[670] 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.

[671] 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.

thus making them even more vulnerable to potential local instability. Because of U.S. dependence on oil, the military could be called on to protect energy resources through such measures as securing shipping lanes from foreign oil fields. Thus, to the degree to which the proposed rules reduce reliance upon imported energy supplies or promote the development of technologies that can be deployed by either consumers or the nation's defense forces, the United States could expect benefits related to national security, reduced energy costs, and increased energy supply. Although NHTSA recognizes that there clearly is a benefit to the United States from reducing dependence on foreign oil, we have been unable to calculate the monetary benefit that the United States will receive from the improvements in national security expected to result from this program. We have therefore included *only* the macroeconomic disruption portion of the energy security benefits to estimate the monetary value of the total energy security benefits of this program. We have calculated energy security in very specific terms, as the reduction of both financial and strategic risks caused by potential sudden disruptions in the supply of imported petroleum to the U.S. Reducing the amount of oil imported reduces those risks, and thus increases the nation's energy security.

Similarly, while the costs for building and maintaining the SPR are more clearly attributable to U.S. petroleum consumption and imports, these costs have not varied historically in response to changes in U.S. oil import levels. Thus the agency has not attempted to estimate the potential reduction in the cost for maintaining the SPR that might result from lower U.S. petroleum imports, or to include an estimate of this value among the benefits of reducing petroleum consumption through higher CAFE standards.

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.[672] 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.[673] The updated ORNL study was subjected to a detailed peer review commissioned 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.[674] Finally, at the request of EPA, ORNL has repeatedly revised its estimates of external costs from U.S. oil imports to reflect changes in the outlook for world petroleum prices, as well as continuing changes in the structure and characteristics of global petroleum supply and demand.

As the preceding discussion indicates, NHTSA's analysis of benefits from adopting higher CAFE standards includes only the reduction in economic disruption costs that is anticipated to result from reduced consumption of petroleum-based fuels and the associated decline in U.S. petroleum imports. ORNL's updated analysis reports that this benefit, which is in addition to the savings in costs for producing fuel itself, is most likely to amount to $0.185 per gallon of fuel saved by requiring MY 2017–25 cars and light trucks to achieve higher fuel economy. However, considerable uncertainty surrounds this estimate, and ORNL's updated analysis also indicates that a range of values extending from a low of $0.091 per gallon to a high of $0.293 per gallon should be used to reflect this uncertainty.

We note that the calculation of energy security benefits does not include energy security costs associated with reliance on foreign sources of lithium and rare earth metals for HEVs and EVs. The agencies intend to attempt to quantify this impact for the final rule stage, and seek public input on information that would enable agencies to develop this analysis. NHTSA also seeks public input on the projections that energy security benefits will grow rapidly through 2025.

l. Air Pollutant Emissions

i. Changes in Criteria Air Pollutant Emissions

Criteria air pollutants 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). These pollutants are emitted during vehicle storage and use, as well as throughout the fuel production and distribution system. While reductions in domestic fuel refining, storage, and distribution that result from lower fuel consumption will reduce emissions of these pollutants, additional vehicle use associated with the fuel economy rebound effect will increase their emissions. The net effect of stricter CAFE standards on total emissions of each criteria pollutant depends on the relative magnitude of reductions in its emissions during fuel refining and distribution, and increases in its emissions resulting from additional 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.

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 for each vehicle class, fuel type, model year, and age. These emission rates were developed by U.S. EPA using its Motor Vehicle Emission Simulator (MOVES 2010a).[675] 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.[676] 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.

Changes in emissions of criteria air pollutants resulting from alternative increases in CAFE standards for MY

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[672] 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://www.esd.ornl.gov/eess/energy_analysis/files/ORNL6851.pdf* (last accessed October 11, 2011).

[673] 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://www.esd.ornl.gov/eess/energy_analysis/files/Leiby2007%20Estimating%20the%20Energy%20Security%20Benefits%20of%20Reduced%20U.S.%20Oil%20Imports%20ornl-tm-2007–028%20rev2007Jul25.pdf* (last accessed October 11, 2011).

[674] *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.

[675] 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.

[676] 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.

2017–2025 cars and light trucks are calculated from the differences between emissions under each alternative increase in CAFE standards, and emissions under the baseline alternative.

Emissions of criteria air pollutants also occur during each phase of fuel production and distribution, including crude oil extraction and transportation, fuel refining, and fuel storage and transportation. NHTSA estimates 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, which provides estimates of air pollutant emissions that occur in different phases of fuel production and distribution.[677] [678] 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.

The resulting emission rates were applied to the agency's estimates of fuel consumption under alternative CAFE standards to develop estimates of total emissions of each criteria pollutant during fuel production and distribution. The agency then employed the estimates of the effects of *changes* in fuel consumption on domestic and imported sources of fuel supply discussed previously to calculate the effects of reductions in fuel use 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. Finally, reduced domestic fuel refining using domestically produced crude oil is assumed to reduce emissions during all four phases of fuel production and distribution.[679]

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.[680] As indicated previously, the effect of adopting higher CAFE standards on total emissions of each criteria pollutant depends on the relative magnitude 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 for MY 2017–25 cars and light trucks would reduce emissions of all criteria air pollutants except carbon monoxide (CO).

The net changes in direct emissions of fine particulates ($PM_{2.5}$) and other criteria pollutants that contribute to the formation of ''secondary'' fine particulates in the atmosphere (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 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 ($PM_{2.5}$) accounts 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 air pollutants (ozone, NO_2, and SO_2) and air toxics. EPA estimates different per-ton values for reducing emissions of PM and other criteria pollutants from vehicle use than for reductions in emissions of those same pollutants during fuel production and distribution.[681] NHTSA applies these separate values to its estimates of changes in emissions from vehicle use and from fuel production and distribution to determine the net change in total economic damages from emissions of these pollutants.

EPA projects that the per-ton values for reducing emissions of criteria pollutants from both mobile sources (including motor vehicles) and stationary sources such as fuel refineries and storage facilities will increase over time. These projected increases reflect rising income levels, which are assumed to increase affected individuals' willingness to pay for reduced exposure to health threats from air pollution, as well as future population growth, which increases population exposure to future levels of air pollution.

ii. Reductions in CO_2 Emissions

Emissions of carbon dioxide and other greenhouse gases (GHGs) occur throughout the process of producing and distributing transportation fuels, as well as from fuel combustion itself. Emissions of GHGs also occur in generating electricity, which NHTSA's analysis anticipates will account for an increasing share of energy consumption by cars and light trucks produced in the model years that would be subject to their proposed rules. 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 system. 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

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[677] Argonne National Laboratories, *The Greenhouse Gas and Regulated Emissions in Transportation (GREET) Model,* Version 1.8, June 2007, *available at http://www.transportation.anl.gov/modeling_simulation/GREET/index.html* (last accessed October 11, 2011).

[678] 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.

[679] 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 transport, our analysis of downstream criteria pollutant impacts assumes no change in the composition of the gasoline fuel supply.

[680] 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.

[681] 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.

by more 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. Because carbon dioxide emissions account for nearly 95 percent of total GHG emissions that result from fuel combustion during vehicle use, NHTSA's analysis of the effect of higher CAFE standards on GHG emissions focuses mainly on estimating changes in emissions of CO_2. The agency estimates 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.

NHTSA estimates emissions of CO_2 that occur during fuel production and distribution using emission rates for each stage of this process (feedstock production and transportation, fuel refining and fuel storage and distribution) derived from Argonne National Laboratories' Greenhouse Gases and Regulated Emissions in Transportation (GREET) model. For liquid fuels, NHTSA converts these rates to a per-gallon basis using the energy content of each fuel, and multiplies them by the number of gallons of each type of fuel produced and consumed under alternative standards to estimate total CO_2 emissions from fuel production and distribution. GREET supplies emission rates for electricity generation that are expressed as grams of CO_2 per unit of energy, so these rates are simply multiplied by the estimates of electrical energy used to charge the on-board storage batteries of plug-in hybrid and battery electric vehicles. As with all other effects of alternative CAFE standards, the reduction in CO_2 emissions resulting from each alternative increase in standards is measured by the difference in total emissions from producing and consuming fuel energy used by MY 2017–25 cars and light trucks with those higher CAFE standards in effect, and total CO_2 emissions from supplying and using fuel energy consumed under the baseline alternative. Unlike criteria pollutants, the agency's estimates of CO_2 emissions include those occurring in domestic fuel production and consumption, as well as in overseas production of petroleum and refined fuel for export to the U.S. Overseas emissions are included because GHG emissions throughout the world contribute equally to the potential for changes in the global climate.

iii. Economic Value of Reductions in CO_2 Emissions

NHTSA takes the economic benefits from reducing CO_2 emissions into account in developing and analyzing the alternative CAFE standards it has considered for MY 2017–25. Because research on the impacts of climate change does not produce direct estimates of the economic benefits from reducing CO_2 or other GHG emissions, these benefits are assumed to be the ''mirror image'' of the estimated incremental costs resulting from increases in 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 agency does not include estimates of the economic benefits from reducing GHGs other than CO_2 in its analysis of alternative CAFE standards.

NHTSA estimates the value of the reductions in emissions of CO_2 resulting from adopting alternative CAFE standards using a measure referred to as the ''social cost of carbon,'' abbreviated SCC. The SCC is intended to provide a monetary measure of the additional economic impacts likely to result from changes in the global climate that would result from an incremental increase in CO_2 emissions. These potential effects include changes in agricultural productivity, the economic damages caused by adverse effects on human health, property losses and damages resulting from rising sea levels, and the value of ecosystem services. The SCC is expressed in constant dollars per additional metric ton of CO_2 emissions occurring during a specific year, and is higher for more distant future years because the damages caused by an additional ton of emissions increase with larger concentrations of CO_2 in the earth's atmosphere.

Reductions in CO_2 emissions that are projected to result from lower fuel production and consumption during each year over the lifetimes of MY 2017–25 cars and light trucks are multiplied by the estimated SCC appropriate for that year to determine the economic benefit from reducing emissions during that year. The net present value of these annual benefits is calculated using a discount rate that is consistent with that used to develop the estimate of each SCC estimate. This calculation is repeated for the reductions in CO_2 emissions projected to result from each alternative increase in CAFE standards.

NHTSA evaluates the economic benefits from reducing CO_2 emissions using estimates of the SCC developed by an interagency working group convened for the specific purpose of developing new estimates for use by U.S. Federal agencies in regulatory evaluations. The group's purpose in developing new estimates of the SCC was to allow Federal agencies to incorporate the social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions that have relatively modest impacts on cumulative global emissions, as most Federal regulatory actions can be expected to have. NHTSA previously relied on the SCC estimates developed by this interagency group to analyze the alternative CAFE standards it considered for MY 2012–16 cars and light trucks, as well as the fuel efficiency standards it adopted for MY 014–18 heavy-duty vehicles.

The interagency group convened on a regular basis over the period from June 2009 through February 2010, to explore technical literature in relevant fields and develop key inputs and assumptions necessary to generate estimates of the SCC. Agencies participating 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 interagency group's main objective was to develop a range of SCC values using clearly articulated input assumptions grounded in the existing scientific and economic literatures, in conjunction with a range of models that employ different representations of climate change and its economic impacts. The group clearly acknowledged the many uncertainties that its process identified, and recommended that its estimates of the SCC should be updated periodically to incorporate developing knowledge of the science and economics of climate impacts. Specifically, it set a preliminary goal to revisit the SCC values within two years, or as substantial improvements in understanding of the science and economics of climate impacts and updated models for estimating and valuing these impacts become available. The group ultimately selected four SCC values for use in federal regulatory analyses. Three values were based on the average of SCC estimates developed using three different climate economic models (referred to as integrated assessment models), using discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95th percentile SCC estimate from the combined distribution of values generated by the three models at a 3 percent discount rate, represents the possibility of possibility of higher-than-expected impacts from the accumulation of GHGs in the earth's atmosphere, and the consequently larger economic damages.

Table IV–10 summarizes the interagency group's estimates of the SCC during various future years, which the agency has updated to 2009 dollars to correspond to the other values it uses to estimate economic benefits from the alternative CAFE standards considered in this NPRM.[682]

Table IV-9. Summary of Published Estimates of the Rebound Effect

Category of Estimates	Number of Studies	Number of Estimates	Range		Distribution		
			Low	High	Median	Mean	Std. Dev.
All Estimates	23	72	7%	75%	21%	23%	13%
Published Estimates	17	50	7%	75%	22%	24%	14%
Authors' Preferred Estimates	17	17	9%	75%	22%	22%	15%
U.S. Time-Series Estimates	7	34	7%	45%	14%	18%	9%
Household Survey Estimates	13	23	9%	75%	31%	31%	16%
Pooled U.S. State Estimates	3	15	8%	58%	22%	23%	12%
Constant Rebound Effect (1)	15	37	7%	75%	20%	23%	16%
Variable Rebound Effect (1) Reported Estimates	10	29	10%	45%	23%	23%	10%
Updated to 2010 (2)	11	33	6%	56%	15%	19%	13%

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[682] The SCC estimates reported in the table assume that the damages resulting from increased emissions are constant for small departures from the baseline emissions forecast incorporated in each estimate, an approximation that is reasonable for policies with projected effects on CO_2 emissions that are small relative to cumulative global emissions.

Table IV-10. Social Cost of CO_2 Emissions for Selected Future Years (2009$ per metric ton)

Discount Rate	**5%**	**3%**	**2.5%**	**3%**
Source	Average of estimates			95th percentile estimate
2012	$5.28	$23.06	$37.53	$70.14
2015	$5.93	$24. 58	$39.57	$74.03
2020	$7.01	$27.10	$42.98	$83.17
2025	$8. 53	$30.43	$47.28	$93.11
2030	$10.05	$33.75	$51.58	$103.06
2035	$11.57	$37.08	$55.88	$113.00
2040	$13.09	$40.40	$60.19	$122.95
2045	$14.63	$43. 34	$63.59	$131.66
2050	$16.18	$46.27	$66.99	$140.37

As Table IV–10 shows, the four SCC estimates selected by the interagency group for use in regulatory analyses are $5, $23, $38, and $70 per metric ton (in 2009 dollars) for emissions occurring in the year 2012. The value that the interagency group centered its attention on is the average SCC estimate developed using different models and a 3 percent discount rate, or $23 per metric ton in 2012. 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 average SCC at the 3 percent discount rate increases to $27 per metric ton of CO_2 by 2020 and reaches $46 per metric ton of CO_2 in 2050.

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.[683]

m. Discounting Future Benefits and Costs

Discounting future fuel savings and other benefits accounts for the reduction in their value when they are deferred until some future date, rather than received immediately. The value of benefits that are not expected to occur until the future is lower partly because people value current consumption more highly than equivalent consumption at some future date—stated simply, they are impatient—and partly because they expect their living standards to be higher in the future, so additional consumption will improve their well-being by more today than it will in the future. The discount rate expresses the percent decline in the value of these benefits—as viewed from today's perspective—for each year they are deferred into the future. In evaluating the benefits from alternative increases in CAFE standards for MY 2017–2025 passenger cars and light trucks, NHTSA primarily employs a discount rate of 3 percent per year, but in accordance with OMB guidance, also presents these benefit and cost estimates using a 7 percent discount rate.

While it presents results that reflect both discount rates, NHTSA believes that the 3 percent rate is more appropriate for discounting future benefits from increased CAFE standards, because the agency expects that most or all of vehicle manufacturers' costs for complying with higher CAFE standards will ultimately be reflected in higher selling 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

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[683] This document is available in the docket for the 2012–2016 rulemaking (NHTSA–2009–0059).

should be discounted at consumers' rate of time preference.[684]

Current 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 the future. Since the real interest rate that savers require to persuade them to defer consumption into the future represents a reasonable estimate of consumers' rate of time preference, NHTSA believes that the 3 percent rate is appropriate for discounting projected future benefits and costs resulting from higher CAFE standards.

Because there is some 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 benefit and cost estimates discounted using a higher rate. To the extent that manufacturers are unable to recover their costs for meeting higher CAFE standards by increasing new vehicle prices, these costs are likely to displace other investment opportunities available to them. 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.[685] Thus the agency's analysis of alternative increases in CAFE standards for MY 2017–25 cars and light trucks also reports benefits and costs discounted at a 7 percent rate.

One important exception to the agency's use of 3 percent and 7 percent discount rates is arises in discounting benefits from reducing CO_2 emissions over the lifetimes of MY 2017–2025 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 (or SCC), the benefits from reducing CO_2 emissions during each future year are discounted using the same ''intergenerational'' discount rates that were used to derive each of the alternative values. As indicated in Table IV–10 above, these rates are 2.5 percent, 3 percent, and 5 percent depending on which estimate of the SCC is being employed.[686]

n. Accounting for Uncertainty in Benefits and Costs

In analyzing the uncertainty surrounding its estimates of benefits and costs from alternative CAFE standards, NHTSA considers 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 anticipated effectiveness in reducing 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 was previously identified in the sections of this notice discussing each variable.

The uncertainty analysis was conducted by assuming either independent normal or beta probability distributions for each of these variables, using the low and high estimates for each variable as the values between which 90 percent of observed values are expected to fall. Each trial of the uncertainty analysis employed a set of values randomly drawn from these probability distributions, under the assumption that the value of each variable is independent from those of the others. In cases where the data on the possible distribution of parameters was relatively sparse, making a choice of distributions difficult, a beta distribution is commonly employed to give more weight to both tails than would be the case had a normal distribution been employed. Benefits and costs of each alternative standard were estimated using each combination of variables, and a total of nearly 40,000 trials were used to estimate the likely range of estimated benefits and costs for each alternative standard.

o. Where can readers find more information about the economic assumptions?

Much more detailed information is provided in Chapter VIII of the PRIA, and a discussion of how NHTSA and EPA jointly reviewed and updated economic assumptions for purposes of this proposal is available in Chapter 4 of the draft 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 proposed rule, NHTSA–2010–0131, and on NHTSA's Web site.[687]

Finally, because much of NHTSA's economic analysis for purposes of this proposal builds on the work that was done for the final rule establishing CAFE standards for MYs 2012–16, we refer readers to that document as well. It contains valuable 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.[688]

4. How does NHTSA use the assumptions in its modeling analysis?

In developing today's proposed CAFE standards, NHTSA has made significant use of results produced by the CAFE Compliance and Effects Model (commonly referred to as ''the CAFE Model'' or ''the Volpe model''), which DOT's Volpe National Transportation Systems Center developed specifically to support NHTSA's CAFE rulemakings. The model, which has been constructed specifically for the purpose of analyzing potential CAFE standards, integrates the following core capabilities:

(1) Estimating how manufacturers could apply technologies in response to new fuel economy standards,

(2) Estimating the costs that would be incurred in applying these technologies,

(3) Estimating the physical effects resulting from the application of these technologies, such as changes in travel demand, fuel consumption, and emissions of carbon dioxide and criteria pollutants, and

(4) Estimating the monetized societal benefits of these physical effects.

An overview of the model follows below. Separate model documentation provides a detailed explanation of the functions the model performs, the calculations it performs in doing so, and how to install the model, construct inputs to the model, and interpret the model's outputs. Documentation of the model, along with model installation files, source code, and sample inputs are available at NHTSA's Web site. The model documentation is also available in the docket for today's proposed rule, as are inputs for and outputs from

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[684] *Id.*

[685] 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 Sept. 26, 2011).

[686] 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.

[687] *See http://www.nhtsa.gov/fuel-economy.*

[688] 74 FR 14308–14358 (Mar. 30, 2009).

analysis of today's proposed CAFE standards.

a. How does the model operate?

As discussed above, the agency uses the CAFE 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.[689] The model applies technologies to each of the projected individual vehicles in a manufacturer's fleet, considering the combined effect of regulatory and market incentives. Depending on how the model is exercised, it will apply technology until one of the following occurs:

(1) The manufacturer's fleet achieves compliance [690] with the applicable standard, and continuing to add technology in the current model year would be attractive neither in terms of stand-alone (*i.e.,* absent regulatory need) cost effectiveness nor in terms of facilitating compliance in future model years; [691]

(2) The manufacturer ''exhausts'' [692] 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.[693]

As discussed below, the model has also been modified in order to—as an option—apply more technology than may be necessary to achieve compliance in a given model year, or to facilitate compliance in later model years. This ability to simulate ''voluntary overcompliance'' reflects the potential that manufacturers will apply some technologies to some vehicles if doing so would be sufficiently inexpensive compared to the expected reduction in owners' outlays for fuel.

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 that level, while ensuring ratable increases in average fuel economy.[694] The multiyear planning capability and (optional) simulation of ''voluntary overcompliance'' and EPCA credit mechanisms increase 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.[695] 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 CAFE model has other capabilities that facilitate the development of a CAFE standard. The integration of (a) Compliance simulation and (b) the calculation of costs, effects,

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[689] 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).

[690] The model has been modified to provide the ability—as an option—to account for credit mechanisms (*i.e.,* carry-forward, carry-back, transfers, and trades) when determining whether compliance has been achieved. For purposes of determining maximum feasible CAFE standards, NHTSA cannot consider these mechanisms, and exercises the CAFE model without enabling these options.

[691] In preparation for the MY 2012–2016 rulemaking, the model was 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.

[692] 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.

[693] 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).

[694] 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.

[695] As for all of its other rulemakings, NHTSA is required by Executive Order 12866 (as amended by Executive Order 13563) 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).

and benefits facilitates analysis of sensitivity of results to model inputs. The model 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?

As discussed in the most recent CAFE rulemaking, while nothing in EPCA requires NHTSA to use the CAFE model, and in principle, NHTSA could perform all of these tasks through other means, the model's 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.[696]

NHTSA notes that the CAFE model not only has been formally peer-reviewed and tested and reviewed 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. 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. In response to comments regarding an early version of the CAFE model, 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.

The CAFE 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. By 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

The CAFE 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 CAFE 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?

Between promulgation of the MY 2012–2016 CAFE standards and today's proposal regarding MY 2017–2025 standards, the CAFE model has been revised to make some minor improvements, and to add some significant new capabilities: (1) Accounting for electricity used to charge electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs), (2) accounting for use of ethanol blends in flexible-fuel vehicles (FFVs), (3) accounting for costs (*i.e.,* ''stranded capital'') related to early replacement of technologies, (4) accounting for previously-applied technology when determining the extent to which a manufacturer could expand use of the technology, (5) applying technology-specific estimates of changes in consumer value, (6) simulating the extent to which manufacturers might utilize EPCA's provisions regarding generation and use of CAFE credits, (7) applying estimates of fuel economy adjustments (and accompanying costs) reflecting increases in air conditioner efficiency, (8) reporting privately-valued benefits, (9) simulating the extent to which manufacturers might voluntarily apply technology beyond levels needed for compliance with CAFE standards, and (10) estimating changes in highway fatalities attributable to any applied reductions in vehicle mass. These capabilities are described below, and in greater detail in the CAFE model documentation.[697]

To support evaluation of the effects electric vehicles (EVs) and plug-in hybrid vehicles (PHEVs) could have on energy consumption and associated costs and environmental effects, DOT has expanded the CAFE model to estimate the amount of electricity that would be required to charge these vehicles (accounting for the potential that PHEVs can also run on gasoline). The model calculates the cost of this electricity, as well as the accompanying upstream criteria pollutant and greenhouse gas emissions.

Similar to this expansion to account for the potential the PHEVs can be refueled with gasoline or recharged with electricity, DOT has expanded the CAFE model to account for the potential that other flexible-fuel vehicles can be operated on multiple fuels. In particular, the model can account for ethanol FFVs consuming E85 or gasoline, and to report consumption of both fuels, as well as corresponding costs and upstream emissions.

Among the concerns raised in the past regarding how technology costs are estimated has been one that stranded capital costs be considered. Capital becomes ''stranded'' when capital equipment is retired or its use is discontinued before the equipment has been fully depreciated and the equipment still retains some value or usefulness. DOT has modified the CAFE model to, if specified for a given technology, when that technology is replaced by a newly applied technology, apply a stream of costs representing the stranded capital cost of the replaced technology. This cost is in addition to the cost for producing the newly

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[696] 75 FR 25598–25599.

[697] Model documentation is available on NHTSA's Web site.

applied technology in the first year of production.

As documented in prior CAFE rulemakings, the CAFE model applies ''phase-in caps'' to constrain technology application at the vehicle manufacturer level. They are intended to reflect a manufacturer's overall resource capacity available for implementing new technologies (such as engineering and development personnel and financial resources), thereby ensuring that resource capacity is accounted for in the modeling process. This helps to ensure technological feasibility and economic practicability in determining the stringency of the standards. When the MY 2012–2016 rulemaking analysis was completed, the model performed the relevant test by comparing a given phase-in cap to the amount (*i.e.,* the share of the manufacturer's fleet) to which the technology had been added by the model. DOT has since modified the CAFE model to take into account the extent to which a given manufacturer has already applied the technology (*i.e.,* as reflected in the market forecast specified as a model inputs), and to apply the relevant test based on the total application of the technology.

The CAFE model requires inputs defining the technology-specific cost and efficacy (*i.e.,* percentage reduction of fuel consumption), and has, to date, effectively assumed that these input values reflect application of the technology in a manner that holds vehicle performance and utility constant. Considering that some technologies may, nonetheless, offer owners greater or lesser value (beyond that related to fuel outlays, which the model calculates internally based on vehicle fuel type and fuel economy), DOT has modified the CAFE model to accept and apply technology-specific estimates of any value gain realized or loss incurred by vehicle purchasers.[698]

For the MY 2012–2016 CAFE rulemaking analysis, DOT modified the CAFE model to accommodate specification and accounting for credits a manufacturer is assumed to earn by producing flexible fuel vehicles (FFVs). Although NHTSA cannot consider such credits when determining maximum feasible CAFE standards, the agency presented an analysis that included FFV credits, in order to communicate the extent to which use of such credits might cause actual costs, effects, and benefits to be lower than estimated in NHTSA's formal analysis. As DOT explained at the time, it was unable to account for other EPCA credit mechanisms, because attempts to do so had been limited by complex interactions between those mechanisms and the multiyear planning aspects of the CAFE model. DOT has since modified the CAFE model to provide the ability to account for any or all of the following flexibilities provided by EPCA: FFV credits, credit carry-forward and carry-back (between model years), credit transfers (between passenger car and light truck fleets), and credit trades (between manufacturers). The model accounts for EPCA-specified limitations applicable to these flexibilities (*e.g.,* limits on the amount of credit that can be transferred between passenger car and light truck fleets). These capabilities in the model provide 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 the ability to examine outcomes more realistically than EPCA allows for purposes of setting new CAFE standards.

NHTSA is today proposing CAFE standards reflecting EPA's proposal to change fuel economy calculation procedures such that a vehicle's fuel consumption improvement will be accounted for if the vehicle has technologies that reduce the amount of energy needed to power the air conditioner. To facilitate analysis of these standards, DOT has modified the CAFE model to account for these adjustments, based on inputs specifying the average amount of improvement anticipated, and the estimated average cost to apply the underlying technology.

Considering that past CAFE rulemakings indicate that most of the benefits of CAFE standards are realized by vehicle owners, DOT has modified the CAFE model to estimate not just social benefits, but also private benefits. The model accommodates separate discount rates for these two valuation methods (*e.g.,* a 3% rate for social benefits with a 7% rate for private benefits). When calculating private benefits, the model includes changes in outlays for fuel taxes (which, as economic transfers, are excluded from social benefits) and excludes changes in economic externalities (*e.g.,* monetized criteria pollutant and greenhouse gas emissions).

Since 2003, the CAFE model (and its predecessors) have provided the ability to estimate the extent to which a manufacturer with a history of paying civil penalties allowed under EPCA might decide to add some fuel-saving technology, but not enough to comply with CAFE standards. In simulating this decision-making, the model considers the cost to add the technology, the calculated reduction in civil penalties, and the calculated present value (at the time of vehicle purchase) of the change in fuel outlays over a specified ''payback period'' (*e.g.,* 5 years). For a manufacturer assumed to be willing to pay civil penalties, the model stops adding technology once paying fines becomes more attractive than continuing to add technology, considering these three factors. As an extension of this simulation approach, DOT has modified the CAFE model to, if specified, simulate the potential that a manufacturer would add more technology than required for purposes of compliance with CAFE standards. When set to operate in this manner, the model will continue to apply technology to a manufacturer's CAFE-compliant fleet until applying further technology will incur more in cost than it will yield in calculated fuel savings over a specified ''payback period'' that is set separately from the payback period applicable until compliance is achieved. In its analysis supporting MY 2012–2016 standards adopted in 2010, NHTSA estimated the extent to which reductions in vehicle mass might lead to changes in the number of highway fatalities occurring over the useful life of the MY 2012–2016 fleet. NHTSA performed these calculations outside the CAFE model (using vehicle-specific mass reduction calculations from the model), based on agency analysis of relevant highway safety data. DOT has since modified the CAFE model to perform these calculations, using an analytical structure indicated by an update to the underlying safety analysis. The model also applies an input value indicating the economic value of a statistical life, and includes resultant benefits (or disbenefits) in the calculation of total social benefits.

In comments on recent NHTSA rulemakings, some reviewers have suggested that the CAFE 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 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. NHTSA has contracted with the Brookings Institution (which has subcontracted with researchers at U.C. Davis, U.C. Irvine) to develop a vehicle choice model estimated at the vehicle configuration level that can be

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[698] For example, a value gain could be specified for a technology expected to improve ride quality, and a value loss could be specified for a technology expected to reduce vehicle range.

implemented as part of DOT's CAFE model. As discussed further in Section V of the PRIA, past efforts by DOT staff demonstrated that a vehicle could be added to the CAFE model, but did not yield credible coefficients specifying such a model. If a suitable and credibly calibrated vehicle choice model becomes available in time—whether through the Brookings-led research or from other sources, DOT may integrate a vehicle choice model into the CAFE model for the final rule.

NHTSA anticipates this integration of a vehicle choice model would be structurally and operationally similar to the integration we implemented previously. As under the version applied in support of today's announcement, the CAFE model would begin with an agency-estimated market forecast, estimate to what extent manufacturers might apply additional fuel-saving technology to each vehicle model in consideration of future fuel prices and baseline or alternative CAFE standards and fuel prices, and calculate resultant changes in the fuel economy (and possibly fuel type) and price of individual vehicle models. With an integrated market share model, the CAFE model would then estimate how the sales volumes of individual vehicle models would change in response to changes in fuel economy levels and prices throughout the light vehicle market, possibly taking into account interactions with the used vehicle market. Having done so, the model would replace the sales estimates in the original market forecast with those reflecting these model-estimated shifts, repeating the entire modeling cycle until converging on a stable solution.

Based on past experience, we anticipate that this recursive simulation will be necessary to ensure consistency between sales volumes and modeled fuel economy standards, because achieved CAFE levels depend on sales mix and, under attribute-based CAFE standards, required CAFE levels also depend on sales mix. NHTSA anticipates, therefore, that application of a market share model would impact estimates of all of the following for a given schedule of CAFE standards: overall market volume, manufacturer market shares and product mix, required and achieved CAFE levels, technology application rates and corresponding incurred costs, fuel consumption, greenhouse gas and criteria pollutant emissions, changes in highway fatalities, and economic benefits.

Past testing by DOT/NHTSA staff did not indicate major shifts in broad measures (*e.g.,* in total costs or total benefits), but that testing emphasized shorter modeling periods (*e.g.,* 1–5 model years) and less stringent standards than reflected in today's proposal. Especially without knowing the characteristics of a future vehicle choice model, it is difficult to anticipate the potential degree to which its inclusion would impact analytical outcomes.

NHTSA invites comment on the above changes to the CAFE model. The agency's consideration of any alternative approaches will be facilitated by specific recommendations regarding implementation within the model's overall structure. NHTSA also invites comment regarding above-mentioned prospects for inclusion of a vehicle choice model. The agency's consideration will be facilitated by specific information demonstrating that inclusion of such a model would lead to more realistic estimates of costs, effects, and benefits, or that inclusion of such a model would lead to less realistic estimates.

d. Does the model set the standards?

Since NHTSA began using the CAFE 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. As the agency explained in its most recent CAFE rulemaking, this is incorrect.[699] Although NHTSA currently uses the CAFE model as a tool to inform its consideration of potential CAFE standards, the CAFE 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. 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.

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)[700] 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 proposal are available in the public docket. With the model and these input files, anyone is capable of independently running the model to repeat, evaluate, and/or modify the agency's analysis.

Because the model is available on NHTSA's web site, the agency has no way of knowing how widely the model has been used. The agency is, however, aware that the model has been used by other federal agencies, vehicle manufacturers, private consultants, academic researchers, and foreign governments. Some of these individuals have found the model complex and challenging to use. Insofar as the model's sole purpose is to help DOT staff efficiently analyze potential CAFE standards, DOT has not expended significant resources trying to make the model as "user friendly" as commercial software intended for wide use. However, DOT wishes to facilitate informed comment on the proposed standards, and encourages reviewers to contact the agency promptly if any difficulties using the model are encountered.

NHTSA arranged for a formal peer review of an older version of the model, has responded to reviewers' comments, and has considered and responded to model-related comments received over the course of four CAFE rulemakings. In the agency's view, this steady and expanding outside review over the course of nearly a decade of model development has helped DOT to significantly strengthen the model's capabilities and technical quality, and has greatly increased transparency, such that all model code is publicly available, and all model inputs and outputs are publicly available in a form that should allow reviewers to reproduce the agency's analysis. NHTSA is currently preparing arrangements for a formal peer review of the current CAFE model. Depending on the schedule for that

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[699] 75 FR 25600.

[700] 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.

review, DOT will consider possible model revisions and, as feasible, attempt to make any appropriate revisions before performing analysis supporting final CAFE standards for MY 2017 and beyond.

D. Statutory Requirements

1. EPCA, as Amended by EISA

a. Standard Setting

EPCA, as amended by EISA, contains a number of provisions regarding how NHTSA must set CAFE standards. NHTSA must establish separate CAFE standards for passenger cars and light trucks[701] for each model year,[702] and each standard must be the maximum feasible that NHTSA believes the manufacturers can achieve in that model year.[703] When determining the maximum feasible 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.[704] 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, and the balance may shift depending on the information before the agency about the expected circumstances in the model years covered by the rulemaking. Always in conducting that balancing, however, the implication of the ''maximum feasible'' requirement is that it calls for setting a standard that exceeds what might be the minimum requirement if the agency determines that the manufacturers can achieve a higher level, and that the agency's decision support the overarching purpose of EPCA, energy conservation.[705]

Besides the requirement that standards be maximum feasible for the fleet in question, EPCA/EISA also contains several other requirements. The standards must be attribute-based and expressed in the form of a mathematical function—NHTSA has thus far based standards on vehicle footprint, and for this rulemaking has expressed them in the form of a constrained linear function that generally sets higher (more stringent) mpg targets for smaller-footprint vehicles and lower (less stringent) mpg targets for larger-footprint vehicles. Second, 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.[706] Third, between MY 2011 and MY 2020, the standards must ''increase ratably'' in each model year.[707] 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. The second and third requirements no longer apply after MY 2020, at which point standards must simply be maximum feasible. And fourth, EISA requires NHTSA to issue CAFE standards for ''at least 1, but not more than 5, model years.''[708] This issue is discussed in section IV.B above.

The following sections discuss the statutory factors behind ''maximum feasible'' in more detail.

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. There are certain technologies that the agency has considered for this rulemaking, for example, that we know to be in the research phase now but which we are fairly confident can be commercially applied by the rulemaking timeframe, and very confident by the end of the rulemaking timeframe. It is important to remember, however, that while the technological feasibility factor may encourage the agency to look toward more technology-forcing standards, and while this could certainly be appropriate given EPCA's overarching purpose of energy conservation depending on the rulemaking, that factor must also be balanced with the other of the four statutory factors. Thus, while ''technological feasibility'' can drive standards higher by assuming the use of technologies that are not yet commercial, ''maximum feasible'' is still also defined in terms of economic practicability, for example, which might caution the agency against basing standards (even fairly distant future standards) entirely on such technologies. By setting standards at levels consistent with an analysis that assumes the use of these nascent technologies at levels that seem reasonable, the agency believes a more reasonable balance is ensured. Nevertheless, as the ''maximum feasible'' 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.''[709] The agency has explained in the past that this factor can be especially important during rulemakings in which the automobile industry is facing significantly adverse economic conditions (with corresponding risks to jobs). Consumer acceptability is also an element of economic practicability, one which is particularly difficult to gauge during times of uncertain fuel prices.[710]

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[701] 49 U.S.C. 32902(b)(1).

[702] 49 U.S.C. 32902(a).

[703] *Id.*

[704] 49 U.S.C. 32902(f).

[705] *Center for Biological Diversity* v. *NHTSA,* 538 F.3d 1172, 1197 (9th Cir. 2008) (''Whatever method it uses, NHTSA cannot set fuel economy standards that are contrary to Congress' purpose in enacting the EPCA—energy conservation.'').

[706] 49 U.S.C. 32902(b)(2)(A).

[707] 49 U.S.C. 32902(b)(2)(C).

[708] 49 U.S.C. 32902(b)(3)(B).

[709] 67 FR 77015, 77021 (Dec. 16, 2002).

[710] *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* v. *NHTSA,* 848 F.2d 256 (Congress established broad guidelines in the fuel economy statute; agency's decision to set lower

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In a rulemaking such as the present one, looking out into the more distant future, economic practicability is a way to consider the uncertainty surrounding future market conditions and consumer demand for fuel economy in addition to other vehicle attributes. 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 fleet that employ a particular type of fuel-saving technology, the specific fleet mixes of different manufacturers, and assumptions about the cost of the standards to consumers and consumers' valuation of fuel economy, among other things.

At the same time, however, 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.'' [711] 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.'' [712] 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. NHTSA has long held that the CAFE program is not necessarily intended to maintain the competitive positioning of each particular company. Rather, it is intended to enhance the fuel economy of the vehicle fleet on American roads, while protecting motor vehicle safety and being mindful of the risk to the overall United States economy.

Consequently, ''economic practicability'' 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 economic 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 establishing 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. We note that for this rulemaking, the agency can and has limited its application of technologies to those that are projected to be cost-effective within the rulemaking time frame, with or without the use of such analysis.

Whether the standards maximize net benefits has thus been a touchstone in the past for NHTSA's consideration of economic practicability. Executive Order 12866, as amended by Executive Order 13563, states that agencies should ''select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits * * *'' In practice, however, agencies, including NHTSA, must consider situations in which the modeling of net benefits does not capture all of the relevant considerations of feasibility. In this case, the NHTSA balancing of the statutory factors suggests that the maximum feasible stringency for this rulemaking points to another level besides the modeled net benefits maximum, and such a situation is well within the guidance provided by EO's 12866 and 13563.[713]

The agency's consideration of economic practicability depends on a number of factors. Expected availability of capital to make investments in new technologies matters; manufacturers' expected ability to sell vehicles with new technologies matters; likely consumer choices matter; and so forth. NHTSA's analysis of the impacts of this rulemaking does incorporate assumptions to capture aspects of consumer preferences, vehicle attributes, safety, and other factors relevant to an impact estimate; however, it is difficult to capture every such constraint. Therefore, it is well within the agency's discretion to deviate from a modeled net benefits maximum in the face of evidence of economic impracticability, and if the agency concludes that the modeled net benefits maximum would not represent the maximum feasible level for future CAFE standards. Economic practicability is a complex factor, and like the other factors must also 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 that are higher or lower, could be economically practicable, and thus maximum feasible.

(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, 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 [714] 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.'' [715] 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.[716] 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

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standard was a reasonable accommodation of conflicting policies).

[711] *CEI–I,* 793 F.2d 1322, 1352 (DC Cir. 1986).

[712] *Id.*

[713] *See* 70 FR at 51435 (Aug. 30, 2005); *CBD* v. *NHTSA,* 538 F.3d at 1197 (9th Cir. 2008).

[714] 42 FR 63184, 63188 (Dec. 15, 1977). *See also* 42 FR 33534, 33537 (Jun. 30, 1977).

[715] 42 FR 33534, 33537 (Jun. 30, 1977).

[716] That provision was deleted as obsolete when EPCA was codified in 1994.

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 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, granting of a waiver to California for its motor vehicle GHG standards, and its own establishment of GHG standards, NHTSA is confronted with the issue of how to treat those standards under EPCA/EISA, such as in the context of 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.

Comment is requested on whether and in what way the effects of the California and EPA standards should be considered under EPCA/EISA, *e.g.,* under the ''other motor vehicle standards'' provision, consistent with NHTSA's independent obligation under EPCA/EISA to issue CAFE standards. The agency has already considered EPA's proposal and the harmonization benefits of the National Program in developing its own proposal.

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

''The need of the United States to conserve energy'' means ''the consumer cost, national balance of payments, environmental, and foreign policy implications of our need for large quantities of petroleum, especially imported petroleum.'' [717] 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 energy 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, which is related to the consumer cost (or rather, benefit) of our need for large quantities of petroleum. In this rule, NHTSA relies on fuel price projections from the U.S. Energy Information Administration's (EIA) most recent 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 [718] 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.[719] 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. Reducing 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,[720] 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.'' [721] In 1988, NHTSA included climate change concepts in its CAFE notices and prepared its first environmental assessment addressing that subject.[722] 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.[723] Since then, NHTSA has considered the benefits of reducing tailpipe carbon dioxide emissions in its fuel economy

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[717] 42 FR 63184, 63188 (1977).

[718] 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.

[719] *See* Section IV.G below for NHTSA's evaluation of this effect.

[720] *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).

[721] 42 FR 63184, 63188 (Dec. 15, 1977) (emphasis added).

[722] 53 FR 33080, 33096 (Aug. 29, 1988).

[723] 53 FR 39275, 39302 (Oct. 6, 1988).

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

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 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 maximum feasible 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 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 prior rulemakings, NHTSA limited the application of mass reduction in our modeling analysis to vehicles over 5,000 lbs GVWR,[724] but for purposes of today's proposed standards, NHTSA has revised its modeling analysis to allow some application of mass reduction for most types of 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 approach to modeling manufacturer use of mass reduction is available in Chapter 3 of the draft Joint TSD and in Section V of the PRIA; and the estimated safety impacts that may be due to the proposed MY 2017–2025 CAFE standards are described in section IV.G 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.[725] 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 statutory 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. By keeping NHTSA from including them in our stringency determination, the provision ensures that the statutory credits remain described above remain true compliance flexibilities.

On the other hand, NHTSA does not believe that flexibilities other than those expressly identified in EPCA are similarly prohibited from being included in the agency's determination of what standards would be maximum feasible. In order to better meet EPCA's overarching purpose of energy conservation, the agency is therefore considering manufacturers' ability to increase the calculated fuel economy levels of their vehicles through A/C efficiency improvements, as proposed by EPA, in the proposed CAFE stringency levels for passenger cars and light trucks for MYs 2017–2025. NHTSA would similarly consider manufacturers' ability to raise their fuel economy using off-cycle technologies as potentially relevant to our determination of maximum feasible CAFE standards, but because we and EPA do not believe that we can yet reasonably predict an average amount by which manufacturers will take advantage of this opportunity, it did not seem reasonable for the proposed standards to include it in our stringency determination at this time. We expect to re-evaluate whether and how to include off-cycle credits in determining maximum feasible standards as the off-cycle technologies and how manufacturers may be expected to employ them become better defined in the future.

Additionally, because we interpret the prohibition against including the defined statutory credits in our determination of maximum feasible standards as applying only to the flexibilities expressly identified in 49 U.S.C. 32902(h), NHTSA must, for the first time in this rulemaking, determine how to consider the fuel economy of dual-fueled automobiles after the statutory credit sunsets in MY 2019. Once there is no statutory credit to protect as a compliance flexibility, it does not seem reasonable to NHTSA to continue to interpret the statute as prohibiting the agency from setting maximum feasible levels at a higher standard, if possible, by considering the fuel economy of dual-fueled automobiles as measured by EPA. The overarching purpose of EPCA is better served by interpreting 32902(h)(2) as moot once the statutory credits provided for in 49 U.S.C. 32905 and 32906 have expired.

49 U.S.C. 32905(b) and (d) states that the special fuel economy measurement prescribed by Congress for dual-fueled automobiles applies only ''in model years 1993 through 2019.'' 49 U.S.C. 32906(a) also provides that the section 32905 calculation will sunset in 2019, as evidenced by the phase-out of the

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[724] *See* 74 FR 14396–14407 (Mar. 30, 2009).

[725] 49 U.S.C. 32902(h).

allowable increase due to that credit; it is clear that the phase-out of the allowable increase in a manufacturer's CAFE levels due to use of dual-fueled automobiles relates only to the special statutory calculation (and not to other ways of incorporating the fuel economy of dual-fueled automobiles into the manufacturer's fleet calculation) by virtue of language in section 32906(b), which states that ''in applying subsection (a) [*i.e.,* the phasing out maximum increase], the Administrator of the Environmental Protection Agency shall determine the increase in a manufacturer's average fuel economy attributable to dual fueled automobiles by subtracting from the manufacturer's average fuel economy calculated under section 32905(e) the number equal to what the manufacturer's average fuel economy would be if it were calculated by the formula under section 32904(a)(1). * * * '' By referring back to the special statutory calculation, Congress makes clear that the phase-out applies only to increases in fuel economy attributable to dual-fueled automobiles due to the special statutory calculation in sections 32905(b) and (d). Similarly, we interpret Congress' statement in section 32906(a)(7) that the maximum increase in fuel economy attributable to dual-fueled automobiles is ''0 miles per gallon for model years after 2019'' within the context of the introductory language of section 32906(a) and the language of section 32906(b), which, again, refers clearly to the statutory credit, and not to dual-fueled automobiles generally. It would be an absurd result if the phase-out of the credit meant that manufacturers would be effectively penalized, in CAFE compliance, for building dual-fueled automobiles like plug-in hybrid electric vehicles, which may be important ''bridge'' vehicles in helping consumers move toward full electric vehicles.

NHTSA has therefore considered the fuel economy of plug-in hybrid electric vehicles (the only dual-fueled automobiles that we predict in significant numbers in MY 2020 and beyond; E85-capable FFVs are not predicted in great numbers after the statutory credit sunsets, and we do not have sufficient information about potential dual-fueled CNG/gasoline vehicles to make reasonable estimates now of their numbers in that time frame in determining the maximum feasible level of the MY 2020–2025 CAFE standards for passenger cars and light trucks.

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.'' [726] The breadth of those guidelines, the absence of any statutorily prescribed formula for balancing the factors and other considerations, 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 EPCA, energy conservation,[727] and as long as that balancing reasonably accommodates ''conflicting policies that were committed to the agency's care by the statute.'' [728] The balancing of the factors in any given rulemaking is highly dependent on the factual and policy context of that rulemaking and the agency's assumptions about the factual and policy context during the time frame covered by the standards at issue. Given the changes over time in facts bearing on assessment of the various factors, such as those relating to 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 or may not be a reasonable balancing of those priorities in another rulemaking.[729] 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. As discussed above, while NHTSA used marginal cost-benefit analysis in the first two rulemakings to establish attribute-based CAFE standards, it was not required to do so and is not required to continue to do so. Regardless of what type of analysis is or is not used, considerations relating to costs and benefits remain an important part of CAFE standard setting.

Because the relevant considerations and factors can reasonably be balanced in a variety of ways under EPCA, and because of uncertainties associated with the many technological and cost inputs, NHTSA considers a wide variety of alternative sets of standards, each reflecting different balancing of those policies and concerns, to aid it in discerning reasonable outcomes. Among the alternatives providing for an increase in the standards in this rulemaking, the alternatives range in stringency from a set of standards that increase, on average, 2 percent annually to a set of standards that increase, on average, 7 percent annually.

v. Other Standards

(1) Minimum Domestic Passenger Car Standard

The minimum domestic passenger car standard was added to the CAFE 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.[730] 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.

NHTSA has proposed minimum standards for domestically-manufactured passenger cars in Section IV.E below, but we also seek comment on whether to consider, for the final rule, the possibility of minimum standards for imported passenger cars and light trucks. Although we are not proposing such standards, we believe it may be prudent to explore this concept again given the considerable amount of time between now and 2017–2025 (particularly the later years), and the accompanying uncertainty in our market forecast and other assumptions,

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[726] *Center for Auto Safety* v. *NHTSA,* 793 F.2d 1322, 1341 (C.A.D.C. 1986).

[727] *Center for Biological Diversity* v. *NHTSA,* 538 F.3d 1172, 1195 (9th Cir. 2008).

[728] *CAS,* 1338 (quoting *Chevron U.S.A., Inc.* v. *Natural Resources Defense Council, Inc.,* 467 U.S. 837, 845).

[729] *CBD* v. *NHTSA,* 538 F.3d 1172, 1198 (9th Cir. 2008).

[730] 49 U.S.C. 32902(b)(4).

that might make such minimum standards relevant to help ensure that currently-expected fuel economy improvements occur during that time frame. To help commenters' consideration of this question, Section IV.E presents illustrative levels of minimum standards for those other fleets.

The minimum domestic passenger car standard was added to the CAFE program through EISA, when Congress gave NHTSA explicit authority to set universal standards for domestically-manufactured passenger cars at the level explained above. 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 with respect to minimum standards for imported passenger cars and light trucks 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 minimum 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.[731]

In the MYs 2012–2016 final rule where NHTSA declined to set minimum standards for imported passenger cars and light trucks, the agency did so not because we believed that we did not have authority to do so, but because we believed that our assumptions about the future fleet mix were reliable within the rulemaking time frame, and that backsliding was very unlikely and would not be sufficient to warrant the regulatory burden of additional minimum standards for those fleets.[732] NHTSA also expressed concern about the possibility of additional minimum standards imposing inequitable regulatory burdens of the kind that attribute-based standards sought to avoid, stating that:

> 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.[733]

NHTSA continues to believe that the risk of additional minimum standards imposing inequitable regulatory burdens on certain manufacturers is real, but at the same time, we recognize that given the time frame of the current rulemaking, the agency cannot be as certain about the unlikelihood of future market changes. Depending on the price of fuel and consumer preferences, the ''kind of industry-wide situation'' described in the MYs 2012–2016 rule is possible in the 2017–2025 time frame, particularly in the later years.

Because the agency does not have sufficient information at this time regarding what tradeoffs might be associated with additional minimum standards, specifically, whether the risk of backsliding during MYs 2017–2025 sufficiently outweighs the possibility of imposing inequitable regulatory burdens on certain manufacturers, we are seeking comment in this NPRM on these issues but not proposing additional minimum standards at this time. We also seek comment on how to structure additional minimum standards (*e.g.,* whether they should be flat or attribute-based, and if the latter, how that would work), and at what level additional minimum standards should potentially be set. The tables in Section IV.E provide an illustration of what levels the additional minimum standards would require if the agency followed the same 92 percent guideline required by EISA for domestically-manufactured passenger cars.

(2) Alternative Standards for Certain Manufacturers

Because EPCA states that standards must be set for '' * * * automobiles manufactured by manufacturers,'' and because Congress provided specific direction on how small-volume manufacturers could obtain exemptions from the passenger car standards, NHTSA has long interpreted its authority as pertaining to setting standards for the industry as a whole. Prior to this NPRM, some manufacturers raised with NHTSA the possibility of NHTSA and EPA setting alternate standards for part of the industry that met certain (relatively low) sales volume criteria—specifically, that separate standards be set so that ''intermediate-size,'' limited-line manufacturers do not have to meet the same levels of stringency that larger manufacturers have to meet until several years later. These manufacturers argued that the same level of standards would not be technologically feasible or economically practicable in the same time frame for them, due to their inability to spread compliance burden across a larger product lineup, and difficulty in obtaining fuel economy-improving technologies quickly from suppliers. NHTSA seeks comment on whether or how EPCA, as amended by EISA, could be interpreted to allow such alternate standards for certain parts of the industry.

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

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[731] 74 FR at 14412 (Mar. 30, 2009).

[732] 75 FR 25324, at 25368–70 (May 7, 2010).

[733] *Id.* at 25369.

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.''[734] The APA also requires that agencies provide notice and comment to the public when proposing regulations,[735] as we are doing here today.

3. National Environmental Policy Act

As discussed above, EPCA requires the agency to determine what level at which to set the CAFE standards for each model year by considering the four factors of technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy. NEPA directs that environmental considerations be integrated into that process. To accomplish that purpose, NEPA requires an agency to compare the potential environmental impacts of its proposed action to those of a reasonable range of alternatives.

To explore the environmental consequences in depth, NHTSA has prepared a draft environmental impact statement (''EIS''). The purpose of an EIS is to ''provide full and fair discussion of significant environmental impacts and [to] inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment.'' 40 CFR 1502.1.

NEPA is ''a procedural statute that mandates a process rather than a particular result.'' *Stewart Park & Reserve Coal., Inc.* v. *Slater,* 352 F.3d at 557. The agency's overall EIS-related obligation is to ''take a 'hard look' at the environmental consequences before taking a major action.'' *Baltimore Gas & Elec. Co.* v. *Natural Res. Def. Council, Inc.,* 462 U.S. 87, 97, 103 S.Ct. 2246, 76 L.Ed.2d 437 (1983). Significantly, ''[i]f the adverse environmental effects of the proposed action are adequately identified and evaluated, the agency is not constrained by NEPA from deciding that other values outweigh the environmental costs.'' *Robertson* v. *Methow Valley Citizens Council,* 490 U.S. 332, 350, 109 S.Ct. 1835, 104 L.Ed.2d 351 (1989).

The agency must identify the ''environmentally preferable'' alternative, but need not adopt it. ''Congress in enacting NEPA * * * did not require agencies to elevate environmental concerns over other appropriate considerations.'' *Baltimore Gas and Elec. Co.* v. *Natural Resources Defense Council, Inc.,* 462 U.S. 87, 97 (1983). Instead, NEPA requires an agency to develop alternatives to the proposed action in preparing an EIS. 42 U.S.C. 4332(2)(C)(iii). The statute does not command the agency to favor an environmentally preferable course of action, only that it make its decision to proceed with the action after taking a hard look at environmental consequences.

E. What are the proposed CAFE standards?

1. Form of the Standards

Each of the CAFE standards that NHTSA is proposing today for passenger cars and light trucks is expressed as a mathematical function that defines a fuel economy target applicable to each vehicle model and, for each fleet, establishes a required CAFE level determined by computing the sales-weighted harmonic average of those targets.[736]

As discussed above in Section II.C, NHTSA has determined passenger car 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 gallons per mile per square foot) of the sloped portion of the function, and d is the intercept (in gallons per mile) 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.

NHTSA is proposing, consistent with the standards for MYs 2011–2016, 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:

$$CAFE_{required} = \frac{\sum_i PRODUCTION_i}{\sum_i \frac{PRODUCTION_i}{TARGET_i}}$$

$PRODUCTION_i$ 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 above and based on the corresponding

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[734] *Ibid.,* 1181.

[735] 5 U.S.C. 553.

[736] Required CAFE levels shown here are estimated required levels based on NHTSA's current projection of manufacturers' vehicle fleets in MYs 2017–2025. Actual required levels are not determined until the end of each model year, when all of the vehicles produced by a manufacturer in that model year are known and their compliance obligation can be determined with certainty. The target curves, as defined by the constrained linear function, and as embedded in the function for the sales-weighted harmonic average, are the real ''standards'' being proposed today.

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 proposed standards for passenger cars are, therefore, specified by the four coefficients defining fuel economy targets:

a = upper limit (mpg)

b = lower limit (mpg)

c = slope (gallon per mile per square foot)

d = intercept (gallon per mile)

For light trucks, NHTSA is proposing to define fuel economy targets in terms of a mathematical function under which the target is the maximum of values determined under each of two constrained linear functions. The second of these establishes a "floor" reflecting the MY 2016 standard, after accounting for estimated adjustments reflecting increased air conditioner efficiency. This prevents the target at any footprint from declining between model years. The resultant mathematical function is as follows:

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

The proposed standards for light trucks are, therefore, specified by the eight coefficients defining fuel economy targets:

a = upper limit (mpg)

b = lower limit (mpg)

c = slope (gallon per mile per square foot)

d = intercept (gallon per mile)

e = upper limit (mpg) of "floor"

f = lower limit (mpg) of "floor"

g = slope (gallon per mile per square foot) of "floor"

h = intercept (gallon per mile) of "floor"

2. Passenger Car Standards for MYs 2017–2025

For passenger cars, NHTSA is proposing CAFE standards defined by the following coefficients during MYs 2017–2025:

Table IV-11. Coefficients Defining Proposed MYs 2017–2025 Fuel Economy Targets For Passenger Cars

Coefficient	2017	2018	2019	2020	2021	2022	2023	2024	2025
a (mpg)	43.61	45.21	46.87	48.74	50.83	53.21	55.71	58.32	61.07
b (mpg)	32.65	33.84	35.07	36.47	38.02	39.79	41.64	43.58	45.61
c (gpm/sf)	0.0005131	0.0004954	0.0004783	0.0004603	0.0004419	0.0004227	0.0004043	0.0003867	0.0003699
d (gpm)	0.001896	0.001811	0.001729	0.001643	0.001555	0.001463	0.001375	0.001290	0.001210

For reference, the coefficients defining the MYs 2012–2016 passenger car standards are also provided below:

Table IV-12. Coefficients Defining Final MYs 2012–2016 Fuel Economy Targets For Passenger Cars

Coefficient	2012	2013	2014	2015	2016
a (mpg)	36.18	37.16	38.31	40.06	42.03
b (mpg)	28.09	28.67	29.35	30.37	31.49
c (gpm/sf)	0.00053	0.00053	0.00053	0.00053	0.00053
d (gpm)	0.00588	0.00515	0.00434	0.00320	0.00203

Also for reference, the following table presents the coefficients based on 2-cycle CAFE only for easier comparison to the MYs 2012–2016 coefficients presented above. We emphasize, again, that the coefficients in Table IV–11 define the proposed standards.

Table IV-13. Coefficients Based Only on 2-Cycle CAFE for MYs 2017–2025 Passenger Cars

Coefficient	2017	2018	2019	2020	2021	2022	2023	2024	2025
a (mpg)	42.57	44.09	45.66	47.44	49.42	51.66	54.01	56.47	59.04
b (mpg)	32.06	33.21	34.39	35.73	37.22	38.92	40.69	42.54	44.47
c (gpm/sf)	0.00051	0.00050	0.00048	0.00046	0.00044	0.00042	0.00040	0.00039	0.00037
d (gpm)	0.00246	0.00237	0.00229	0.00221	0.00212	0.00203	0.00194	0.00185	0.00177

Section II.C above and Chapter 2 of the draft Joint TSD discusses how the coefficients in Table IV–11 were developed for this proposed rule. The proposed coefficients result in the footprint-dependent targets shown graphically below for MYs 2017–2025. The MY 2012–2016 final standards are also shown for comparison.

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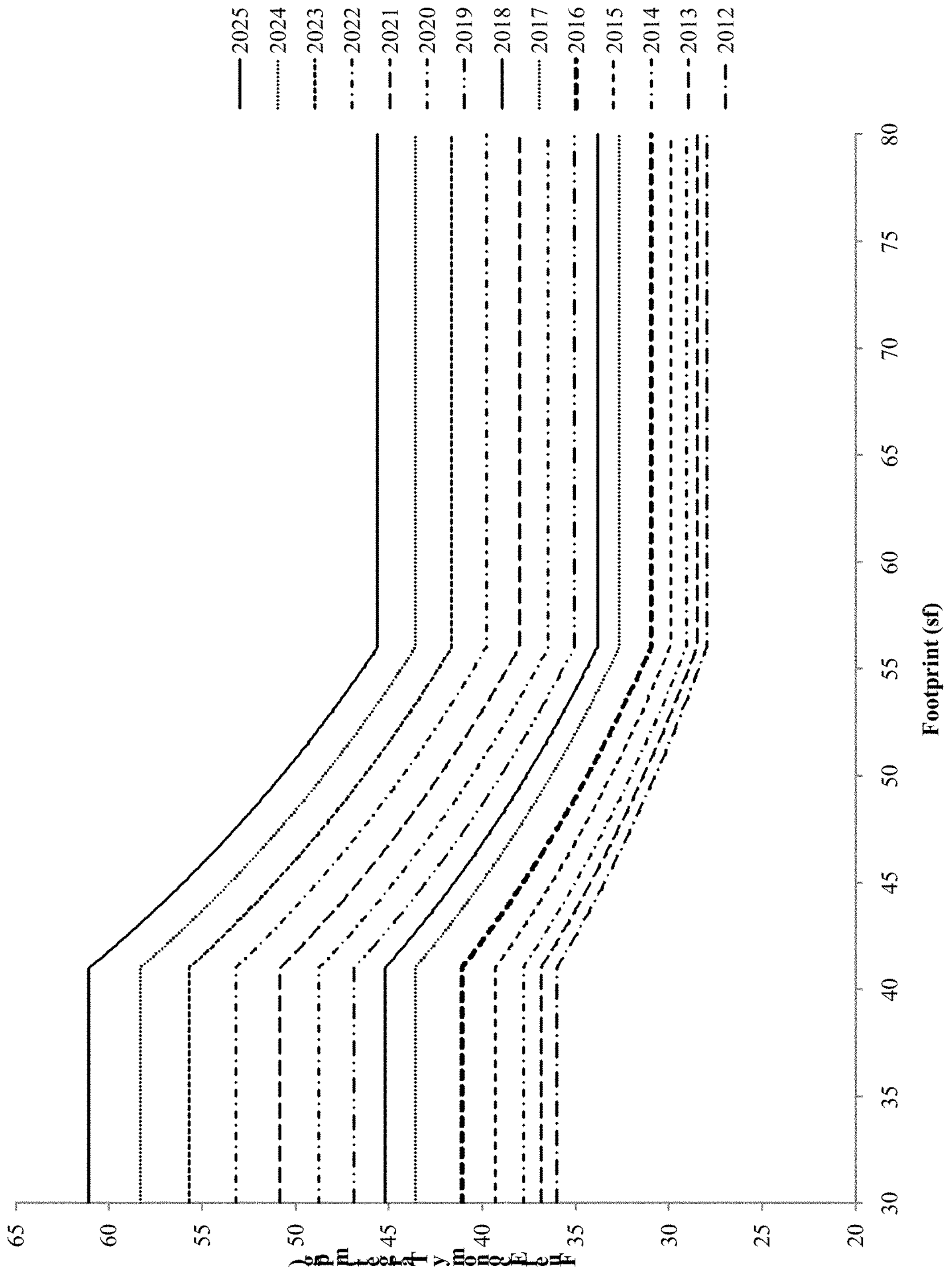
Figure IV-1. Fuel Economy Targets for MYs 2012–2016 and 2017–2025 Passenger Cars



As discussed, the CAFE levels ultimately required of individual manufacturers will depend on the mix of vehicles they produce for sale in the United States. Based on the market forecast of future sales that NHTSA has used to examine today's proposed CAFE standards, the agency currently estimates that the target curves shown above will result in the following average required fuel economy levels for individual manufacturers during MYs 2017–2025 (an updated estimate of the average required fuel economy level under the final MY 2016 standard is also shown for comparison): [737]

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[737] In the May 2010 final rule establishing MY 2016 standards for passenger cars and light trucks, NHTSA estimated that the required fuel economy levels for passenger cars would average 37.8 mpg under the MY 2016 passenger car standard. Based on the agency's current forecast of the MY 2016 passenger car market, NHTSA again estimates that the average required fuel economy level for passenger cars will be 37.8 mpg in MY 2016.

[738] For purposes of CAFE compliance, "Chrysler/Fiat" is assumed to include Ferrari and Maserati in addition to the larger-volume Chrysler and Fiat brands.

Table IV-14. Estimated Average Fuel Economy Required Under Final MY 2016 and Proposed MYs 2017–2025 CAFE Standards For Passenger Cars

Manufacturer	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Aston Martin	38.2	40.5	41.9	43.5	45.2	47.2	49.4	51.7	54.1	56.6
BMW	37.3	39.4	40.9	42.4	44.1	46.0	48.1	50.4	52.7	55.2
Daimler	35.9	37.8	39.1	40.5	42.2	44.0	46.1	48.2	50.4	52.8
Chrysler/Fiat[738]	36.6	39.2	40.7	42.2	43.7	45.7	48.0	50.2	52.7	55.1
Ford	37.1	39.1	40.6	42.1	43.7	45.6	47.7	49.9	52.3	54.7
Geely (Volvo)	36.6	38.8	40.3	41.7	43.4	45.3	47.4	49.6	51.9	54.4
General Motors	36.9	39.3	40.7	42.3	43.9	45.8	48.0	50.2	52.6	55.1
Honda	38.3	40.5	42.0	43.6	45.3	47.3	49.5	51.7	54.2	56.7
Hyundai	38.2	40.3	41.8	43.4	45.1	47.1	49.3	51.5	54.0	56.5
Kia	37.9	40.0	41.5	43.1	44.8	46.7	48.9	51.2	53.6	56.1
Lotus	41.1	43.6	45.2	46.9	48.7	50.8	53.2	55.7	58.3	61.1
Mazda	38.3	40.5	41.9	43.5	45.2	47.1	49.2	51.5	54.0	56.6
Mitsubishi	38.7	41.1	42.6	44.2	45.9	47.9	50.1	52.5	54.9	57.5
Nissan	37.7	39.7	41.2	42.7	44.4	46.3	48.4	50.7	53.1	55.5
Porsche	41.1	43.6	45.2	46.9	48.7	50.8	53.2	55.7	58.3	61.1
Spyker (Saab)	38.3	40.6	42.1	43.6	45.3	47.3	49.5	51.8	54.2	56.8
Subaru	39.3	41.7	43.2	44.8	46.6	48.6	50.9	53.3	55.8	58.4
Suzuki	40.8	43.3	44.9	46.5	48.4	50.5	52.8	55.3	57.9	60.6
Tata (Jaguar, Rover)	34.7	36.8	38.1	39.6	41.1	42.9	44.9	47.0	49.2	51.5

Tesla	41.1	43.6	45.2	46.9	48.7	50.8	53.2	55.7	58.3	61.1
Toyota	38.4	40.7	42.2	43.8	45.5	47.5	49.7	52.0	54.4	57.0
VW[739]	38.9	41.2	42.7	44.2	46.0	48.0	50.2	52.6	55.0	57.6
Average	37.8	40.0	41.4	43.0	44.7	46.6	48.8	51.0	53.5	56.0

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. Readers should remember that the mpg levels describing the ''estimated required standards'' shown throughout this section are not necessarily the ultimate mpg level with which manufacturers will have to comply, for the reasons explained above, and that the mpg level designated as ''estimated required'' is exactly that, an estimate.

Additionally, again for reference, the following table presents estimated mpg levels based on 2-cycle CAFE for easier comparison to the MYs 2012–2016 standards.

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[739] For purposes of CAFE compliance, VW is assumed to include Audi-Bentley, Bugatti, and Lamborghini, along with the larger-volume VW brand.

Table IV-15. Estimated Average Fuel Economy Required Under Final MY 2016 and Using 2-Cycle CAFE for MYs 2017-2025 For Passenger Cars

Manufacturer	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Aston Martin	38.2	39.6	41.0	42.4	44.1	45.9	48.0	50.2	52.5	54.9
BMW	37.3	38.6	40.0	41.4	43.0	44.8	46.8	49.0	51.2	53.5
Daimler	35.9	37.0	38.2	39.6	41.2	42.9	44.9	46.9	49.0	51.2
Chrysler/Fiat[740]	36.6	38.3	39.7	41.2	42.7	44.6	46.7	48.8	51.2	53.5
Ford	37.1	38.3	39.7	41.1	42.7	44.4	46.5	48.6	50.8	53.1
Geely (Volvo)	36.6	38.0	39.4	40.8	42.4	44.1	46.1	48.2	50.5	52.8
General Motors	36.9	38.4	39.8	41.3	42.9	44.7	46.7	48.8	51.1	53.4
Honda	38.3	39.6	41.1	42.5	44.2	46.0	48.1	50.3	52.6	55.0
Hyundai	38.2	39.5	40.9	42.3	44.0	45.8	47.9	50.1	52.4	54.8
Kia	37.9	39.2	40.6	42.0	43.7	45.5	47.6	49.7	52.0	54.4
Lotus	41.1	42.6	44.1	45.7	47.4	49.4	51.7	54.0	56.5	59.0
Mazda	38.3	39.6	41.0	42.5	44.1	45.9	47.9	50.1	52.4	54.8
Mitsubishi	38.7	40.1	41.6	43.1	44.8	46.6	48.8	51.0	53.3	55.7
Nissan	37.7	38.9	40.3	41.7	43.3	45.1	47.2	49.3	51.5	53.9
Porsche	41.1	42.6	44.1	45.7	47.4	49.4	51.7	54.0	56.5	59.0
Spyker (Saab)	38.3	39.7	41.1	42.6	44.2	46.1	48.2	50.3	52.6	55.0
Subaru	39.3	40.7	42.2	43.7	45.4	47.3	49.5	51.7	54.1	56.5
Suzuki	40.8	42.2	43.8	45.3	47.1	49.1	51.3	53.6	56.1	58.6
Tata (Jaguar, Rover)	34.7	36.0	37.3	38.6	40.1	41.8	43.7	45.7	47.7	49.9
Tesla	41.1	42.6	44.1	45.7	47.4	49.4	51.7	54.0	56.5	59.0
Toyota	38.4	39.8	41.2	42.7	44.4	46.2	48.3	50.5	52.8	55.2
VW[741]	38.9	40.2	41.7	43.1	44.8	46.7	48.9	51.1	53.4	55.8
Average	37.8	39.1	40.5	42.0	43.6	45.4	47.5	49.6	51.9	54.3

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 nondomestic passenger automobile fleets manufactured for sale in the United States by all manufacturers in

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[740] For purposes of CAFE compliance, "Chrysler/Fiat" is assumed to include Ferrari and Maserati in addition to the larger-volume Chrysler and Fiat brands.

[741] For purposes of CAFE compliance, VW is assumed to include Audi-Bentley, Bugatti, and Lamborghini, along with the larger-volume VW brand.

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 a practical matter, as standards for both cars and trucks continue to rise over time, 49 U.S.C. 32902(b)(4)(A) will likely eventually cease to be relevant.

As discussed in the final rule establishing the MYs 2012–2016 CAFE standards, because 49 U.S.C. 32902(b)(4)(B) states 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," NHTSA interprets EISA as indicating 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.

However, we note that we do not read this language to preclude any change, ever, 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. This issue will be particularly relevant for the current rulemaking, given the considerable leadtime involved and the necessity of a mid-term review for the MYs 2022–2025 standards. We seek comment on this interpretation, and on whether or not the agency should consider instead for MYs 2017–2025 designating the minimum domestic passenger car standards proposed here as "estimated," just as the passenger car standards are "estimated," and waiting until the end of each model year to finalize the 92 percent mpg value.

We note also that in the MYs 2012–2016 final rule, we interpreted EISA as indicating that the 92 percent minimum standard should be based on the estimated required CAFE level rather than, as suggested by the Alliance, the estimated achieved CAFE level (which would likely be lower than the estimated required level if it reflected manufacturers' use of dual-fuel vehicle credits under 49 U.S.C. 32905, at least in the context of the MYs 2012–2016 standards). NHTSA continues to believe that this interpretation is appropriate.

Based on NHTSA's current market forecast, the agency's estimates of these minimum standards under the proposed MYs 2017–2025 CAFE standards (and, for comparison, the final MY 2016 minimum domestic passenger car standard) are summarized below in Table IV–16.

Table IV-16. Estimated Minimum Standard For Domestically Manufactured Passenger Cars Under Final MY 2016 and Proposed MYs 2017–2025 CAFE Standards For Passenger Cars

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
34.7	36.8	38.1	39.6	41.1	42.9	44.9	47.0	49.2	51.5

Again, for the reader's reference, the following table the following table presents estimated mpg levels based on 2-cycle CAFE for easier comparison to the MYs 2012–2016 standards.

Table IV-17. Estimated Minimum Standard For Domestically Manufactured Passenger Cars Under Final MY 2016 and Using 2-Cycle CAFE Only for MYs 2017–2025 Passenger Cars

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
34.7	35.9	37.2	38.6	40.1	41.7	43.7	45.6	47.7	49.9

As discussed in Section IV.D above, NHTSA is also seeking comment on whether to consider, for the final rule, the possibility of minimum standards for imported passenger cars and light trucks. Although we are not proposing such standards, we believe it may be prudent to explore this concept again given the considerable amount of time between now and 2017–2025 (particularly the later years), and the accompanying uncertainty in our market forecast and other assumptions, that might make such minimum standards relevant to help ensure that currently-expected fuel economy improvements occur during that time frame. To help commenters' consideration of this question, illustrative levels of minimum standards for those other fleets are presented below.

Table IV-18. Illustrative Estimated Minimum Standard For Imported Passenger Cars

Under Proposed MYs 2017–2025 CAFE Standards For Passenger Cars

2017	2018	2019	2020	2021	2022	2023	2024	2025
36.8	38.1	39.6	41.1	42.9	44.9	47.0	49.2	51.5

Table IV-19. Illustrative Estimated Minimum Standard For Light Trucks Under Proposed

MYs 2017–2025 CAFE Standards For Light Trucks

2017	2018	2019	2020	2021	2022	2023	2024	2025
27.1	27.6	28.1	28.7	30.7	32.1	33.7	35.4	37.1

NHTSA emphasizes again that we are not proposing additional minimum standards for imported passenger cars and light trucks at this time, but we may consider including them in the final rule if it seems reasonable and appropriate to do so based on the information provided by commenters and the agency's analysis. NHTSA also may wait until we are able to observe potential market changes during the implementation of the MYs 2012–2016 standards and consider additional minimum standards in a future rulemaking action. Any additional minimum standards for MYs 2022–2025 that may be set in the future would, like the primary standards, be subject to the mid-term review discussed in Section IV.B above, and potentially revised at that time.

4. Light Truck Standards

For light trucks, NHTSA is proposing CAFE standards defined by the following coefficients during MYs 2017–2025:

Table IV-20. Coefficients Defining Proposed MYs 2017–2025 Fuel Economy Targets For Light Trucks

Coefficient	2017	2018	2019	2020	2021	2022	2023	2024	2025
a (mpg)	36.26	37.36	38.16	39.11	41.80	43.79	45.89	48.09	50.39
b (mpg)	25.09	25.20	25.25	25.25	25.25	26.29	27.53	28.83	30.19
c (gpm/sf)	0.0005484	0.0005358	0.0005265	0.0005140	0.0004820	0.0004607	0.0004404	0.0004210	0.0004025
d (gpm)	0.005097	0.004797	0.004623	0.004494	0.004164	0.003944	0.003735	0.003534	0.003343
e (mpg)	35.10	35.31	35.41	35.41	35.41	35.41	35.41	35.41	35.41
f (mpg)	25.09	25.20	25.25	25.25	25.25	25.25	25.25	25.25	25.25
g (gpm/sf)	0.0004546	0.0004546	0.0004546	0.0004546	0.0004546	0.0004546	0.0004546	0.0004546	0.0004546
h (gpm)	0.009851	0.009682	0.009603	0.009603	0.009603	0.009603	0.009603	0.009603	0.009603

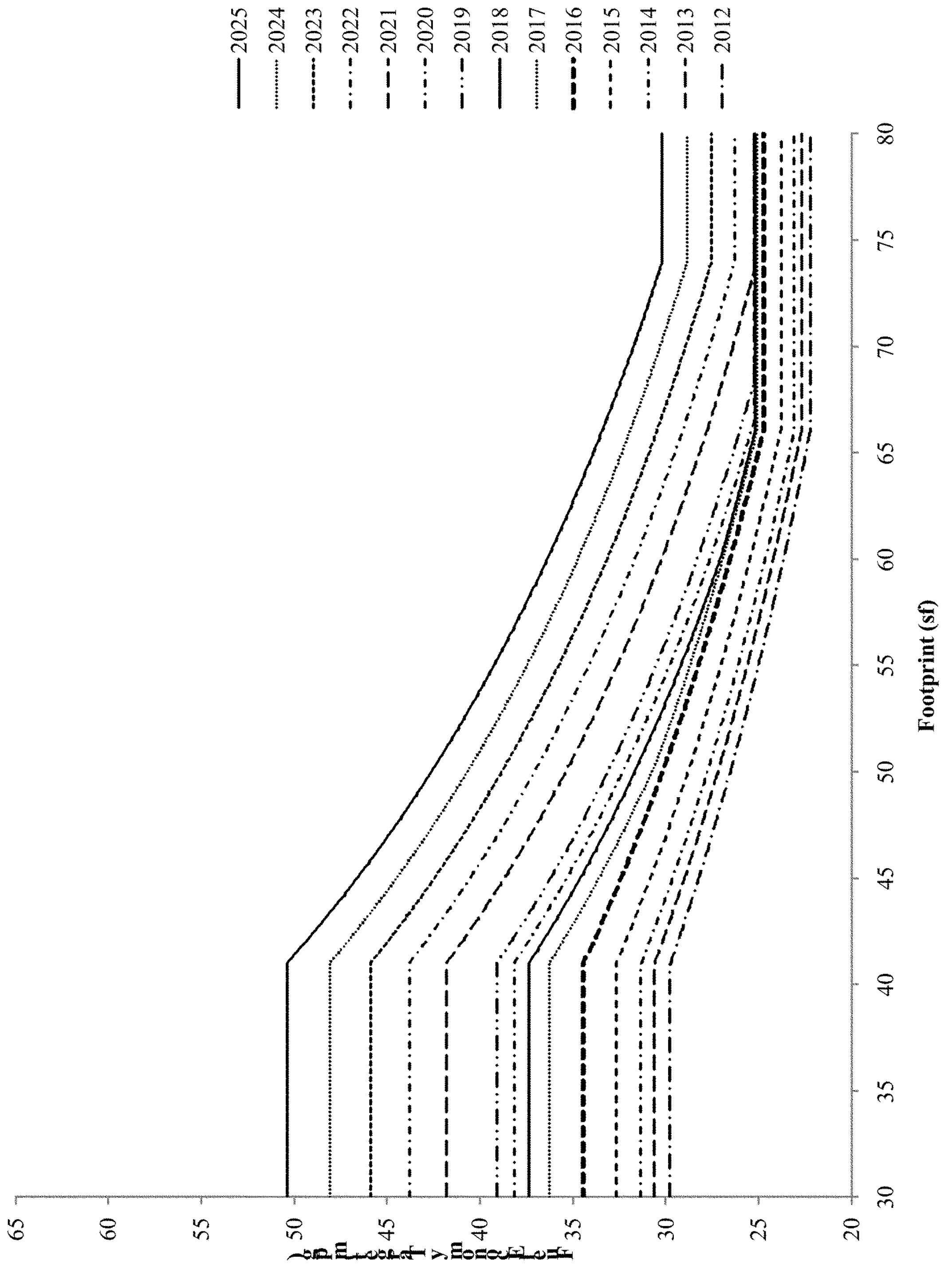
For reference, the coefficients defining the MYs 2012–2016 light truck standards (which did not include a "floor" term defined by coefficients *e, f, g,* and *h*) are also provided below:

Table IV-21. Coefficients Defining Final MYs 2012–2016 Fuel Economy Targets For Light Trucks

Coefficient	2012	2013	2014	2015	2016
a (mpg)	36.18	37.16	38.31	40.06	42.03
b (mpg)	28.09	28.67	29.35	30.37	31.49
c (gpm/sf)	0.00053	0.00053	0.00053	0.00053	0.00053
d (gpm)	0.00588	0.00515	0.00434	0.00320	0.00203

The proposed coefficients result in the footprint-dependent targets shown graphically below for MYs 2017–2025. MYs 2012–2016 final standards are shown for comparison.

Figure IV-2. Fuel Economy Targets for MYs 2012–2016 and 2017–2025 Light Trucks



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Also for reference, the following table presents the coefficients based on2-cycle CAFE only for easier comparison to the MYs 2012–2016 coefficients presented above. We emphasize, again, that the coefficients in Table IV–20 define the proposed standards.

Table IV-22. Coefficients Based Only on 2-Cycle CAFE for MYs 2017–2025 Light Trucks

Coefficient	2017	2018	2019	2020	2021	2022	2023	2024	2025
a (mpg)	35.53	36.37	37.01	37.91	40.43	42.29	44.24	46.28	48.42
b (mpg)	24.74	24.74	24.74	24.74	24.74	25.74	26.93	28.17	29.47
c (gpm/sf)	0.00055	0.00054	0.00053	0.00051	0.00048	0.00046	0.00044	0.00042	0.00040
d (gpm)	0.00566	0.00553	0.00543	0.00530	0.00497	0.00475	0.00454	0.00434	0.00415

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 proposed CAFE standards, the agency currently estimates that the targets shown above will result in the following average required fuel economy levels for individual manufacturers during MYs 2017–2025 (an updated estimate of the average required fuel economy level under the final MY 2016 standard is shown for comparison):[742]

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[742] In the May 2010 final rule establishing MYs 2012–2016 standards for passenger cars and light trucks, NHTSA estimated that the required fuel economy levels for light trucks would average 28.8 mpg under the MY 2016 light truck standard. Based on the agency's current forecast of the MY 2016 light truck market, NHTSA again estimates that the required fuel economy levels will average 28.8 mpg in MY 2016. However, the agency's market forecast reflects less of a future market shift away from light trucks than reflected in the agency's prior market forecast; as a result, NHTSA currently estimates that the combined (*i.e.*, passenger car and light truck) average required fuel economy in MY 2016 will be 33.8 mpg, 0.3 mpg lower than the agency's earlier estimate of 34.1 mpg. The agency has made no changes to MY 2016 standards and projects no changes in fleet-specific average requirements (although within-fleet market shifts could, under an attribute-based standard, produce such changes).

Table IV-23. Estimated Average Fuel Economy Required Under Final MY 2016 and Proposed MYs 2017–2025 CAFE Standards For Light Trucks

Manufacturer	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Aston Martin	-	-	-	-	-	-	-	-	-	-
BMW	30.2	30.6	31.4	32.1	32.9	35.1	36.7	38.4	40.2	42.1
Daimler	29.1	29.1	29.6	30.2	30.9	32.9	34.5	36.1	37.8	39.5
Chrysler/Fiat[743]	29.0	29.6	30.2	30.8	31.6	33.7	35.3	37.0	38.8	40.7
Ford	28.0	28.4	29.0	29.4	29.9	31.8	33.3	35.0	36.8	38.6
Geely (Volvo)	30.5	31.1	32.1	32.7	33.5	35.8	37.5	39.3	41.2	43.1
General Motors	27.4	28.1	28.7	29.2	29.8	31.9	33.4	35.1	36.8	38.6
Honda	30.4	31.0	31.8	32.4	33.2	35.5	37.1	38.9	40.8	42.7
Hyundai	30.7	31.3	32.1	32.8	33.6	35.9	37.6	39.4	41.3	43.2
Kia	29.5	30.0	30.6	31.2	32.0	34.2	35.8	37.5	39.3	41.1
Lotus	-	-	-	-	-	-	-	-	-	-
Mazda	31.5	31.9	32.9	33.5	34.3	36.5	38.1	39.8	41.8	43.8
Mitsubishi	31.7	32.6	33.5	34.2	35.1	37.5	39.3	41.1	43.1	45.2
Nissan	29.1	29.6	30.3	30.9	31.6	33.5	35.1	36.9	38.7	40.6
Porsche	29.8	30.3	31.2	31.8	32.6	34.8	36.5	38.2	40.0	41.9
Spyker (Saab)	30.5	31.2	32.1	32.8	33.6	35.9	37.6	39.4	41.3	43.3
Subaru	31.9	33.0	34.0	34.7	35.5	38.0	39.8	41.7	43.6	45.7
Suzuki	31.4	32.2	33.2	33.9	34.7	37.1	38.9	40.7	42.7	44.7
Tata (Jaguar, Rover)	31.3	32.1	33.1	33.8	34.6	37.0	38.8	40.6	42.6	44.6
Tesla	-	-	-	-	-	-	-	-	-	-
Toyota	29.1	29.7	30.4	31.0	31.6	33.8	35.4	37.1	39.0	40.9
VW[2]	29.2	29.5	30.1	30.8	31.5	33.5	35.1	36.7	38.5	40.3
Average	28.8	29.4	30.0	30.6	31.2	33.3	34.9	36.6	38.5	40.3

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As discussed above with respect to the proposed passenger cars standards, we note that a manufacturer's required light truck fuel economy level for a model year under the ultimate final standards will be based on its actual production numbers in that model year.

Additionally, again for reference, the following table presents estimated mpg levels based on 2-cycle CAFE for easier comparison to the MYs 2012–2016 standards.

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[743] For purposes of CAFE compliance, "Chrysler/Fiat" is assumed to include Ferrari and Maserati in addition to the larger-volume Chrysler and Fiat brands.

[744] For purposes of CAFE compliance, VW is assumed to include Audi-Bentley, Bugatti, and Lamborghini, along with the larger-volume VW brand.

Table IV-24. Estimated Average Fuel Economy Required Under Final MY 2016 and Using 2-Cycle CAFE for MYs 2017-2025 For Light Trucks

Manufacturer	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Aston Martin	-	-	-	-	-	-	-	-	-	-
BMW	30.2	30.1	30.7	31.3	32.0	34.1	35.7	37.3	39.0	40.8
Daimler	29.1	28.6	29.0	29.5	30.2	32.1	33.5	35.0	36.6	38.3
Chrysler/Fiat[745]	29.0	29.1	29.6	30.0	30.8	32.8	34.3	35.9	37.6	39.4
Ford	28.0	28.0	28.4	28.8	29.2	31.0	32.4	34.0	35.7	37.4
Geely (Volvo)	30.5	30.6	31.3	31.9	32.6	34.8	36.4	38.1	39.9	41.7
General Motors	27.4	27.7	28.1	28.5	29.1	31.1	32.5	34.1	35.7	37.4
Honda	30.4	30.5	31.0	31.6	32.3	34.5	36.1	37.7	39.5	41.3
Hyundai	30.7	30.8	31.4	31.9	32.7	34.9	36.5	38.1	39.9	41.8
Kia	29.5	29.5	29.9	30.4	31.2	33.3	34.8	36.4	38.1	39.8
Lotus	-	-	-	-	-	-	-	-	-	-
Mazda	31.5	31.3	32.1	32.7	33.4	35.4	37.0	38.6	40.4	42.3
Mitsubishi	31.7	32.0	32.7	33.3	34.1	36.4	38.1	39.8	41.6	43.6
Nissan	29.1	29.2	29.7	30.2	30.8	32.7	34.1	35.8	37.6	39.3
Porsche	29.8	29.8	30.5	31.0	31.8	33.9	35.4	37.1	38.8	40.6
Spyker (Saab)	30.5	30.7	31.4	32.0	32.7	34.9	36.5	38.2	40.0	41.8
Subaru	31.9	32.4	33.1	33.7	34.5	36.8	38.5	40.3	42.2	44.1
Suzuki	31.4	31.7	32.4	33.0	33.8	36.0	37.7	39.4	41.3	43.2
Tata (Jaguar, Rover)	31.3	31.5	32.3	32.9	33.7	35.9	37.6	39.3	41.2	43.1
Tesla	-	-	-	-	-	-	-	-	-	-
Toyota	29.1	29.2	29.8	30.3	30.8	32.9	34.4	36.0	37.8	39.5
VW[2]	29.2	29.0	29.5	30.0	30.7	32.7	34.1	35.7	37.3	39.1
Average	28.8	29.0	29.4	29.9	30.4	32.5	33.9	35.6	37.3	39.0

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F. How do the proposed standards fulfill NHTSA's statutory obligations?

The discussion that follows is necessarily complex, but the central points are straightforward. NHTSA has tentatively concluded that the standards presented above in Section IV.E are the maximum feasible standards for passenger cars and light trucks in MYs 2017–2025. EPCA/EISA requires NHTSA to consider four statutory factors in determining the maximum feasible CAFE standards in a rulemaking: Specifically, technological

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[745] For purposes of CAFE compliance, "Chrysler/Fiat" is assumed to include Ferrari and Maserati in addition to the larger-volume Chrysler and Fiat brands.

[746] for purposes of CAFE compliance, VW is assumed to include Audi-Bentley, Bugatti, and Lamborghini, along with the larger-volume VW brand.

feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the nation to conserve energy. The agency considered a number of regulatory alternatives in its analysis of potential CAFE standards for those model years, including several that increase stringency on average at set percentages each year, one that approximates the point at which the modeled net benefits are maximized in each model year, and one that approximates the point at which the modeled total costs equal total benefits in each model year. Some of those alternatives represent standards that would be more stringent than the proposed standards,[747] and some are less stringent.[748] As the discussion below explains, we tentatively conclude that the correct balancing of the relevant factors that the agency must consider in determining the maximum feasible standards recognizes economic practicability concerns as discussed below, and sets standards accordingly. We expect that the proposed standards will enable further research and development into the more advanced fuel economy-improving technologies, and enable significant fuel savings and environmental benefits throughout the program, with particularly substantial benefits in the later years of the program and beyond. Additionally, consistent with Executive Order 13563, the agency believes that the benefits of the preferred alternative amply justify the costs; indeed, the monetized benefits exceed the monetized costs by $358 billion over the lifetime of the vehicles covered by the proposed standards. In full consideration of all of the information currently before the agency, we have weighed the statutory factors carefully and selected proposed passenger car and light truck standards that we believe are the maximum feasible for MYs 2017–2025.

1. What are NHTSA's statutory obligations?

As discussed above in Section IV.D, NHTSA sets CAFE standards under EPCA, as amended by EISA, and is also subject to the APA and NEPA in developing and promulgating CAFE standards.

NEPA requires the agency to develop and consider the findings of an Environmental Impact Statement (EIS) for ''major Federal actions significantly affecting the quality of the human environment.'' NHTSA has determined that this action is such an action and therefore that an EIS is necessary, and has accordingly prepared a Draft EIS to inform its development and consideration of the proposed standards. The agency has evaluated the environmental impacts of a range of regulatory alternatives in our proposal, and integrated the results of that consideration into our balancing of the EPCA/EISA factors, as discussed below.

The APA and relevant case law requires our rulemaking decision to be rational, based on consideration of the relevant factors, and within the scope of the authority delegated to the agency by EPCA/EISA. The relevant factors are those required by EPCA/EISA and the additional factors approved in case law as ones historically considered by the agency in determining the maximum feasible CAFE standards, such as safety. The statute requires us to set standards at the maximum feasible level for passenger cars and light trucks for each model year, and the agency tentatively concludes that the standards, if adopted as proposed, would satisfy this requirement. NHTSA has carefully examined the relevant data and other considerations, as discussed below in our explanation of our tentative conclusion that the proposed standards are the maximum feasible levels for those model years based on our evaluation of the information before us for this NPRM.

As discussed in Section IV.D, EPCA/EISA requires that NHTSA establish separate passenger car and light truck 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.[749] NHTSA has developed definitions for these terms over the course of multiple CAFE rulemakings[750] and determines the appropriate weight and balancing of the terms given the circumstances in each CAFE rulemaking. 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. For model years after 2020, standards need simply be set at the maximum feasible level.

The agency thus balances the relevant factors to determine the maximum feasible level of the CAFE standards for each fleet, in each model year. The next section discusses how the agency balanced the factors for this proposal, and why we believe the proposed standards are the maximum feasible.

2. How did the agency balance the factors for this NPRM?

There are numerous ways that the relevant factors can be balanced (and thus weight given to each factor) depending on the agency's policy priorities and on the information before the agency regarding any given model year, and the agency therefore considered a range of alternatives that represent different regulatory options that we thought were potentially reasonable for purposes of this rulemaking. For this proposal, the regulatory alternatives considered in the agency's analysis include several alternatives for fuel economy levels that increase annually, on average, at set rates—specifically, 2%/year, 3%/year, 4%/year, 5%/year, 6%/year, and 7%/

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[747] We recognize that higher standards would help the need of the nation to conserve more energy and might potentially be technologically feasible (in the narrowest sense) during those model years, but based on our analysis and the evidence presented by the industry, we tentatively conclude that higher standards would not represent the proper balancing for MYs 2017–2025 cars and trucks, because they would raise serious questions about economic practicability. As explained above, NHTSA's modeled estimates necessarily do not perfectly capture all of the factors of economic practicability, and this conclusion regarding net benefits versus economic practicability is similar to the conclusion reached in the 2012–2016 analysis.

[748] We also recognize that lower standards might be less burdensome on the industry, but considering the environmental impacts of the different regulatory alternatives as required under NEPA and the need of the nation to conserve energy, we do not believe they would have represented the appropriate balancing of the relevant factors, because they would have left technology, fuel savings, and emissions reductions on the table unnecessarily, and not contributed as much as possible to reducing our nation's energy security and climate change concerns. They would also have lower net benefits than the Preferred Alternative.

[749] As explained in Section IV.D, 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 statutory provisions that facilitate compliance with the CAFE standards and thereby reduce the costs of compliance. Specifically, in determining the maximum feasible level of fuel economy for passenger cars and light trucks, NHTSA cannot consider the fuel economy benefits of ''dedicated'' alternative fuel vehicles (like battery electric vehicles or natural gas vehicles), must consider dual-fueled automobiles to be operated only on gasoline or diesel fuel (at least through MY 2019), and may not consider the ability of manufacturers to use, trade, or transfer credits. This provision limits, to some extent, the fuel economy levels that NHTSA can find to be ''maximum feasible''—if NHTSA cannot consider the fuel economy of electric vehicles, for example, NHTSA cannot set standards predicated on manufacturers' usage of electric vehicles to meet the standards.

[750] These factors are defined in Section IV.D; for brevity, we do not repeat those definitions here.

year.[751] Analysis of these various rates of increase effectively encompasses the entire range of fuel economy improvements that, based on information currently available to the agency, could conceivably fall within the statutory boundary of ''maximum feasible'' standards. The regulatory alternatives also include two alternatives based on benefit-cost criteria, one in which standards would be set at the point where the modeled net benefits would be maximized for each fleet in each year (MNB), and another in which standards would be set at the point at which total costs would be most nearly equal to total benefits for each fleet in each year (TC=TB),[752] as well as the preferred alternative, which is within the range of the other alternatives. These alternatives are discussed in more detail in Chapter III of the PRIA accompanying this NPRM, which also contains an extensive analysis of the relative impacts of the alternatives in terms of fuel savings, costs (both per-vehicle and aggregate), carbon dioxide emissions avoided, and many other metrics. Because the agency could conceivably select any of the regulatory alternatives above, all of which fall between 2%/year and 7%/year, inclusive, the Draft EIS that accompanies this proposal analyzes these lower and upper bounds as well as the preferred alternative. Additionally, the Draft EIS analyzes a ''No Action Alternative,'' which assumes that, for MYs 2017 and beyond, NHTSA would set standards at the same level as MY 2016. The No Action Alternative provides a baseline for comparing the environmental impacts of the other alternatives.

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 factors under EPCA/EISA. 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 that achieve the maximum feasible levels. For example, the 2% Alternative, the least stringent alternative, would represent a balancing in which economic practicability—which include concerns about availability of technology, capital, and consumer preferences for vehicles built to meet the future standards—weighs more heavily in the agency's consideration, and the need of the nation to conserve energy would weigh less heavily. In contrast, under the 7% Alternative, one of the most stringent, the need of the nation to conserve energy—which includes energy conservation and climate change considerations—would weigh more heavily in the agency's consideration, and other factors would weigh less heavily. Balancing and assessing the feasibility of different alternative can also be influenced by differences and uncertainties in the way in which key economic factors (*e.g.,* the price of fuel and the social cost of carbon) and technological inputs could be assessed and estimated or valued. While NHTSA believes that our analysis conducted in support of this NPRM uses the best and most transparent technology-related inputs and economic assumption inputs that the agencies could derive for MYs 2017–2025, we recognize that there is uncertainty in these inputs, and the balancing could be different if, for example, the inputs are adjusted in response to new information.

This is the first CAFE rulemaking in which the agency has looked this far into the future, which makes our traditional approach to balancing more challenging than in past (even recent past) rulemakings. NHTSA does not presently believe, for example, that technological feasibility as the agency defines it is as constraining in this rulemaking as it has been in the past in light of the time frame of this rulemaking. ''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. In previous CAFE rulemakings, it has been more difficult for the agency to say that the most advanced technologies would be available for commercial application in the model years for which standards were being established. For this rulemaking, which is longer term, NHTSA has considered all types of technologies that improve real-world fuel economy, including air-conditioner efficiency and other off-cycle technology, PHEVs, EVs, and highly-advanced internal combustion engines not yet in production, but all of which the agencies' expect to be commercially applicable by the rulemaking time frame. On the one hand, we recognize that some technologies that currently have limited commercial use cannot be deployed on every vehicle model in MY 2017, but require a realistic schedule for widespread commercialization to be feasible. On the other hand, however, the agency expects, based on our analysis, that all of the alternatives could narrowly be considered as technologically feasible, in that they could be achieved based on the existence or projected future existence of technologies that could be incorporated on future vehicles, and enable any of the alternatives to be achieved on a technical basis alone if the level of resources that might be required to implement the technologies is not considered. If all alternatives are at least theoretically technologically feasible in the MY 2017–2025 timeframe, and the need of the nation is best served by pushing standards as stringent as possible, then the agency might be inclined to select the alternative that results in the very most stringent standards considered.

However, the agency must also consider what is required to practically implement technologies, which is part of economic practicability, and to which the most stringent alternatives give little weight. ''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.'' Consumer acceptability is also an element of economic practicability, one that is particularly difficult to gauge during times of uncertain fuel prices.[753] In a rulemaking such as the present one,

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[751] This is an approach similar to that used by the agency in the MY 2012–2016 rulemaking, in which we also considered several alternatives that increased annually, on average, at 3%, 4%, 5%, 6% and 7%/year. The ''percent-per-year'' alternatives in this proposal are somewhat different from those considered in the MY 2012–2016 rulemaking, however, in terms of how the annual rate of increase is applied. For this proposal, the stringency curves are themselves advanced directly by the annual increase amount, without reference to any yearly changes in the fleet mix. In the 2012–2016 rule, the annual increases for the stringency alternatives reflected the estimated required fuel economy of the fleet which accounted for both the changes in the target curves and changes in the fleet mix.

[752] We included the MNB and TC=TB alternatives in part for the reference of commenters familiar with NHTSA's past several CAFE rulemakings—these alternatives represent balancings carefully considered by the agency in past rulemaking actions as potentially maximum feasible—and because Executive Orders 12866 and 13563 focus attention on an approach that maximizes net benefits. The assessment of maximum net benefits is challenging in the context of setting CAFE standards, in part because standards which maximize net benefits for each fleet, for each model year, would not necessarily be the standards that lead to the greatest net benefits over the entire rulemaking period.

[753] *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 v. NHTSA, 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).

determining economic practicability requires consideration of the uncertainty surrounding relatively distant future market conditions and consumer demand for fuel economy in addition to other vehicle attributes. In an attempt to evaluate the economic practicability of attribute-based standards, NHTSA includes a variety of factors in its analysis, including the annual rate at which manufacturers can increase the percentage of their fleet that employ a particular type of fuel-saving technology, the specific fleet mixes of different manufacturers, and assumptions about the cost of the standards to consumers and consumers' valuation of fuel economy, among other things. Ensuring that a reasonable amount of lead time exists to make capital investments and to devote the resources and time to design and prepare for commercial production of a more fuel efficient fleet is also relevant to the agency's consideration of economic practicability. Yet there are some aspects of economic practicability that the agency's analysis is not able to capture at this time—for example, the computer model that we use to analyze alternative standards does not account for all aspects of uncertainty, in part because the agency cannot know what we cannot know. The agency must thus account for uncertainty in the context of economic practicability as best as we can based on the entire record before us.

Both technological feasibility and economic practicability enter into the agency's determination of the maximum feasible levels of stringency, and economic practicability concerns may cause the agency to decide that standards that might be technologically feasible are, in fact, beyond maximum feasible. Standards that require aggressive application of and widespread deployment of advanced technologies could raise serious issues with the adequacy of time to coordinate such significant changes with manufacturers' redesign cycles, as well as with the availability of engineering resources to develop and integrate the technologies into products, and the pace at which capital costs can be incurred to acquire and integrate the manufacturing and production equipment necessary to increase the production volume of the technologies. Moreover, the agency must consider whether consumers would be likely to accept a specific technological change under consideration, and how the cost to the consumer of making that change might affect their acceptance of it. The agency maintains, as it has in prior CAFE rulemakings, that there is an important distinction between considerations of technological feasibility and economic practicability. As explained above, 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 in the first year of the standards perform at the highest technologically feasible level, because manufacturers do not have unlimited access to the financial resources or may not practically be able to hire enough engineers, build enough facilities, and install enough tooling.

NHTSA therefore believes, based on the information currently before us, that economic practicability concerns render certain standards that might otherwise be technologically feasible to be beyond maximum feasible within the meaning of the statute for the 2017–2025 standards. Our analysis indicated that technologies seem to exist to meet the stringency levels required by future standards under nearly all of the regulatory alternatives; but it also indicated that manufacturers would not be able to apply those technologies quickly enough, given their redesign cycles, and the level of the resources that would be required to implement those technologies widely across their products, to meet all applicable standards in every model year under some of the alternatives.

Another consideration for economic practicability is incremental per-vehicle increases in technology cost. In looking at the incremental technology cost results from our modeling analysis, the agency saw that in progressing from alternatives with lower stringencies to alternatives with higher stringencies, technology cost increases (perhaps predictably) at a progressively higher rate, until the model projects that manufacturers are unable to comply with the increasing standards and enter (or deepen) non-compliance. Table IV–25 and Table IV–26 show estimated cumulative lifetime fuel savings and estimated average vehicle cost increase for passenger cars and light trucks. The results show that there is a significant increase in technology cost between the 4% alternatives and the 5% alternatives.

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Table IV-25. Estimated Passenger Car Cumulative Lifetime Fuel Savings and Average Vehicle Cost Increase

	Cumulative Lifetime Fuel Savings 2017-2021 (billion gallons)	Average Vehicle Cost Increase in 2021 (2009 $)	Cumulative Lifetime Fuel Savings 2017-2025 (billion gallons)	Average Vehicle Cost Increase in 2025 (2009 $)
2%	22	$451	58	$684
3%	32	$775	85	$1,367
MNB	54	$1,060	108	$1,313
Preferred Alternative	39	$1,108	104	$2,023
4%	42	$1,252	110	$2,213
TC=TB	62	$1,607	135	$2,515
5%	51	$1,844	130	$3,040
6%	57	$1,789	140	$3,229
7%	61	$1,930	144	$3,304

Table IV-26. Estimated Light Truck Cumulative Lifetime Fuel Savings and Average Vehicle Cost Increase

	Cumulative Lifetime Fuel Savings 2017-2021 (billion gallons)	Average Vehicle Cost Increase in 2021 (2009 $)	Cumulative Lifetime Fuel Savings 2017-2025 (billion gallons)	Average Vehicle Cost Increase in 2025 (2009 $)
2%	22	$498	53	$706
3%	33	$909	77	$1,308
Preferred Alternative	22	$965	69	$1,578
4%	41	$1,619	98	$2,423
MNB	62	$2,262	126	$3,427
TC=TB	62	$2,232	126	$3,416
5%	50	$2,154	116	$3,444
6%	56	$2,298	123	$3,611
7%	59	$2,482	127	$3,692

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Thus, if technological feasibility and the need of the nation are not particularly limiting in a given rulemaking, then maximum feasible standards would be represented by the mpg levels that we could require of the industry to improve fuel economy before we reach a tipping point that presents risk of significantly adverse economic consequences. Standards that are lower than that point would likely not be maximum feasible, because such standards would leave fuel-saving technologies on the table unnecessarily; standards that are higher than that point would likely be beyond what the agency would consider economically practicable, and therefore beyond what we would consider maximum feasible, even if they might be technologically feasible or better meet the need of the nation to conserve energy. The agency does not believe that standards are balanced if they weight one or two factors so heavily as to ignore another.

We explained above that part of the way that we try to evaluate economic practicability is through a variety of model inputs, such as phase-in caps (the annual rate at which manufacturers can increase the percentage of their fleet that employ a particular type of fuel-saving technology) and redesign schedules to account for needed lead time. These inputs limit how much technology can be applied to a manufacturer's fleet in the agency's analysis attempting to simulate a way for the manufacturer to comply with standards set under different regulatory alternatives. If the limits (and technology cost-effectiveness) prevent enough manufacturers from meeting the required levels of stringency, the agency may decide that the standards under consideration may not be economically practicable. The difference between the required fuel economy level that applies to a manufacturer's fleet and the level of fuel economy that the agency projects the manufacturer would achieve in that year, based on our analysis, is called a "compliance shortfall."[754]

We underscore again that the modeling analysis does not dictate the "answer," it is merely one source of information among others that aids the agency's balancing of the standards. These considerations, shortfalls and increases in incremental technology costs, do not entirely define economic practicability, but we believe they are symptomatic of it. In looking at the projected compliance shortfall results from our modeling analysis, the agency preliminarily concluded, based on the information before us at the time, that for both passenger car and for light trucks, the MNB and TC=TB alternatives, and the 5%, 6% and 7% alternatives did not appear to be economically practicable, and were thus likely beyond maximum feasible levels for MYs 2017–2025. In other words, despite the theoretical technological feasibility of achieving these levels, various manufacturers would likely lack the financial and engineering resources and sufficient lead time to do so.

The analysis showed that for the passenger car 5% alternative, there were significant compliance shortfalls for Chrysler in MY 2025, Ford in MYs 2021 and 2023–2025, GM in MYs 2022 and 2024–2025, Mazda in MYs 2021 and 2024–2025, and Nissan in MY 2025. For light trucks, the analysis showed the 5% alternative had significant compliance shortfalls for Chrysler in MYs 2022–2025, Ford in MY 2025, GM in MYs 2023–2025, Kia in MY 2025, Mazda in MYs 2022 and 2025, and Nissan in MYs 2023–2025. However, the 4%, 3% and 2% alternatives did not appear, based on shortfalls, to be beyond the level of economic practicability, and thus appeared potentially to be within the range of alternatives that might yet be maximum feasible.

Table IV-27. Estimated Passenger Car Compliance Shortfall for the 5%/Year Alternative (MPG)

Estimated Compliance Shortfall for Passenger Car (mpg)									
	2017	2018	2019	2020	2021	2022	2023	2024	2025
Chrysler	-	-	-	-	-	1.7	-	-	2.3
Ford	-	-	-	0.2	-	-	1.5	2.9	5.2
General Motors	-	-	-	-	-	2.3	0.8	2.1	2.5
Honda	-	-	-	-	-	-	-	-	-
Hyundai	-	-	-	-	-	-	-	-	-
Kia	-	-	-	-	-	-	-	-	-
Mazda	-	-	-	-	1.9	-	-	1.6	1.9
Nissan	-	-	-	-	-	-	-	-	1.3
Toyota	-	-	-	-	-	-	-	-	-

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[754] The agency's modeling estimates how the application of technologies could increase vehicle costs, reduce fuel consumption, and reduce CO_2 emissions, and affect other factors. As CAFE standards are performance-based, NHTSA does not mandate that specific technologies be used for compliance. CAFE modeling, therefore projects one way that manufacturers could comply. Manufacturers may choose a different mix of technologies based on their unique circumstances and products.

Table IV-28. Estimated Light Truck Compliance Shortfall for the 5%/Year Alternative (MPG)

Estimated Compliance Shortfall for Light Truck (mpg)									
	2017	2018	2019	2020	2021	2022	2023	2024	2025
Chrysler	-	-	-	-	-	1.8	0.9	3.2	0.9
Ford	-	-	-	-	-	-	-	0.1	1.8
General Motors	-	-	-	-	-	0.1	1.8	3.2	2.9
Honda	-	-	-	-	-	-	-	-	0.6
Hyundai	-	-	-	-	-	-	0.6	-	-
Kia	-	-	-	-	-	-	-	-	2.1
Mazda	-	-	-	-	-	1.0	-	-	2.1
Nissan	-	-	-	-	-	-	1.1	2.1	4.6
Toyota	-	-	-	-	-	-	-	-	-

The preliminary analysis referred to above, in which the agency tentatively concluded that the 5%, 6%, 7%, MNB, and TC=TB alternatives were likely beyond the level of economic practicability based on the information available to the agency at the time, was conducted following the first SNOI and prior to the second SNOI—thus, between the end of 2010 and July 2011. The agencies stated in the first SNOI that we had not conducted sufficient analysis at the time to narrow the range of potential stringencies that had been discussed in the initial NOI and in the Interim Joint TAR, and that we would be conducting more analyses and continuing extensive dialogue with stakeholders in the coming months to refine our proposal. Based on our initial consideration of how the factors might be balanced to determine the maximum feasible standards to propose for MYs 2017–2025 (*i.e.,* where technological feasibility did not appear to be particularly limiting and the need of the nation would counsel for choosing more stringent alternatives, but economic practicability posed significant limitations), NHTSA's preliminary analysis indicated that the alternatives including up to 4% per year for cars and 4% per year for trucks should reasonably remain under consideration.

With that preliminary estimate of 4%/year for cars and trucks as the upper end of the range of alternatives that should reasonably remain under consideration for MYs 2017–2025, the agencies began meeting again intensely with stakeholders, including many individual manufacturers, between June 21, 2011 and July 27, 2011 to determine whether additional information would aid NHTSA in further consideration. Beginning in the June 21, 2011 meeting, NHTSA and EPA presented the 4% alternative target curves as a potential concept along with preliminary program flexibilities and provisions, in order to get feedback from the manufacturer stakeholders. Manufacturer stakeholders provided comments, much of which was confidential business information, which included projections of how they might comply with concept standards, the challenges that they expected, and their recommendations on program stringency and provisions.[755]

Regarding passenger cars, several manufacturers shared projections that they would be capable of meeting stringency levels similar to NHTSA's preliminary CAFE modeling projections for the 4% alternative in MY 2020 or in 2021, with some of those arguing that they faced challenges in the earlier years of that period with meeting a constant 4% rate throughout the entire period. Some manufacturers shared projections that they could comply with stringencies that ramped up, increasing more slowly in MY 2017 and then progressively increasing through MY 2021. Most manufacturers provided limited projections beyond MY 2021, although some stated that they could meet the agency's concept stringency targets in MY 2025. Manufacturers generally suggested that the most significant challenges to meeting a constant 4% (or faster) year-over-year increase in the passenger car standards related to their ability to implement the

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[755] Feedback from these stakeholder meetings is summarized in section IV.B and documents that are referenced in that section.

new technologies quickly enough to achieve the required levels, given their need to implement fuel economy improvements in both the passenger car and light truck fleets concurrently; challenges related to the cadence of redesign and refresh schedules; the pace at which new technology can be implemented considering economic factors such as availability of engineering resources to develop and integrate the technologies into products; and the pace at which capital costs can be incurred to acquire and integrate the manufacturing and production equipment necessary to increase the production volume of the technologies. Manufacturers often expressed concern that the 4% levels could require greater numbers of advanced technology vehicles than they thought they would be able to sell in that time frame, given their belief that the cost of some technologies was much higher than the agencies had estimated and their observations of current consumer acceptance of and willingness to pay for advanced technology vehicles that are available now in the marketplace. A number of manufacturers argued that they did not believe that they could create a sustainable business case under passenger car standards that increased at the rate required by the 4% alternative.

Regarding light trucks, most manufacturers expressed significantly greater concerns over the 4% alternative for light trucks than for passenger cars. Many manufacturers argued that increases in light truck standard stringency should be slower than increases in passenger car standard stringency, based on, among other things, the greater payload, cargo capacity and towing utility requirements of light trucks, and what they perceived to be lower consumer acceptance of certain (albeit not all) advanced technologies on light trucks. Many manufacturers also commented that redesign cycles are longer on trucks than they are on passenger cars, which reduces the frequency at which significant changes can be made cost-effectively to comply with increasing standards, and that the significant increases in stringency in the MY 2012–2016 program[756] in combination with redesign schedules would not make it possible to comply with the 4% alternative in the earliest years of the MY 2017–2025 program, such that only significantly lower stringencies in those years would be feasible in their estimation. As for cars, most manufacturers provided limited projections beyond MY 2021. Manufacturers generally stated that the most significant challenges to meeting a constant 4% (or faster) year-over-year increase in the light truck standards were similar to what they had described for passenger cars as enumerated in the paragraph above, but were compounded by concerns that applying technologies to meet the 4% alternative standards would result in trucks that were more expensive and provided less utility to consumers. As was the case for cars, manufacturers argued that their technology cost estimates were higher than the agencies' and consumers are less willing to accept/pay for some advanced technologies in trucks, but manufacturers argued that these concerns were more significant for trucks than for cars, and that they were not optimistic that they could recoup the costs through higher prices for vehicles with the technologies that would be needed to comply with the 4% alternative. Given their concerns about having to reduce utility and raise truck prices, and about their ability to apply technologies quickly enough given the longer redesign periods for trucks, a number of manufacturers argued that they did not believe that they could create a sustainable business case under light truck standards that increased at the rate required by the 4% alternative.

Other stakeholders, such as environmental and consumer groups, consistently stated that stringent standards are technically achievable and critical to important national interests, such as improving energy independence, reducing climate change, and enabling the domestic automobile industry to remain competitive in the global market. Labor interests stressed the need to carefully consider economic impacts and the opportunity to create and support new jobs, and consumer advocates emphasized the economic and practical benefits to consumers of improved fuel economy and the need to preserve consumer choice. In addition, a number of stakeholders stated that the standards under development should not have an adverse impact on safety.

NHTSA, in collaboration with EPA and in coordination with CARB, carefully considered the inputs received from all stakeholders, conducted additional independent analyses, and deliberated over the feedback received on the agencies' analyses. NHTSA considered individual manufacturers' redesign cycles and, where available, the level of technologies planned for their future products that improve fuel economy, as well as some estimation of the resources that would likely be needed to support those plans and the potential future standards. The agency also considered whether we agreed that there could conceivably be compromises to vehicle utility depending on the technologies chosen to meet the potential new standards, and whether a change in the cadence of the rate at which standards increase could provide additional opportunity for industry to develop and implement technologies that would not adversely affect utility. NHTSA considered feedback on consumer acceptance of some advanced technologies and consumers' willingness to pay for improved fuel economy. In addition, the agency carefully considered whether manufacturer assertions about potential uncertainties in the agency's technical, economic, and consumer acceptance assumptions and estimates were potentially valid, and if so, what the potential effects of these uncertainties might be on economic practicability.

Regarding passenger cars, after considering this feedback from stakeholders, the agency considered further how it thought the factors should be balanced to determine the maximum feasible passenger car standards for MYs 2017–2025. Based on that reconsideration of the information before the agency and how it informs our balancing of the factors, NHTSA tentatively concludes that the points raised may indicate that the agency's preliminary analysis supporting consideration of standards that increased up to 4%/year may not have captured fully the level of uncertainty that surrounds economic practicability in these future model years. Nevertheless, while we believe there may be some uncertainty, we do not agree that it is nearly as significant as a number of manufacturers maintained, especially for passenger cars. The most persuasive information received from stakeholders for passenger cars concerned practicability issues in the first phase of the MY 2017–2025 standards. We therefore tentatively conclude that the maximum feasible stringency levels for passenger cars are only slightly different from the 4%/year levels suggested as the high end preliminarily considered by the agency; increasing on average 3.7%/year in MYs 2017–2021, and on average 4.5%/year in MYs 2022–2025. For the overall MY 2017–2025 period, the maximum feasible stringency curves increase on average at 4.1%/year, and our analysis

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[756] Some manufacturers indicated that their light truck fleet fuel economy would be below what they anticipated their required fuel economy level would be in MY 2016, and that they currently expect that they will need to employ available flexibilities to comply with that standard.

indicates that the costs and benefits attributable to the 4% alternative and the preferred alternative for passenger cars are very similar: The preferred alternative is 8.8 percent less expensive for manufacturers than the 4% alternative (estimated total costs are $113 billion for the preferred alternative and $124 billion for the 4% alternative), and achieves only $20 billion less in total benefits than the 4% alternative (estimated total benefits are $310 billion for the preferred alternative and $330 billion for the 4% alternative), a very small difference given that benefits are spread across the entire lifetimes of all vehicles subject to the standards. The analysis also shows that the lifetime cumulative fuel savings is only 5 percent higher for the 4% alternative than the preferred alternative (the estimated fuel savings is 104 billion gallons for the preferred alternative, and 110 billion gallons for the 4% alternative).

At the same time, the increase in average vehicle cost in MY 2025 is 9.4 percent higher for the 4% alternative (the estimated cost increase for the average vehicle is $2,023 for the preferred alternative, and $2,213 for the 4% alternative). The rates of increase in stringency for each model year are summarized in Table IV–29. NHTSA emphasizes that under 49 U.S.C. 32902(b), the standards must be maximum feasible in each model year without reference to other model years, but we believe that the small amount of progressiveness in the proposed standards for MYs 2017–2021, which has very little effect on total benefits attributable to the proposed passenger car standards, will help to enable the continuation of, or increases in, research and development into the more advanced technologies that will enable greater stringency increases in MYs 2022–2025, and help to capture the considerable fuel savings and environmental benefits similar to the 4% alternative beginning in MY 2025.

We are concerned that requiring manufacturers to invest that capital to meet higher standards in MYs 2017–2021, rather than allowing them to increase fuel economy in those years slightly more slowly, would reduce the levels that would be feasible in the second phase of the program by diverting research and development resources to those earlier model years. Thus, after considerable deliberation with EPA and consultation with CARB, NHTSA selected the preferred alternative as the maximum feasible alternative for MYs 2017–2025 passenger cars based on consideration of inputs from manufacturers and the agency's independent analysis, which reaches the stringency levels of the 4% alternative in MY 2025, but has a slightly slower ramp up rate in the earlier years.

Table IV-29. Annual Rate Of Increase in the Stringency of the Preferred Alternative for Each Model Year

Model Year	Passenger Car	Light Truck
2017	3.6%	0.6%
2018	3.6%	2.1%
2019	3.6%	1.7%
2020	3.7%	2.0%
2021	4.2%	6.4%
2022	4.5%	4.5%
2023	4.4%	4.7%
2024	4.5%	4.7%
2025	4.5%	4.6%

Table IV-30. Annual Rate Of Increase in the Stringency of the Preferred Alternative Over Various Periods

Model Years	Passenger Car	Light Truck
2017-2021	3.7%	2.6%
2022-2025	4.5%	4.6%
2017-2025	4.1%	3.5%

Regarding light trucks, while NHTSA does not agree with the manufacturer's overall cost assessments and believe that our technology cost and effectiveness assumptions should allow the most capable manufacturers to preserve all necessary vehicle utility, the agencies do believe there is merit to some of the concerns raised in stakeholder feedback. Specifically, concerns about longer redesign schedules for trucks, compounded by the need to invest simultaneously in raising passenger car fuel economy, may not have been fully captured in our preliminary analysis. This could lead manufacturers to implement technologies that do not maintain vehicle utility, based on the cadence of the standards under the 4% alternative. A number of manufacturers repeatedly stated, in providing feedback, that the MYs 2012–2016 standards for trucks, while feasible, required significant investment to reach the required levels, and that given the redesign schedule for trucks, that level of investment throughout the entire MYs 2012–2025 time period was not sustainable. Based on the confidential business information that manufacturers provided to us, we believe that this point may be valid. If the agency pushes CAFE increases that require considerable sustained investment at a faster rate than industry redesign cycles, adverse economic consequences could ensue. The best information that the agency has at this time, therefore, indicates that requiring light truck fuel economy improvements at the 4% annual rate could create potentially severe economic consequences.

Thus, evaluating the inputs from stakeholders and the agency's independent analysis, the agency also considered further how it thought the factors should be balanced to determine the maximum feasible light truck standards for MYs 2017–2025. Based on that consideration of the information before the agency and how it informs our balancing of the factors, NHTSA tentatively concludes that 4%/year CAFE stringency increases for light trucks in MYs 2017–2021 are likely beyond maximum feasible, and in fact, in the earliest model years of the MY 2017–2021 period, that the 3%/year and 2%/year alternatives for trucks are also likely beyond maximum feasible. NHTSA therefore tentatively concludes that the preferred alternative, which would in MYs 2017–2021 increase on average 2.6%/year, and in MYs 2022–2025 would increase on average 4.6%/year, is the maximum feasible level that the industry can reach in those model years. For the overall MY 2017–2025 period, the maximum feasible stringency curves would increase on average 3.5%/year. The rates of increase in stringency for each model year are summarized in Table IV–29 and Table IV–30.

Our analysis indicates that the preferred alternative has 48 percent lower cost than the 4% alternative (estimated total costs are $44 billion for the preferred alternative and $83 billion for the 4% alternative), and the total benefits of the preferred alternative are 30 percent lower ($87 billion lower) than the 4% alternative (estimated total benefits are $206 billion for the preferred alternative and $293 billion for the 4% alternative), spread across the entire lifetimes of all vehicles subject to the standards. The analysis also shows that the lifetime cumulative fuel savings is 42 percent higher for the 4% alternative than the preferred alternative (the estimated fuel savings is 69 billion gallons for the preferred alternative, and 98 billion gallons for the 4% alternative). At the same time, the increase in average vehicle cost in MY 2025 is 54 percent higher for the 4% alternative (the estimated cost increase for the average vehicle is $1,578 for the preferred alternative, and $2,423 for the 4% alternative).

While these differences are larger than for passenger cars, NHTSA believes that standards set at these levels for these model years will help address concerns raised by manufacturer stakeholders and reduce the risk for adverse economic consequences, while at the same time ensuring most of the substantial improvements in fuel efficiency initially envisioned over the entire period and supported by other stakeholders. NHTSA believes that these stringency levels, along with the provisions for incentives for advanced technologies to encourage their development and implementation, and the agencies' expectation that some of the uncertainties surrounding consumer acceptance of new technologies in light trucks should have resolved themselves by that time frame based on consumers' experience with the advanced technologies, will enable these increases in stringency over the entire MY 2017–2025 period. Although, as stated above, the light truck standards must be maximum feasible in each model year without reference to other model years, we believe that standards set at the stated levels for MYs 2017–2021 and the incentives for advanced technologies for pickup trucks will create the best opportunity to ensure that the MY 2022–2025 standards are economically practicable, and avoid adverse consequences. The first phase of light truck standards, in that respect, acts as a kind of bridge to the second phase, in which industry should be able to realize considerable additional improvements in fuel economy.

The proposed standards also account for the effect of EPA's standards, in light of the agencies' close coordination and the fact that both sets of standards were developed together to harmonize as part of the National Program. Given the close relationship between fuel economy and CO_2 emissions, and the efforts NHTSA and EPA have made to conduct joint analysis and jointly deliberate on information and tentative conclusions,[757] the agencies have sought to harmonize and align their proposed standards to the greatest extent possible, consistent with their respective statutory authorities. In comparing the proposed standards, the agencies' stringency curves are equivalent, except for the fact that the stringency of EPA's proposed passenger car standards reflect the ability to improve GHG emissions through reductions in A/C system refrigerant leakage and the use of lower GWP refrigerants (direct A/C improvements),[758] and that EPA provides incentives for PHEV, EV and FCV vehicles, which NHTSA does not provide because statutory incentives have already been defined for these technologies. The stringency of NHTSA's proposed standards for passenger cars for MYs 2017–2025 align with the stringency of EPA's equivalent standards when these differences are considered.[759] NHTSA is proposing the preferred alternative based on the tentative determination of maximum feasibility as described earlier in the section, but, based on efforts NHTSA and EPA have made to conduct joint analysis and jointly deliberate on information and tentative conclusions, NHTSA has also aligned the proposed CAFE standards with EPA's proposed standards.

Thus, consistent with President Obama's announcement on July 29, 2011, and with the August 9, 2011 SNOI, NHTSA has tentatively concluded that the standards represented by the preferred alternative are the maximum feasible standards for passenger cars and light trucks in MYs 2017–2025. We recognize that higher standards would help the need of the nation to conserve more energy and might potentially be technologically feasible (in the narrowest sense) during those model years, but based on our analysis and the evidence presented by the industry, we tentatively conclude that higher standards would not represent the proper balancing for MYs 2017–2025 cars and trucks.[760] We

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[757] NHTSA and EPA conducted joint analysis and jointly deliberated on information and tentative conclusions related to technology cost, effectiveness, manufacturers' capability to implement technologies, the cadence at which manufacturers might support the implementation of technologies, economic factors, and the assessment of comments from manufacturers.

[758] As these A/C system improvements do not influence fuel economy, the stringency of NHTSA's preferred alternatives do not reflect the availability of these technologies.

[759] We note, however, that the alignment is based on the assumption that manufacturers implement the same level of direct A/C system improvements as EPA currently forecasts for those model years, and on the assumption of PHEV, EV, and FCV penetration at specific levels. If a manufacturer implements a higher level of direct A/C improvement technology and/or a higher penetration of PHEVs, EVs and FCVs, then NHTSA's proposed standards would effectively be more stringent than EPA's. Conversely, if a manufacturer implements a lower level of direct A/C improvement technology and/or a lower penetration of PHEVs, EVs and FCVs, then EPA's proposed standards would effectively be more stringent than NHTSA's.

[760] We note, for example, that while Executive Orders 12866 and 13563 focus attention on an approach that maximizes net benefits, both Executive Orders recognize that this focus is subject to the requirements of the governing statute. In this rulemaking, the standards represented by the "MNB" alternative are more stringent than what NHTSA has tentatively concluded would be maximum feasible for MYs 2017–2025, and thus setting standards at that level would be inconsistent

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tentatively conclude that the correct balancing recognizes economic practicability concerns as discussed above, and sets standards at the levels that the agency is proposing in this NPRM.[761] In the same vein, lower standards might be less burdensome on the industry, but considering the environmental impacts of the different regulatory alternatives as required under NEPA and the need of the nation to conserve energy, we do not believe they would have represented the appropriate balancing of the relevant factors, because they would have left technology, fuel savings, and emissions reductions on the table unnecessarily, and not contributed as much as possible to reducing our nation's energy security and climate change concerns. Standards set at the proposed levels for MYs 2017–2021 will provide the additional benefit of helping to promote further research and development into the more advanced fuel economy-improving technologies to provide a bridge to more stringent standards in MYs 2022–2025, and enable significant fuel savings and environmental benefits throughout the program, and particularly substantial benefits in the later years of the program and beyond. Additionally, consistent with Executive Order 13563, the agency believes that the benefits of the preferred alternative amply justify the costs; indeed, the monetized benefits exceed the monetized costs by $358 billion over the lifetime of the vehicles covered by the proposed standards. In full consideration of all of the information currently before the agency, we have weighed the statutory factors carefully and selected proposed passenger car and light truck standards that we believe are the maximum feasible for MYs 2017–2025.

G. Impacts of the Proposed CAFE Standards

1. How will these standards improve fuel economy and reduce GHG emissions for MY 2017–2025 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 the proposed CAFE and CO_2 emissions standards, NHTSA estimates that the proposed new CAFE standards would lead average required fuel consumption (fuel consumption is the inverse of fuel economy) levels to increase by an average of 4.0 percent annually through MY 2025, reaching a combined average fuel economy requirement of 49.6 mpg in that model year:

Table IV-31. Estimated Required Average Fuel Economy (mpg) under the Proposed Standards – MYs 2017-2021

Model Year	2017	2018	2019	2020	2021
Passenger cars	40.0	41.4	43.0	44.7	46.6
Light trucks	29.4	30.0	30.6	31.2	33.3
Combined	35.3	36.4	37.5	38.8	40.9

Table IV-32. Estimated Required Average Fuel Economy (mpg) under the Proposed Standards – MYs 2022-2025

Model Year	2022	2023	2024	2025
Passenger cars	48.8	51.0	53.5	56.0
Light trucks	34.9	36.6	38.5	40.3
Combined	42.9	45.0	47.3	49.6

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with the requirements of EPCA/EISA to set maximum feasible standards.

[761] We underscore that the agency's tentative decision regarding what standards would be maximum feasible for MYs 2017–2025 is made with reference to the rulemaking time frame and circumstances of this proposal. Each CAFE rulemaking (indeed, each stage of any given CAFE rulemaking) presents the agency with new information that may affect how we balance the relevant actors.

Accounting for differences between fuel economy levels under laboratory conditions, NHTSA estimates that these requirements would translate into the following required average levels under real-world operating conditions:

Table IV-33. Estimated Required Average Fuel Economy (real-world mpg) under the Proposed Standards – MYs 2017-2021

Model Year	2017	2018	2019	2020	2021
Passenger cars	32.0	33.1	34.4	35.8	37.3
Light trucks	23.5	24.0	24.5	25.0	26.6
Combined	28.2	29.1	30.0	31.0	32.7

Table IV-34. Estimated Required Average Fuel Economy (real-world mpg) under the Proposed Standards – MYs 2022-2025

Model Year	2022	2023	2024	2025
Passenger cars	39.0	40.8	42.8	44.8
Light trucks	27.9	29.3	30.8	32.2
Combined	34.3	36.0	37.8	39.7

If manufacturers apply technology only as far as necessary to comply with CAFE standards, NHTSA estimates that, setting aside factors the agency cannot consider for purposes of determining maximum feasible CAFE standards,[762] average achieved fuel economy levels would correspondingly increase through MY 2025, but that manufacturers would, on average, under-comply[763] in some model years and over-comply[764] in others, reaching a combined average fuel economy of 47.4 mpg (taking into account estimated adjustments reflecting improved air conditioner efficiency) in MY 2025:

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[762] 49 U.S.C. 32902(h) states that NHTSA may not consider the fuel economy of dedicated alternative fuel vehicles, the alternative-fuel portion of dual-fueled automobile fuel economy, or the ability of manufacturers to earn and use credits for over-compliance, in determining the maximum feasible stringency of CAFE standards.

[763] "Under-compliance" with CAFE standards can be mitigated either through use of FFV credits, use of existing or "banked" credits, or through fine payment. Although, as mentioned above, NHTSA cannot consider availability of statutorily-provided credits in setting standards, NHTSA is not prohibited from considering fine payment. Therefore, the estimated achieved CAFE levels presented here include the assumption that Aston Martin, BMW, Daimler (*i.e.,* Mercedes), Geely (*i.e.,* Volvo), Lotus, Porsche, Spyker (*i.e.,* Saab), and, Tata (*i.e.,* Jaguar and Rover), and Volkswagen will only apply technology up to the point that it would be less expensive to pay civil penalties.

[764] In NHTSA's analysis, "over-compliance" 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).

Table IV-35. Estimated Achieved Average Fuel Economy (mpg) under the Proposed Standards – MYs 2017-2021

Model Year	2017	2018	2019	2020	2021
Passenger cars	39.6	41.7	43.6	45.4	47.1
Light trucks	29.5	30.6	32.4	33.6	35.6
Combined	35.2	36.8	38.8	40.4	42.3

Table IV-36. Estimated Achieved Average Fuel Economy (mpg) under the Proposed Standards – MYs 2022-2025

Model Year	2022	2023	2024	2025
Passenger cars	48.2	49.5	51.3	52.7
Light trucks	36.6	37.7	38.6	39.6
Combined	43.5	44.7	46.2	47.5

Accounting for differences between fuel economy levels under laboratory conditions, NHTSA estimates that these requirements would translate into the following required average levels under real-world operating conditions:

Table IV-37. Estimated Achieved Average Fuel Economy (real-world mpg) under the Proposed Standards – MYs 2017-2021

Model Year	2017	2018	2019	2020	2021
Passenger cars	31.7	33.4	34.9	36.3	37.7
Light trucks	23.6	24.5	25.9	26.9	28.5
Combined	28.2	29.4	31.0	32.3	33.8

Table IV-38. Estimated Achieved Average Fuel Economy (real-world mpg) under the Proposed Standards – MYs 2022-2025

Model Year	2022	2023	2024	2025
Passenger cars	38.6	39.6	41.0	42.2
Light trucks	29.4	30.2	30.9	31.7
Combined	34.8	35.8	37.0	38.0

Setting aside the potential to produce additional EVs (or, prior to MY 2020, PHEVs) or take advantage of EPCA's provisions regarding CAFE credits, NHTSA estimates that today's proposed standards could increase achieved fuel economy levels by average amounts of up to 0.5 mpg during the few model years leading into MY 2017, as manufacturers apply technology during redesigns leading into model years covered by today's new standards.[765] As shown below, these ''early'' fuel economy increases yield corresponding reductions in fuel consumption and greenhouse gas emissions, and incur corresponding increases in technology outlays.

Within the context EPCA requires NHTSA to apply for purposes of determining maximum feasible stringency of CAFE standards (*i.e.,* setting aside EVs, pre-MY 2020 PHEVs, and all statutory CAFE credit provisions), NHTSA estimates that these fuel economy increases would lead to fuel savings totaling 173 billion gallons during the useful lives of vehicles manufactured in MYs 2017–2025 and the few MYs preceding MY 2017:

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[765] This outcome is a direct result of revisions, made to DOT's CAFE model in preparation for the MY 2012–2016 rule, to simulate ''multiyear planning'' effects—that is, the potential that manufacturers will apply ''extra'' technology in one model year if doing so will be sufficiently advantageous with respect to the ability to comply with CAFE standards in later model years. For example, for today's rulemaking analysis, NHTSA has estimated that Ford will redesign the F–150 pickup truck in MY 2015, and again in MY 2021. As explained in Chapter V of the PRIA, NHTSA expects that many technologies would be applied as part of a vehicle redesign. Therefore, in NHTSA's analysis, if Ford does not anticipate ensuing standards when redesigning the MY 2015 F–150, Ford may find it more difficult to comply with light truck standard during MY 2016–2020. Through simulation of multiyear planning effects, NHTSA's analysis indicates that Ford could apply more technology to the MY 2015 F–150 if standards continue to increase after MY 2016 than Ford need apply if standards remain unchanged after MY 2016, and that this additional technology would yield further fuel economy improvements of up to 1.3 mpg, depending on pickup configuration.

Table IV-39. Estimated Fuel Saved (billion gallons) under the Proposed Standards

Model year	Pre-2017	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
PC	4	2	5	7	9	11	13	15	17	19	104
LT	0	0	2	5	6	9	10	11	12	13	69
Combined	4	3	7	12	16	20	23	26	30	33	173

The agency also estimates that these new CAFE standards would lead to corresponding reductions of CO_2 emissions totaling 1,834 million metric tons (mmt) during the useful lives of vehicles sold in MYs 2017–2025 and the few MYs preceding MY 2017:

Table IV-40. Carbon Dioxide Emissions Avoided (mmt) under the Proposed Standards

Model year	Pre-2017	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
PC	41	26	52	76	100	122	139	158	184	202	1,100
LT	4	5	22	49	65	93	108	118	129	141	734
Combined	45	31	74	124	165	215	246	276	313	343	1,834

2. How will these standards improve fleet-wide fuel economy and reduce GHG emissions beyond MY 2025?

Under the assumption that CAFE standards at least as stringent as those being proposed today for MY 2025 would be established for subsequent model years, the effects of the proposed standards on fuel consumption and GHG emissions will continue to increase for many years. This will occur because over time, a growing fraction of the U.S. light-duty vehicle fleet will be comprised of cars and light trucks that meet at least the MY 2025 standard. The impact of the new standards on fuel use and GHG emissions would therefore continue to grow through approximately 2060, when virtually all cars and light trucks in service will have met standards as stringent as those established for MY 2025.

As Table IV–41 shows, NHTSA estimates that the fuel economy increases resulting from the proposed standards will lead to reductions in total fuel consumption by cars and light trucks of 3 billion gallons during 2020, increasing to 40 billion gallons by 2060. Over the period from 2017, when the proposed standards would begin to take effect, through 2050, cumulative fuel savings would total 1,232 billion gallons, as Table IV–41 also indicates.

Table IV-41. Reduction in Fleet-Wide Fuel Use (billion gasoline gallon equivalents) under the Proposed Standards

Calendar year	2020	2030	2040	2050	2060	Total, 2017-2060
PC	1.6	10.9	16.5	19.1	21.6	596.6
LT	1.4	11.2	17.3	20.7	23.7	635.2
Combined	3.0	22.1	33.8	39.9	39.9	1,231.8

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 Draft EIS. This analysis indicates that the leakage effect is likely to offset only a very small fraction of the reductions in fuel use and 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 2017–2025 would 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 would decline by 32 million metric tons (mmt) in 2020 as a consequence of the new CAFE standards, as Table IV–42 reports. The table also shows that this annual reduction is estimated to grow to nearly 488 million metric tons by the year 2060, and will total over 13 billion metric tons over the period from 2017, when the proposed standards would take effect, through 2060.

Table IV-42. Reduction in Fleet-Wide Carbon Dioxide Emissions (mmt) from Passenger Car and Light Truck Use under the Proposed Standards

Calendar year	2020	2030	2040	2050	2060	Total, 2017-2060
PC	17.0	116.9	176.6	204.1	230.7	6,382.2
LT	15.2	121.8	187.2	224.8	257.0	6,885.3
Combined	32.2	238.7	363.8	428.9	487.7	13,267.5

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 draft Environmental Impact Statement (EIS) that informed the agency's decisions regarding this proposal, are summarized in Table IV–43 below.

Table IV-43. Effects of Reduction 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 CO2 concentration	Ppm	2100	784.9	781.8	3.1
Increase in global mean surface temperature	°C	2100	3.064	3.053	0.011
Sea level rise	Cm	2100	37.40	37.30	0.10
Global mean precipitation	% change from 1980-1999 avg.	2090	4.50%	4.48%	0.02%

3. How will these proposed standards impact non-GHG emissions and their associated effects?

Under the assumption that CAFE standards at least as stringent as those proposed for MY 2025 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 2025 standard, and this growth will continue until approximately 2060.

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–40 and IV–41 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.[766]

Tables IV–44 and IV–45 report estimated reductions in emissions of selected criteria air pollutants (or their chemical precursors) and airborne toxics expected to result from the proposed standards during calendar year 2040. By that date, cars and light trucks meeting the MY 2025 CAFE standards will account for the majority of light-duty vehicle use, 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. In the tables below, positive values indicate increases in emissions, while negative values indicate reductions.

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[766] 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.

Table IV-44. Projected Changes in Emissions of Criteria Air Pollutants from Passenger Car and Light Truck Use (calendar year 2040; 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	14,742.6	-126.9	-2,412.2	334.8
	Fuel production and distribution	-17,464.3	-1,910.1	-6,968.9	-39,230.5
	All sources	-2,721.7	-2,036.9	-9,381.1	-38,895.7
Light trucks	Vehicle use	6,097.1	202.9	-2,180.3	2,014.8
	Fuel production and distribution	-18,978.4	-2,100.3	-9,544.7	-32,679.8
	All sources	-12,881.3	-1,897.3	-11,725.0	-30,665.0
Total	Vehicle use	15,600	-204	-4,275	-221
	Fuel production and distribution	-33,928	-3,735	-15,427	-67,161
	All sources	-15,603.0	-3,934.2	-21,106.1	-69,560.7

Table IV-45. Projected Changes in Emissions of Airborne Toxics from Passenger Car and Light Truck Use (calendar year 2040; tons)

Vehicle class	Source of emissions	Toxic air pollutant		
		Benzene	1,3-Butadiene	Formaldehyde
Passenger cars	Vehicle use	-114.6	5.0	379.8
	Fuel production and distribution	-172.0	-1.5	-50.6
	All sources	-286.6	3.6	329.2
Light trucks	Vehicle use	44.6	11.9	92.2
	Fuel production and distribution	-145.3	-1.5	-51.4
	All sources	-100.7	10.4	40.8
Total	Vehicle use	-147	2.1	412
	Fuel production and distribution	-296	-2.8	
	All sources	-387.3	14.0	370.0

In turn, the reductions in emissions reported in Tables IV–44 and IV–45 are projected to result in significant declines in the adverse health effects that result from population exposure to these pollutants. Table IV–46 reports the estimated reductions in selected $PM_{2.5}$-related human health impacts that are expected to result from reduced population exposure to unhealthful atmospheric concentrations of $PM_{2.5}$. The estimates reported in Table IV–46, based on analysis documented in the draft Environmental Impact Statement (EIS) that informed the agency's decisions regarding this proposed rule, are derived from $PM_{2.5}$-related dollar-per-ton estimates that reflect the quantifiable reductions in health impacts likely to result from reduced population exposure to particular matter ($PM_{2.5}$). 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.

There may be localized air quality and health impacts associated with this rulemaking that are not reflected in the estimates of aggregate air quality changes and health impacts reported in this analysis. Emissions changes and dollar-per-ton estimates alone are not necessarily a good indication of local or regional air quality and health impacts, because the atmospheric chemistry governing formation and accumulation of ambient concentrations of $PM_{2.5}$, ozone, and air toxics is very complex. Full-scale photochemical modeling would provide 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. NHTSA intends to conduct such modeling for purposes of the final rule, but it was not available in time to inform these proposed standards or to be included in the Draft EIS.

Table IV-46. Projected Reductions in Health Impacts from Exposure to Criteria Air Pollutants Due to Proposed Standards (calendar year 2040)

Health impact	**Measure**	**Projected reduction (2040)**
Mortality (ages 30 and older)	premature deaths per year	380-970[767]
Chronic bronchitis	cases per year	240
Emergency room visits for asthma	number per year	330
Work loss	workdays per year	42,000

4. What are the estimated costs and benefits of these proposed standards?

NHTSA estimates that the proposed standards could entail significant additional technology beyond the levels that could be applied under baseline CAFE standards (*i.e.,* the application of MY 2016 CAFE standards to MYs 2017–2025). This additional technology will lead to increases in costs to manufacturers and vehicle buyers, as well as fuel savings to vehicle buyers. Also, as discussed above, NHTSA estimates that today's proposed standards could induce manufacturers to apply technology during redesigns leading into model years covered by today's new standards, and to incur corresponding increases in technology outlays.

Technology costs are assumed to change over time due to the influence of cost learning and the conversion from short- to long-term ICMs. Table I–47 represents the CAFE model inputs for MY 2012, MY 2017, MY 2021 and MY 2025 approximate net (accumulated) technology costs for some of the key enabling technologies as applied to Midsize passenger cars.[768] Additional details on technology cost estimates can be found in Chapter V of NHTSA's PRIA and Chapter 3 of the Joint Draft TSD.

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[768] The net (accumulated) technology costs represent the costs from a baseline vehicle (i.e. the top of the decision tree) to each of the technologies listed in the table. The baseline vehicle is assumed to utilize a fixed-valve naturally aspirated inline 4 cylinder engine, 5-speed transmission and no electrification/hybridization improvements.

Table IV-47. Approximate Net (Accumulated) Technology Costs, Midsize PC

APPROXIMATE ICM NET COSTS PER VEHICLE (2009 dollars) FOR MIDSIZE PC SUBCLASS FOR KEY TECHNOLOGIES					
Final technology (as compared to baseline vehicle prior to technology application)		MY 2012	MY 2017	MY 2021	MY 2025
Stoichiometric Gasoline Direct Injection (GDI)	SGDI	$688	$631	$564	$535
Turbocharging and Downsizing - Level 1 (18 bar BMEP)	TRBDS1	$1,225	$1,120	$980	$929
Turbocharging and Downsizing - Level 2 (24 bar BMEP)	TRBDS2	$1,243	$1,146	$1,000	$934
Cooled Exhaust Gas Recirculation (EGR) - Level 1 (24 bar BMEP)	CEGR1	n/a	$1,449	$1,285	$1,181
Cooled Exhaust Gas Recirculation (EGR) - Level 2 (27 bar BMEP)	CEGR2	n/a	$1,969	$1,776	$1,606
Advanced Diesel	ADSL	n/a	$2,842	$2,672	$2,295
6-speed DCT	DCT	-$71	-$51	-$61	-$52
8-Speed Trans (Auto or DCT)	8SPD	$212	$204	$160	$157
Shift Optimizer	SHFTOPT	n/a	$453	$386	$357
12V Micro-Hybrid (Stop-Start)	MHEV	$836	$631	$548	$503
Strong Hybrid - Level 2	SHEV2	n/a	$6,758	$5,821	$5,220
Plug-in Hybrid - 30 mi range	PHEV1	n/a	$18,622	$14,661	$12,282
Electric Vehicle (Early Adopter) - 75 mile range	EV1	n/a	$22,342	$17,312	$13,517
Electric Vehicle (Broad Market) - 150 mile range	EV4	n/a	$31,552	$24,032	$18,450

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 increase relative to levels resulting from compliance with baseline (MY 2016) standards by $228–$2,023 and $44–$1,578, respectively, during MYs 2017–2025. 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):

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Table IV-48. Average Passenger Car Incremental Cost Increases ($) under Proposed Standards – MYs 2017-2021

Manufacturer	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Average	228	467	652	885	1,108
Aston Martin	2	2	2	2	2
BMW	2	3	1	1	(34)
Daimler (Mercedes)	2	2	1	11	11
Fiat (Chrysler)	310	748	755	1,471	1,503
Ford	434	784	954	1,213	1,448
Geely (Volvo)	2	4	108	113	229
General Motors	284	707	918	1,335	1,713
Honda	155	469	518	549	1,160
Hyundai	303	370	719	735	960
Kia	179	243	508	1,048	1,418
Lotus	2	2	2	2	2
Mazda	631	905	871	1,411	1,387
Mitsubishi	2	458	461	710	1,078
Nissan	367	474	1,020	1,161	1,232
Porsche	(4)	(4)	(3)	10	16
Spyker (Saab)	2	2	2	2	(5)
Subaru	2	35	336	932	898
Suzuki	624	612	1,920	1,924	1,880
Tata (Jaguar, Rover)	44	43	40	39	106
Tesla	2	2	2	2	2
Toyota	114	375	552	780	969
Volkswagen	4	4	4	6	9

Table IV-49. Average Passenger Car Incremental Cost Increases ($) under Proposed Standards – MYs 2022-2025

Manufacturer	MY 2022	MY 2023	MY 2024	MY 2025
Average	1,259	1,536	1,927	2,023
Aston Martin	2	2	2	2
BMW	(42)	(41)	126	119
Daimler (Mercedes)	11	243	243	645
Fiat (Chrysler)	1,564	2,310	2,462	2,638
Ford	1,658	2,349	3,261	2,897
Geely (Volvo)	222	329	609	595
General Motors	1,702	2,269	2,575	2,734
Honda	1,271	1,531	1,615	1,754
Hyundai	1,492	1,560	2,158	2,043
Kia	1,522	1,704	1,688	1,836
Lotus	2	2	2	2
Mazda	1,848	2,089	2,480	3,474
Mitsubishi	1,047	1,022	1,402	3,869
Nissan	1,676	1,853	2,293	2,233
Porsche	2	2	2	2
Spyker (Saab)	(6)	1	1	1
Subaru	883	868	1,599	3,057
Suzuki	1,869	1,839	3,831	3,347
Tata (Jaguar, Rover)	338	550	543	547
Tesla	2	2	2	2
Toyota	1,084	1,078	1,539	1,631
Volkswagen	83	106	129	302

Table IV-50. Average Light Truck Incremental Cost Increases ($) under Proposed Standards – MYs 2017-2021

Manufacturer	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Average	44	187	427	688	965
Aston Martin	-	-	-	-	-
BMW	36	48	95	220	326
Daimler (Mercedes)	48	59	63	178	168
Fiat (Chrysler)	238	234	289	1,137	1,252
Ford	(6)	270	279	423	1,435
Geely (Volvo)	1	68	69	68	66
General Motors	(5)	198	595	1,188	1,242
Honda	154	163	340	373	757
Hyundai	262	269	714	712	696
Kia	60	73	192	321	907
Lotus	-	-	-	-	-
Mazda	(3)	472	450	480	550
Mitsubishi	322	347	319	431	2,668
Nissan	21	50	288	431	820
Porsche	1	45	49	48	48
Spyker (Saab)	1	13	18	18	446
Subaru	176	505	1,366	1,337	1,334
Suzuki	293	301	1,793	1,763	1,996
Tata (Jaguar, Rover)	1	13	49	50	15
Tesla	-	-	-	-	-
Toyota	(13)	179	445	462	656
Volkswagen	1	41	350	358	421

Table IV-51. Average Light Truck Incremental Cost Increases ($) under Proposed Standards – MYs 2022-2025

Manufacturer	MY 2022	MY 2023	MY 2024	MY 2025
Average	1,102	1,284	1,428	1,578
Aston Martin	-	-	-	-
BMW	746	738	787	735
Daimler (Mercedes)	1,134	1,130	1,096	1,050
Fiat (Chrysler)	1,296	1,588	1,665	1,948
Ford	1,482	1,981	2,005	2,064
Geely (Volvo)	357	770	759	707
General Motors	1,285	1,456	1,511	1,863
Honda	1,279	1,263	1,296	1,370
Hyundai	1,207	1,191	1,693	1,687
Kia	891	1,020	1,149	1,150
Lotus	-	-	-	-
Mazda	540	1,108	1,393	1,315
Mitsubishi	2,606	2,564	2,526	2,356
Nissan	1,169	1,213	1,469	1,677
Porsche	75	640	629	568
Spyker (Saab)	440	435	429	395
Subaru	1,376	1,358	1,606	1,532
Suzuki	2,000	1,965	1,935	2,252
Tata (Jaguar, Rover)	15	16	16	15
Tesla	-	-	-	-
Toyota	663	858	1,175	1,253
Volkswagen	426	555	959	884

Table IV-52. Average Incremental Cost Increases ($) by Manufacturer under Proposed Standards – MYs 2017-2021

Manufacturer	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Average	161	365	572	815	1,058
Aston Martin	2	2	2	2	2
BMW	12	16	27	59	61
Daimler (Mercedes)	13	15	16	51	50
Fiat (Chrysler)	275	496	532	1,317	1,391
Ford	271	597	718	943	1,444
Geely (Volvo)	2	24	95	98	179
General Motors	144	455	756	1,262	1,480
Honda	155	370	462	494	1,035
Hyundai	295	349	718	730	906
Kia	151	203	431	881	1,304
Lotus	2	2	2	2	2
Mazda	523	827	796	1,246	1,239
Mitsubishi	119	418	411	612	1,633
Nissan	250	335	787	934	1,105
Porsche	(2)	9	9	19	23
Spyker (Saab)	2	4	4	4	59
Subaru	47	156	595	1,031	1,002
Suzuki	559	552	1,882	1,895	1,901
Tata (Jaguar, Rover)	22	28	44	44	61
Tesla	2	2	2	2	2
Toyota	61	297	511	659	847
Volkswagen	4	12	78	79	92

Table IV-53. Average Incremental Cost Increases ($) by Manufacturer under Proposed Standards – MYs 2022-2025

Manufacturer	MY 2022	MY 2023	MY 2024	MY 2025
Average	1,205	1,450	1,760	1,876
Aston Martin	2	2	2	2
BMW	166	162	307	282
Daimler (Mercedes)	290	467	451	738
Fiat (Chrysler)	1,442	1,981	2,109	2,343
Ford	1,599	2,231	2,866	2,640
Geely (Volvo)	264	462	654	629
General Motors	1,498	1,877	2,067	2,319
Honda	1,274	1,451	1,522	1,641
Hyundai	1,435	1,485	2,064	1,972
Kia	1,384	1,555	1,572	1,690
Lotus	2	2	2	2
Mazda	1,617	1,919	2,294	3,115
Mitsubishi	1,583	1,553	1,781	3,367
Nissan	1,521	1,659	2,046	2,068
Porsche	19	152	142	124
Spyker (Saab)	56	59	57	52
Subaru	998	981	1,601	2,714
Suzuki	1,892	1,861	3,501	3,159
Tata (Jaguar, Rover)	178	287	292	300
Tesla	2	2	2	2
Toyota	923	995	1,406	1,493
Volkswagen	151	198	300	416

These cost estimates reflect the potential that a given manufacturer's efforts to minimize overall regulatory costs could focus technology where the most fuel can be saved at the least cost, and not necessarily, for example, where the cost to add technology would be smallest relative to baseline production costs. Therefore, if average incremental vehicle cost increases (including any civil penalties) are measured as increases relative to baseline prices (estimated by adding baseline costs to MY 2008 prices), the agency's analysis shows relative cost increases declining as baseline vehicle price increases. Figure IV–3 shows the trend for MY 2025, for vehicles with estimated baseline prices up to $100,000:

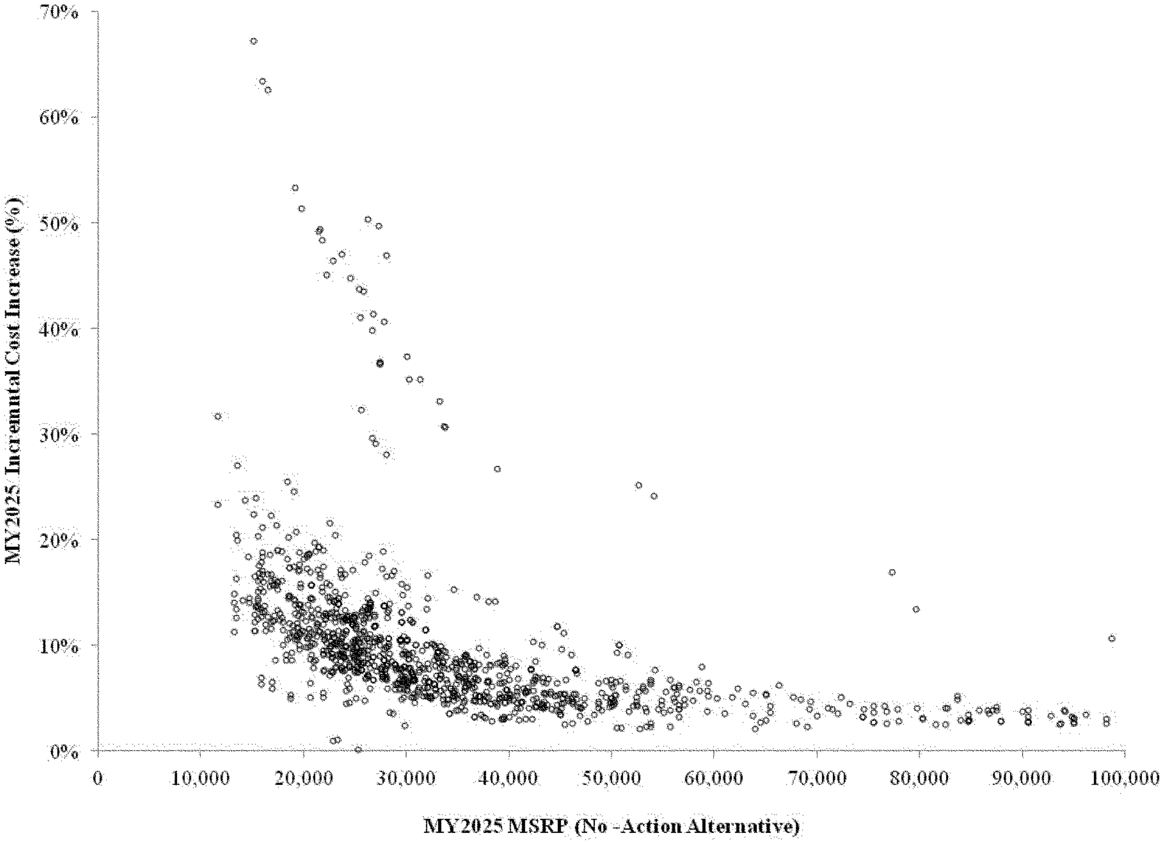

Figure IV-3. Estimated Incremental Cost Increases in MY 2025

If manufacturers pass along these costs rather than reducing profits, and pass these costs along where they are incurred rather than ''cross-subsidizing'' among products, the quantity of vehicles produced at different price levels would change. Shifts in production may potentially occur, which could create marketing challenges for manufacturers that are active in certain segments. We recognize, however, that many manufacturers do in fact cross-subsidize to some extent, and take losses on some vehicles while continuing to make profits from others. NHTSA has no evidence to indicate that manufacturers will inevitably shift production plans in response to these proposed standards, but nevertheless believes that this issue is worth monitoring in the market going forward. NHTSA seeks comment on potential market effects related to this issue.

As mentioned above, these estimated costs derive primarily from the additional application of technology under the proposed standards. The following three tables summarize the incremental 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, relative to the estimated application under baseline standards (*i.e.,* application of MY 2016 standards through MY 2025), and are negative in cases where one technology is superseded (*i.e.,* displaced) by another. For example, the agency estimates that manufacturers could apply many improvements to transmissions (*e.g.,* dual clutch transmissions, denoted below by ''DCT'') through MY 2025 under baseline standards. However, the agency also estimates that manufacturers could apply even more advanced high efficiency transmissions (denoted below by ''HETRANS'') under the proposed standards, and that these transmissions would supersede DCTs and other transmission advances. Therefore, as shown in the following three tables, the *incremental* application of DCTs under the proposed standards is negative.

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Table IV-54. Incremental Application of Technologies to Passenger Car Fleet under Proposed Standards – MYs 2017-2025

Technology	2017	2018	2019	2020	2021	2022	2023	2024	2025
LUB1	8%	16%	16%	16%	16%	16%	16%	16%	16%
EFR1	20%	25%	28%	28%	27%	28%	28%	28%	28%
LUB2_EFR2	2%	10%	21%	28%	38%	43%	46%	52%	53%
CCPS	3%	4%	6%	6%	6%	6%	6%	7%	6%
DVVLS				1%	1%	1%	1%	1%	1%
DEACS							(1%)	(1%)	(1%)
ICP									
DCP	6%	11%	13%	15%	18%	19%	19%	18%	17%
DVVLD	12%	16%	21%	25%	29%	34%	33%	32%	32%
DEACD									
SGDI	11%	15%	22%	28%	36%	43%	46%	54%	55%
DEACO			(1%)	(2%)	(2%)	(2%)	(2%)	(2%)	(2%)
VVA									
SGDIO			1%	2%	2%	2%	2%	2%	2%
TRBDS1_SD	6%	8%	8%	9%	13%	9%	7%	4%	2%
TRBDS1_MD	3%	3%	5%	6%	7%	6%	2%	(4%)	(7%)
TRBDS1_LD									
TRBDS2_SD			3%	3%	3%	3%	4%	1%	
TRBDS2_MD	(2%)	(2%)	(2%)	(3%)	(3%)	(3%)	(3%)	(3%)	(3%)
TRBDS2_LD									
CEGR1_SD	1%	2%	2%	5%	9%	16%	18%	28%	32%

CEGR1_MD	3%	5%	5%	7%	4%	6%	6%	10%	12%
CEGR1_LD									
CEGR2_SD				1%	2%	2%	2%	5%	4%
CEGR2_MD					3%	4%	6%	7%	6%
CEGR2_LD		1%	1%	2%	2%	2%	2%	2%	1%
ADSL_SD			1%	2%	2%	3%	3%	4%	5%
ADSL_MD		1%	1%	1%	1%	1%	2%	2%	3%
ADSL_LD									
6MAN	1%	1%		(1%)	(1%)	(1%)	(1%)	(1%)	(1%)
HETRANSM		1%	1%	3%	4%	5%	5%	6%	7%
IATC		(1%)	(1%)	(1%)	(1%)	(1%)	(1%)	(1%)	(1%)
NAUTO	(3%)	(4%)	(6%)	(7%)	(7%)	(7%)	(7%)	(7%)	(7%)
DCT	(6%)	(17%)	(29%)	(35%)	(44%)	(45%)	(46%)	(46%)	(46%)
8SPD	3%	3%	1%	(4%)	(7%)	(8%)	(9%)	(10%)	(14%)
HETRANS	5%	20%	31%	43%	49%	53%	51%	48%	49%
SHFTOPT	9%	27%	37%	49%	65%	68%	64%	60%	56%
EPS	8%	10%	13%	17%	29%	32%	35%	35%	34%
IACC1	13%	16%	18%	23%	41%	46%	49%	52%	52%
IACC2	13%	21%	31%	40%	50%	55%	65%	70%	70%
MHEV	3%	6%	11%	22%	29%	34%	36%	37%	33%
SHEV1									
SHEV1_2									1%
SHEV2							4%	6%	10%
PHEV1							1%	3%	4%

MR1	5%	11%	14%	14%	14%	14%	15%	14%	14%
MR2	2%	15%	27%	30%	30%	30%	30%	30%	29%
MR3	1%	4%	5%	7%	7%	7%	8%	9%	9%
MR4	2%	4%	4%	6%	6%	7%	8%	10%	10%
MR5		2%	2%	3%	4%	4%	5%	8%	9%
ROLL1		2%	2%	3%	3%	3%	3%	3%	3%
ROLL2	5%	23%	36%	45%	56%	66%	67%	68%	68%
LDB	2%	2%	2%	2%	2%	3%	3%	3%	3%
SAX									
AERO1		3%	3%	3%	3%	3%	3%	3%	3%
AERO2	6%	15%	29%	35%	47%	51%	51%	51%	51%

Table IV-55. Incremental Application of Technologies to Light Truck Fleet under Proposed Standards – MYs 2017-2025

Technology	2017	2018	2019	2020	2021	2022	2023	2024	2025
LUB1									
EFR1									
LUB2_EFR2	2%	8%	21%	35%	49%	61%	77%	83%	84%
CCPS			2%	1%	4%	4%	4%	4%	4%
DVVLS					1%	1%	1%	1%	1%
DEACS	2%	2%	2%	2%	(2%)	(5%)	(5%)	(5%)	(5%)
ICP									
DCP	4%	4%	4%	4%	4%	4%	5%	5%	3%
DVVLD		1%	6%	2%	8%	9%	12%	14%	13%

DEACD			(1%)	(1%)	(2%)	(2%)	(2%)	(2%)	(2%)
SGDI			8%	4%	19%	25%	29%	33%	33%
DEACO			(1%)	(6%)	(7%)	(6%)	(8%)	(8%)	(8%)
VVA			4%	4%	3%	3%	3%	3%	3%
SGDIO			2%	6%	7%	7%	8%	8%	9%
TRBDS1_SD									
TRBDS1_MD		(2%)	4%	(2%)	4%	3%	(3%)	(14%)	(18%)
TRBDS1_LD					3%	3%	5%	5%	5%
TRBDS2_SD			1%	1%	1%	3%	3%	6%	6%
TRBDS2_MD					1%	1%	1%	2%	1%
TRBDS2_LD									
CEGR1_SD			1%	1%			1%	2%	3%
CEGR1_MD									
CEGR1_LD									
CEGR2_SD									
CEGR2_MD									
CEGR2_LD			1%	1%	3%	6%	7%	7%	7%
ADSL_SD									
ADSL_MD				5%	6%	6%	7%	6%	8%
ADSL_LD									
6MAN									
HETRANSM	0%	1%	1%	1%	1%	1%	2%	2%	2%
IATC			(1%)	(1%)	(1%)	(1%)	(1%)	(1%)	(1%)
NAUTO	(2%)	(7%)	(16%)	(17%)	(26%)	(26%)	(25%)	(25%)	(25%)

DCT	(1%)	(7%)	(7%)	(8%)	(9%)	(12%)	(12%)	(12%)	(12%)
8SPD	3%	3%	(9%)	(15%)	(28%)	(28%)	(29%)	(30%)	(34%)
HETRANS		15%	34%	50%	61%	61%	61%	61%	66%
SHFTOPT	4%	14%	27%	39%	61%	77%	78%	79%	79%
EPS	4%	7%	17%	28%	35%	43%	49%	53%	54%
IACC1	3%	5%	5%	12%	18%	21%	21%	25%	29%
IACC2	3%	7%	17%	31%	42%	48%	54%	58%	62%
MHEV			3%	8%	10%	10%	16%	20%	21%
SHEV1_2									
SHEV2									
PHEV1									
MR1	10%	9%	10%	12%	14%	14%	14%	14%	14%
MR2	1%	12%	33%	42%	50%	54%	56%	57%	58%
MR3	(1%)	2%	6%	14%	24%	36%	48%	64%	77%
MR4	1%	1%	1%	4%	10%	12%	16%	20%	39%
MR5						1%	6%	8%	23%
ROLL1									
ROLL2	2%	15%	32%	48%	59%	70%	74%	81%	82%
ROLL3									
LDB		2%	3%	9%	15%	22%	28%	32%	38%
SAX		4%	4%	5%	9%	11%	13%	15%	22%
AERO1									
AERO2	6%	11%	27%	33%	33%	37%	37%	38%	38%

Table IV-56. Incremental Application of Technologies to Overall Fleet under Proposed Standards – MYs 2017-2025

Technology	2017	2018	2019	2020	2021	2022	2023	2024	2025
LUB1	5%	10%	10%	10%	10%	10%	11%	11%	10%
EFR1	12%	16%	18%	18%	18%	18%	18%	19%	19%
LUB2_EFR2	2%	9%	21%	31%	42%	50%	57%	62%	64%
CCPS	2%	3%	5%	5%	6%	6%	6%	6%	5%
DVVLS					1%	1%	1%	1%	1%
DEACS	1%	1%	1%		(1%)	(2%)	(2%)	(2%)	(2%)
ICP									
DCP	5%	8%	10%	11%	13%	14%	14%	13%	12%
DVVLD	7%	10%	16%	17%	22%	25%	26%	26%	26%
DEACD					(1%)	(1%)	(1%)	(1%)	(1%)
SGDI	7%	10%	17%	19%	30%	37%	40%	47%	48%
DEACO			(1%)	(3%)	(4%)	(4%)	(4%)	(4%)	(4%)
VVA			1%	1%	1%	1%	1%	1%	1%
SGDIO	0%	0%	1%	4%	4%	4%	4%	4%	5%
TRBDS1_SD	4%	5%	5%	6%	9%	6%	5%	3%	1%
TRBDS1_MD	2%	1%	5%	4%	6%	5%		(7%)	(11%)
TRBDS1_LD					1%	1%	2%	2%	1%
TRBDS2_SD			2%	2%	2%	3%	3%	3%	2%
TRBDS2_MD	(1%)	(2%)	(2%)	(2%)	(2%)	(2%)	(2%)	(2%)	(2%)
CEGR1_SD	1%	1%	2%	4%	6%	11%	13%	19%	22%
CEGR1_MD	2%	4%	5%	8%	8%	10%	12%	18%	21%

CEGR1_LD									
CEGR2_SD				1%	1%	1%	2%	3%	2%
CEGR2_MD				0%	2%	3%	4%	5%	5%
CEGR2_LD			1%	2%	3%	3%	4%	4%	3%
ADSL_SD			1%	1%	2%	2%	2%	3%	3%
ADSL_MD		1%	1%	2%	3%	3%	3%	3%	5%
ADSL_LD									
6MAN						(1%)	(1%)	(1%)	(1%)
HETRANSM		1%	1%	2%	3%	4%	4%	5%	5%
IATC		(1%)	(1%)	(1%)	(1%)	(1%)	(1%)	(1%)	(1%)
NAUTO	(3%)	(5%)	(10%)	(10%)	(13%)	(13%)	(13%)	(13%)	(13%)
DCT	(4%)	(14%)	(21%)	(26%)	(32%)	(34%)	(34%)	(35%)	(35%)
8SPD	3%	3%	(3%)	(8%)	(14%)	(15%)	(16%)	(17%)	(21%)
HETRANS	3%	18%	32%	46%	53%	56%	55%	53%	54%
SHFTOPT	7%	22%	34%	46%	64%	71%	69%	67%	64%
EPS	7%	9%	14%	21%	31%	36%	39%	41%	41%
IACC1	9%	12%	13%	19%	33%	37%	39%	43%	45%
IACC2	10%	16%	26%	37%	47%	52%	61%	66%	67%
MHEV	2%	4%	8%	17%	22%	26%	29%	31%	29%
SHEV1_2									
SHEV2							3%	4%	6%
PHEV1							1%	2%	3%
MR1	7%	11%	12%	14%	14%	14%	14%	14%	14%
MR2	2%	14%	29%	34%	37%	38%	39%	39%	39%

MR3		3%	5%	9%	13%	17%	22%	27%	32%
MR4	2%	3%	3%	5%	8%	9%	11%	14%	20%
MR5	0%	1%	1%	2%	3%	3%	5%	8%	14%
ROLL1		1%	1%	2%	2%	2%	2%	2%	2%
ROLL2	4%	20%	34%	46%	57%	67%	70%	73%	73%
LDB	1%	2%	2%	5%	7%	10%	11%	13%	15%
SAX		2%	2%	2%	3%	4%	5%	5%	8%
AERO1		2%	2%	2%	2%	2%	2%	2%	2%
AERO2	6%	14%	28%	34%	42%	46%	46%	47%	47%

Based on the agencies' estimates of manufacturers' future sales volumes, and taking into account early outlays attributable to multiyear planning effects (discussed above), the cost increases associated with this additional application of technology will lead to a total of nearly $157 billion in incremental outlays during MYs 2017–2025 (and model years leading up to MY 2017) for additional technology attributable to the proposed standards:

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Table IV-57. Incremental Technology Outlays ($M) under Proposed Standards – MYs 2017-2021

	Earlier	MY2017	MY2018	MY2019	MY2020	MY2021
Total	3,976	2,537	5,681	8,905	12,957	17,123
Aston Martin	-	0	0	0	0	0
BMW	-	6	7	13	29	30
Daimler (Mercedes)	-	5	5	6	20	20
Fiat (Chrysler)	394	229	393	407	1,031	1,080
Ford	734	559	1,230	1,472	1,976	3,055
Geely (Volvo)	-	0	3	13	13	24
General Motors	1,029	408	1,327	2,266	3,881	4,580
Honda	189	271	622	773	835	1,796
Hyundai	231	220	255	530	549	698
Kia	107	64	83	179	370	556
Lotus	-	0	0	0	0	0
Mazda	360	160	265	258	409	414
Mitsubishi	43	12	42	41	61	165
Nissan	434	328	423	986	1,196	1,459
Porsche	-	0	0	0	1	1
Spyker (Saab)	-	0	0	0	0	1
Subaru	42	14	45	172	305	304
Suzuki	233	63	61	209	216	221
Tata (Jaguar, Rover)	3	3	3	5	5	7
Tesla	-	0	0	0	0	0
Toyota	177	194	907	1,521	2,003	2,643

Volkswagen	0	2	8	54	56	68
Passenger cars	3,641	2,280	4,621	6,521	9,103	11,636
Light trucks	335	257	1,060	2,384	3,853	5,487
Combined	3,976	2,537	5,681	8,905	12,957	17,123

Table IV-58. Incremental Technology Outlays ($M) under Proposed Standards – MYs 2022-2025

(and total through MY 2025)

	MY2022	MY2023	MY2024	MY2025	Total
Total	19,807	24,155	29,798	32,354	157,293
Aston Martin	0	0	0	0	0
BMW	81	79	164	155	564
Daimler (Mercedes)	118	195	198	326	893
Fiat (Chrysler)	1,145	1,569	1,641	1,818	9,708
Ford	3,405	4,851	6,284	5,874	29,440
Geely (Volvo)	35	64	93	90	336
General Motors	4,623	5,824	6,471	7,415	37,823
Honda	2,263	2,615	2,808	3,114	15,285
Hyundai	1,127	1,181	1,701	1,667	8,160
Kia	601	682	704	778	4,124
Lotus	0	(0)	(0)	(0)	(0)
Mazda	552	689	832	1,147	5,085
Mitsubishi	162	160	190	369	1,246
Nissan	2,052	2,275	2,874	2,981	15,009

Porsche	(1)	7	7	6	25
Spyker (Saab)	1	2	1	1	8
Subaru	311	309	516	900	2,919
Suzuki	224	223	426	393	2,272
Tata (Jaguar, Rover)	21	34	35	37	153
Tesla	0	0	0	0	0
Toyota	2,972	3,247	4,622	4,954	23,239
Volkswagen	112	149	229	327	1,004
Passenger cars	11,636	13,519	16,852	21,695	113,218
Light trucks	5,487	6,287	7,303	8,102	44,075
Combined	19,807	24,155	29,798	32,354	157,293

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—with very limited exceptions[769]—to hold vehicle performance, capacity, and utility constant when applying fuel-saving technologies to vehicles, the analysis imputes no cost to any actual reductions in vehicle performance, capacity, and utility that may result from manufacturers' efforts to comply with the proposed CAFE standards. Although these costs are difficult to estimate accurately, they nonetheless represent a 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 includes estimates of the economic value of potential changes in motor vehicle fatalities that could result from reductions in the size or weight of vehicles, but not of changes in non-fatal injuries that could result from reductions in vehicle size and/or weight.

Finally, while NHTSA is confident that the cost estimates are the best available and appropriate for purposes of this proposed 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 proposed standards.

However, offsetting these costs, the achieved increases in fuel economy will also produce significant benefits to society. Most of these benefits are attributable to reductions in fuel consumption; fuel savings are valued using forecasts of pretax prices in EIA's reference case forecast from AEO 2011. 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 costs of additional congestion, accidents, and noise attributable to that additional travel. The PRIA accompanying today's proposed rule presents a detailed analysis of the rule's specific benefits.

As Tables IV–59 and 60 show, NHTSA estimates that at the discount rates of 3 percent prescribed in OMB guidance for regulatory analysis, the present value of total benefits from the proposed CAFE standards over the lifetimes of MY 2017–2025 (and, accounting for multiyear planning effects discussed above, model years leading up to MY 2017) passenger cars and light trucks will be $515 billion.

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[769] For example, the agencies have assumed no cost changes due to our assumption that HEV towing capability is not maintained; due to potential drivability issues with the P2 HEV; and due to potential drivability and NVH issues with the shift optimizer.

Table IV-59. Present Value of Benefits ($b) under Proposed Standards Using 3 Percent Discount Rate – MYs 2017-2021[770]

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	11	7	14	21	27	34
LT	1	1	6	13	18	26
Combined	12	8	20	34	45	60

Table IV-60. Present Value of Benefits ($b) under Proposed Standards Using 3 Percent Discount Rate – MYs 2022-2025 (and total through MY 2025)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	39	45	53	59	310
LT	30	33	37	40	206
Combined	69	78	90	100	516

Tables IV–61 and 62 report that the present value of total benefits from requiring cars and light trucks to achieve the fuel economy levels specified in the proposed CAFE standards for MYs 2017–25 will be $419 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 proposed standards is $96 billion—or about 19 percent—lower when discounted at a 7 percent annual rate than when discounted using the 3 percent annual rate.[771]

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[770] 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.

[771] 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.

Table IV-61. Present Value of Benefits ($b) under Proposed Standards Using 7 Percent Discount Rate – MYs 2017-2021

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	9	6	12	17	22	28
LT	1	1	5	10	14	21
Combined	9	7	16	27	37	49

Table IV-62. Present Value of Benefits ($b) under Proposed Standards Using 7 Percent Discount Rate – MYs 2022-2025 (and total through MY2025)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	32	37	44	49	254
LT	24	27	30	33	165
Combined	56	64	73	81	419

For both the passenger car and light truck fleets, NHTSA estimates that the benefits of today's proposed standards will exceed the corresponding costs in every model year, 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 proposed standards are incurred during the model years when the 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. Thus the net benefits of the proposed 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 Tables IV–63 and 64 show, over the lifetimes of the affected (MY 2017–2025, and MYs leading up to MY 2017) vehicles, the agency estimates that when the benefits of the proposed standards are discounted at a 3 percent rate, they will exceed the costs of the proposed standards by $358 billion:

Table IV-63. Present Value of Net Benefits ($b) under Proposed Standards Using 3 Percent Discount Rate – MYs 2017-2021

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	7	4	9	14	18	22
LT	1	1	5	11	14	20
Combined	8	6	14	25	32	43

Table IV-64. Present Value of Net Benefits ($b) under Proposed Standards Using 3 Percent Discount Rate – MYs 2022-2025 (and total through MY 2025)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	26	28	31	36	197
LT	24	26	29	31	161
Combined	49	54	60	67	358

As indicated previously, when fuel savings and other future benefits resulting from the proposed standards are discounted at the 7 percent rate prescribed in OMB guidance, they are $96 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, Tables IV–65 and 66 show 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 $262 billion over MYs 2017–25. Net benefits are thus about 27 percent lower when future benefits are discounted at a 7 percent annual rate than at a 3 percent rate.

Table IV-65. Present Value of Net Benefits ($b) under Proposed Standards Using 7 Percent Discount Rate – MYs 2017-2021

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	5	3	7	10	13	16
LT	1	1	4	8	10	15
Combined	5	4	11	18	24	31

Table IV-66. Present Value of Net Benefits ($b) under Proposed Standards Using 7 Percent Discount Rate – MYs 2022-2025 (and total through MY 2025)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	18	20	22	25	141
LT	18	20	21	24	121
Combined	36	40	43	49	262

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 2016 CAFE standards, and under alternative increases in the standards that apply to MYs 2017–25 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 proposed 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 2011. 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 2011 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.

However, it is also possible that NHTSA's estimates of economic benefits from establishing higher CAFE standards underestimate the true economic benefits of the fuel savings those standards would produce. If the AEO 2011 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 2017–25. As another example, the agency's estimate of benefits from reducing the threat of economic damages from disruptions in the supply of imported petroleum to the U.S. applies to calendar year 2020. 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 to 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.[772] For example, none of the three models used to value climate-related economic damages includes those resulting from ocean acidification or loss of species and wildlife. The models also may not adequately capture certain other impacts, including potentially abrupt changes in climate associated with thresholds that govern climate system responses, interregional interactions such as global security impacts of 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 proposed standards and for all model years combined, using both discount rates prescribed by OMB regulatory guidance. Tables IV–67 and 68 report 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.)

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[772] *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.

Table IV-67. Present Value of Net Benefits ($b) under Proposed Standards Using 3 Percent Discount Rate – MYs 2017-2021

	Earlier	**MY 2017**	**MY 2018**	**MY 2019**	**MY 2020**	**MY 2021**
Costs						
Technology costs	4.0	3.0	6.0	9.0	13.0	17.0
Benefits						
Savings in lifetime fuel expenditures	10.2	7.1	17.5	29.6	40.0	52.5
Consumer surplus from additional driving	0.6	0.4	0.7	1.1	1.2	1.7
Value of savings in refueling time	0.1	0.1	0.2	0.5	0.7	1.0
Reduction in petroleum market externalities	0.6	0.4	0.9	1.6	2.1	2.7
Reduction in climate-related damages from lower CO_2 emissions[773]	1.1	0.7	1.8	3.1	4.2	5.6

Reduction in highway fatalities from changes in vehicle mass	(0.6)	(0.0)	0.0	(0.1)	(0.0)	(0.0)
Reduction in health damage costs from lower emissions of criteria air pollutants:						
CO	-	-	-	-	-	-
VOC	0.0	0.0	0.0	0.0	0.1	0.1
NO_X	0.0	0.0	0.0	0.0	0.0	0.0
PM	0.2	0.1	0.1	0.3	0.5	0.8
SO_X	**0.2**	**0.1**	**0.3**	**0.4**	**0.6**	**0.8**
Dis-benefits from increased driving:						
Congestion costs	(0.8)	(0.6)	(1.3)	(2.2)	(2.9)	(3.8)
Noise costs	(0.0)	(0.0)	(0.0)	(0.0)	(0.1)	(0.1)
Crash costs	(0.4)	(0.3)	(0.6)	(1.0)	(1.4)	(1.8)
Total benefits	12.0	8.0	20.0	34.0	45.0	60.0
Net benefits	8.0	6.0	14.0	25.0	32.0	43.0

Table IV-68. Present Value of Net Benefits ($b) under Proposed Standards Using 3 Percent Discount Rate – MYs 2022-2025 and Total for All MYs

	MY 2022	MY 2023	MY 2024	MY 2025	Total
Costs					
Technology costs	20.0	24.0	30.0	32.0	157
Benefits					
Savings in lifetime fuel expenditures	60.6	68.6	78.4	87.0	452
Consumer surplus from additional driving	2.0	2.2	2.5	2.4	14.8
Value of savings in refueling time	1.3	1.6	2.0	2.4	9.9
Reduction in petroleum market externalities	3.1	3.5	4.0	4.4	23.4
Reduction in climate-related damages from lower CO_2 emissions	6.6	7.5	8.7	9.7	49.1
Reduction in highway fatalities from changes in vehicle mass	(0.0)	(0.0)	(0.0)	(0.0)	(0.1)
Reduction in health damage costs from lower emissions of criteria air pollutants:					
CO	-	-	-	-	-

VOC	0.1	0.1	0.1	0.1	0.7
NO_X	0.0	0.0	0.0	0.0	0.2
PM	1.1	1.3	1.4	1.7	8.3
SO_X	0.9	1.0	1.0	1.1	6.3
Dis-benefits from increased driving:					
Congestion costs	(4.3)	(4.9)	(5.6)	(6.2)	(32.7)
Noise costs	(0.1)	(0.1)	(0.1)	(0.1)	(0.6)
Crash costs	(2.1)	(2.3)	(2.7)	(3.0)	(15.5)
Total benefits	69	78	90	100	515
Net benefits	49	54	60	67	358

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Similarly, Tables IV–69 and 70 below report 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.)

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Table IV-69. Present Value of Net Benefits ($b) under Proposed Standards Using 7 Percent Discount Rate – MYs 2017-2021

	Earlier	**MY 2017**	**MY 2018**	**MY 2019**	**MY 2020**	**MY 2021**
Costs						
Technology costs	4.0	3	6	9	13	17
Benefits						
Savings in lifetime fuel expenditures	8.1	5.7	13.9	23.4	31.7	41.6
Consumer surplus from additional driving	0.1	0.0	0.2	0.4	0.6	0.8
Value of savings in refueling time	0.4	0.3	0.6	0.9	1.0	1.4
Reduction in petroleum market externalities	0.5	0.3	0.7	1.2	1.7	2.2
Reduction in climate-related damages from lower CO_2 emissions[774]	1.1	0.7	1.8	3.1	4.2	5.6

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[774] Using the central value of $22 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 $22 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.

Reduction in highway fatalities from changes in vehicle mass	(0.0)	(0.0)	0.0	(0.1)	(0.0)	(0.0)
Reduction in health damage costs from lower emissions of criteria air pollutants:						
CO	-	-	-	-	-	-
VOC	0.0	0.0	0.0	0.0	0.1	0.1
NO_X	0.0	0.0	0.0	0.0	0.0	0.0
PM	0.1	0.1	0.2	0.4	0.6	0.8
SO_X	0.1	0.1	0.2	0.4	0.5	0.6
Dis-benefits from increased driving:						
Congestion costs	(0.7)	(0.4)	(1.1)	(1.7)	(2.3)	(3.0)
Noise costs	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.1)
Crash costs	(0.3)	(0.2)	(0.5)	(0.8)	(1.1)	(1.4)
Total benefits	9.0	6.6	16.2	27.2	36.8	48.5
Net benefits	5.0	4.0	10.5	18.3	23.8	31.4

Table IV-70. Present Value of Net Benefits ($b) under Proposed Standards Using 7 Percent Discount Rate – MYs 2022-2025 and Total for All MYs

	MY 2022	MY 2023	MY 2024	MY 2025	Total
Costs					
Technology costs	20	24	30	32	157
Benefits					
Savings in lifetime fuel expenditures	48.1	54.4	62.3	69.2	358.3
Consumer surplus from additional driving	1.0	1.3	1.6	1.9	7.9
Value of savings in refueling time	1.6	1.8	2.0	2.0	11.9
Reduction in petroleum market externalities	2.5	2.8	3.2	3.6	18.7
Reduction in climate-related damages from lower CO_2 emissions	6.6	7.5	8.7	9.7	49.1
Reduction in highway fatalities from changes in vehicle mass	(0.0)	(0.0)	(0.0)	(0.0)	(0.1)
Reduction in health damage costs from lower emissions of criteria air pollutants:					

CO	-	-	-	-	-
VOC	0.1	0.1	0.1	0.1	0.6
NO_X	0.0	0.0	0.0	0.0	0.2
PM	0.9	1.0	1.1	1.3	6.6
SO_X	0.7	0.8	0.8	0.9	5.1
Dis-benefits from increased driving:					
Congestion costs	(3.5)	(3.9)	(4.5)	(5.0)	(26.2)
Noise costs	(0.1)	(0.1)	(0.1)	(0.1)	(0.5)
Crash costs	(1.6)	(1.9)	(2.1)	(2.4)	(12.4)
Total benefits	56.2	63.8	73.2	81.2	419.2
Net benefits	36.4	39.7	43.4	48.8	252.2

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These benefit and cost estimates do not reflect the availability and use of certain 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 notes that, in reality, manufacturers are likely to rely to some extent on flexibility mechanisms and would thereby reduce the cost of complying with the proposed standards to a meaningful extent.

As discussed in the PRIA, NHTSA has performed an analysis to estimate costs and benefits taking into account EPCA's provisions regarding EVs, PHEVs produced before MY 2020, FFV credits, and other CAFE credit provisions. Accounting for these provisions indicates that achieved fuel economies would be 0.5–1.6 mpg lower than when these provisions are not considered:

Table IV-71. Average Achieved Fuel Economy (mpg) under Proposed Standards – MYs 2017-2021 (with EPCA AFV and credit provisions)

	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Passenger cars	38.8	40.6	42.7	44.6	46.1
Light trucks	29.0	30.1	31.8	33.0	34.8
Combined	34.5	36.0	38.0	39.7	41.4

Table IV-72. Average Achieved Fuel Economy (mpg) under Proposed Standards – MYs 2022-2025 (with EPCA AFV and credit provisions)

	MY 2022	MY 2023	MY 2024	MY 2025
Passenger cars	47.2	48.8	50.5	52.7
Light trucks	35.5	36.3	37.4	38.6
Combined	42.4	43.7	45.2	47.0

As a result, NHTSA estimates that, when EPCA AFV and credit provisions are taken into account, fuel savings will total 163 billion gallons—5.8 percent less than the 173 billion gallons estimated when these flexibilities are not considered:

Table IV-73. Fuel Saved (billion gallons) under Proposed Standards – MYs 2017-2021 (with EPCA AFV and credit provisions)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	4	2	4	6	9	10
LT	0	1	2	4	6	8
Combined	4	3	6	11	14	19

Table IV-74. Fuel Saved (billion gallons) under Proposed Standards – MYs 2022-2025 (with EPCA AFV and credit provisions)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	12	14	17	20	98
LT	9	10	11	13	65
Combined	21	24	28	32	153

The agency similarly estimates CO_2 emissions reductions will total 1,742 million metric tons (mmt), 5.0 percent less than the 1,834 mmt estimated when these EPCA provisions are not considered:[775]

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[775] Differences in the application of diesel engines and plug-in hybrid electric vehicles lead to differences in the percentage changes in fuel consumption and carbon dioxide emissions between the with- and without-credit cases.

Table IV-75. Avoided Carbon Dioxide Emissions (mmt) under Proposed Standards – MYs 2017-2021 (with EPCA AFV and credit provisions)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	41	23	43	69	93	111
LT	4	7	22	47	64	89
Combined	45	31	65	116	157	200

Table IV-76. Avoided Carbon Dioxide Emissions (mmt) under Proposed Standards – MYs 2022-2025 (with EPCA AFV and credit provisions)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	128	151	177	204	1,040
LT	100	109	123	138	702
Combined	227	260	300	341	1,742

This analysis further indicates that significant reductions in outlays for additional technology will result when EPCA's AFV and credit provisions are taken into account. Tables IV–77 and 78 below show that, total technology costs are estimated to decline to $133 billion as a result of manufacturers' use of these provisions, or about 15 percent less than the $157 billion estimated when excluding these flexibilities:

Table IV-77. Incremental Technology Outlays ($ billion) under Proposed Standards – MYs 2017-2021 (with EPCA AFV and credit provisions)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	1	1	3	5	8	10
LT	0	0	1	2	3	4
Combined	1	2	4	7	11	15

Table IV-78. Incremental Technology Outlays ($ billion) under Proposed Standards – MYs 2022-2025 (with EPCA AFV and credit provisions)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	12	16	19	22	98
LT	5	6	6	8	35
Combined	17	21	25	30	133

Because NHTSA's analysis indicated that these EPCA provisions will modestly reduce fuel savings and related benefits, the agency's estimate of the present value of total benefits will be $488 billion when discounted at a 3 percent annual rate, as Tables IV–79 and 80 below report. This estimate of total benefits is $27 billion, or 5.2 percent, lower than the $515 billion reported previously for the analysis that excluded these provisions:

Table IVV-79. Present Value of Benefits ($ billion) under Proposed Standards Using a 3 Percent Discount Rate – MYs 2017-2021 (with EPCA AFV and credit provisions)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	10	6	12	19	26	31
LT	1	2	6	12	17	24
Combined	11	8	17	31	43	55

Table IV-80. Present Value of Benefits ($ billion) under Proposed Standards Using a 3 Percent Discount Rate – MYs 2022-2025 (with EPCA AFV and credit provisions)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	36	43	51	60	293
LT	28	30	35	39	195
Combined	63	74	86	99	488

Similarly, NHTSA estimates that the present value of total benefits will decline modestly from its previous estimate when future fuel savings and other benefits are discounted at the higher 7 percent rate. Tables IV–81 and 82 report that the present value of benefits from requiring higher fuel economy for MY 2017–25 cars and light trucks will total $397 billion when discounted using a 7 percent rate, about $22 billion (5.3 percent) below the previous $419.2 billion estimate of total benefits when FFV credits were not permitted:

Table IV-81. Present Value of Benefits ($ billion) under Proposed Standards Using a 7 Percent Discount Rate – MYs 2017-2021 (with EPCA AFV and credit provisions)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	8	5	9	15	21	25
LT	1	2	5	10	14	20
Combined	9	7	14	25	35	45

Table IV-82. Present Value of Benefits ($ billion) under Proposed Standards Using a 7 Percent Discount Rate – MYs 2022-2025 (with EPCA AFV and credit provisions)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	29	35	42	49	240
LT	22	24	28	32	157
Combined	52	60	70	81	397

Although the discounted present value of total benefits will be modestly lower when EPCA AFV and credit provisions are taken into account, the agency estimates that these provisions will reduce net benefits by a smaller proportion. As Tables IV–83 and 84 show, the agency estimates that these will reduce net benefits from the proposed CAFE standards to $355 billion from the previously-reported estimate of $358 billion without those credits, or by only about 1 percent.

Table IV-83. Present Value of Net Benefits ($ billion) under Proposed Standards Using a 3 Percent Discount Rate – MYs 2017-2021 (with EPCA AFV and credit provisions)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	9	5	8	13	18	21
LT	1	2	5	10	14	20
Combined	10	6	13	24	32	41

Table IV-84. Present Value of Net Benefits ($ billion) under Proposed Standards Using a 3 Percent Discount Rate – MYs 2022-2025 (with EPCA AFV and credit provisions)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	24	28	32	38	195
LT	23	25	28	31	159
Combined	47	52	60	69	354

Similarly, Tables IV–85 and 86 immediately below show that NHTSA estimates manufacturers' use of EPCA AFV and credit provisions will increase net benefits from requiring higher fuel economy for MY 2017–25 cars and light trucks, but very slightly—to $264 billion—if a 7 percent discount rate is applied to future benefits. This estimate is $2 billion—or 0.8 percent—higher than the previously-reported $262 billion estimate of net benefits without the availability of EPCA AFV and credit provisions using that same discount rate.

Table IV-85. Present Value of Net Benefits ($ billion) under Proposed Standards Using a 7 Percent Discount Rate – MYs 2017-2021 (with EPCA AFV and credit provisions)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	7	4	6	10	13	15
LT	1	1	4	8	11	15
Combined	8	5	10	18	24	30

Table IV-86. Present Value of Net Benefits ($ billion) under Proposed Standards Using a 7 Percent Discount Rate – MYs 2022-2025 (with EPCA AFV and credit provisions)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
PC	17	20	23	27	142
LT	17	19	21	24	121
Combined	35	39	44	51	263

The agency has performed several sensitivity analyses to examine important assumptions. All sensitivity analyses were based on the ''standard setting'' output of the CAFE model. We examine sensitivity with respect to the following economic parameters:

(1) The price of gasoline: The main analysis (*i.e.,* the Reference Case) uses the AEO 2011 Reference Case estimate for the price of gasoline. In this sensitivity analysis we examine the effect of using the AEO 2011 High Price Case or Low Price Case forecast estimates instead.

(2) The rebound effect: The main analysis uses a rebound effect of 10 percent to project increased miles traveled as the cost per mile driven decreases. In the sensitivity analysis, we examine the effect of using a 5, 15, or 20 percent rebound effect instead.

(3) The value of CO_2 benefits: The main analysis uses $22 per ton discounted at a 3 percent discount rate to quantify the benefits of reducing CO_2 emissions and $0.174 per gallon to quantify the benefits of reducing fuel consumption. In the sensitivity analysis, we examine the following values and discount rates applied only to the social cost of carbon to value carbon benefits, considering low, high, and very high valuations of approximately $5, $36, and $67 per ton, respectively with regard to the benefits of reducing CO_2 emissions.[776] These are the 2010 values, which increase over time. These values can be translated into cents per gallon by multiplying by 0.0089,[777] giving the following values:

- ($4.86 per ton CO_2) × 0.0089 = $0.043 per gallon discounted at 5%
- ($22.00 per ton CO_2) × 0.0089 = $0.196 per gallon discounted at 3% (used in the main analysis)
- ($36.13 per ton CO_2) ×0.0089 = $0.322 per gallon discounted at 2.5%
- And a 95th percentile estimate of
- ($66.88 per ton CO_2) × 0.0089 = $0.595 per gallon discounted at 3%

(4) Military security: The main analysis does not assign a value to the military security benefits of reducing fuel consumption. In the sensitivity analysis, we examine the impact of using a value of 12 cents per gallon instead.

(5) Consumer Benefit: The main analysis assumes there is no loss in value to consumers resulting from vehicles that have an increase in price and higher fuel economy. This sensitivity analysis assumes that there is a 25, or 50 percent loss in value to consumers—equivalent to the assumption that consumers will only value the calculated benefits they will achieve at 75, or 50 percent,

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[776] The low, high, and very high valuations of $5, $36, and $67 are rounded for brevity; the exact values are $4.86, $36.13, and $66.88, respectively. While the model uses the unrounded values, the use of unrounded values is not intended to imply that the chosen values are precisely accurate to the nearest cent; rather, they are average levels resulting from the many published studies on the topic.

[777] 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. 1 gallon of gas weighs 2,819 grams, of that 2,433 grams are carbon. One ton of CO_2/One ton of C (44/12)* 2433grams C/gallon *1 ton/1000kg * 1 kg/1000g = (44 * 2433*1*1)/(12*1*1000 * 1000) = 0.0089. Thus, one ton of CO_2*0.0089 = 1 gallon of gasoline.

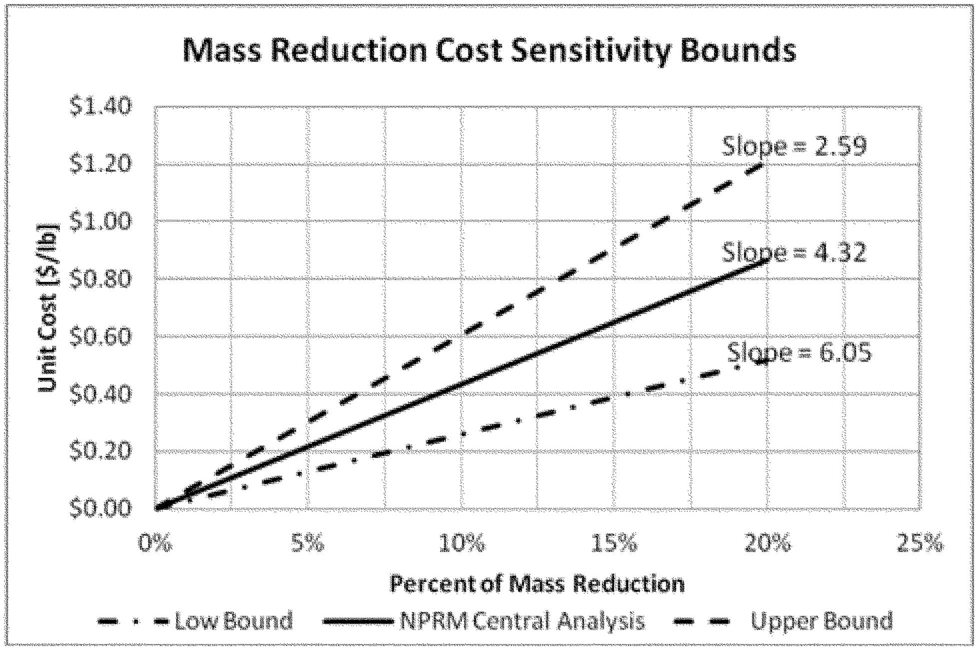
respectively, of the main analysis estimates.

(6) Battery cost: The agency conducted a sensitivity analysis of technology cost in relation to battery costs for HEV, PHEV, and EV batteries. The ranges are based on recommendations from technical experts in the field of battery energy storage technologies at the Department of Energy (DOE) and at Argonne National Laboratories (ANL), and were developed using the Battery Performance and Cost (BatPac) model developed by ANL and funded by DOE.[778] The values for these ranges are shown in the table below and are calculated with 95 percent confidence intervals after analyzing the confidence bound using the BatPac model.

Suggested Confidence Bounds as a Percentage of the Calculated Point Estimate for a Graphite-Based Li-ion Battery Using the Default Inputs in BatPac

Battery Type	Cathodes	Confidence Interval	
		Lower	Upper
HEV	LMO, LFP, NCA, NMC	-10%	10%
PHEV, EV	NMC, NCA	-10%	20%
PHEV, EV	LMO, LFP	-20%	35%

(7) Mass reduction cost: Due to the wide range of mass reduction costs as discussed in Chapter 3 of the draft joint TSD, a sensitivity analysis was performed examining the impact of the cost of vehicle mass reduction to the total technology cost. The direct manufacturing cost (DMC) for mass reduction is represented as a linear function between the unit DMC versus percent of mass reduction, as shown in the figure below:



The slope of the line used in the central analysis for this NPRM is $4.32 per pound per percent of mass reduction. The slope of the line is varied + 40% as the upper and lower bound for this sensitivity study. The resultant values

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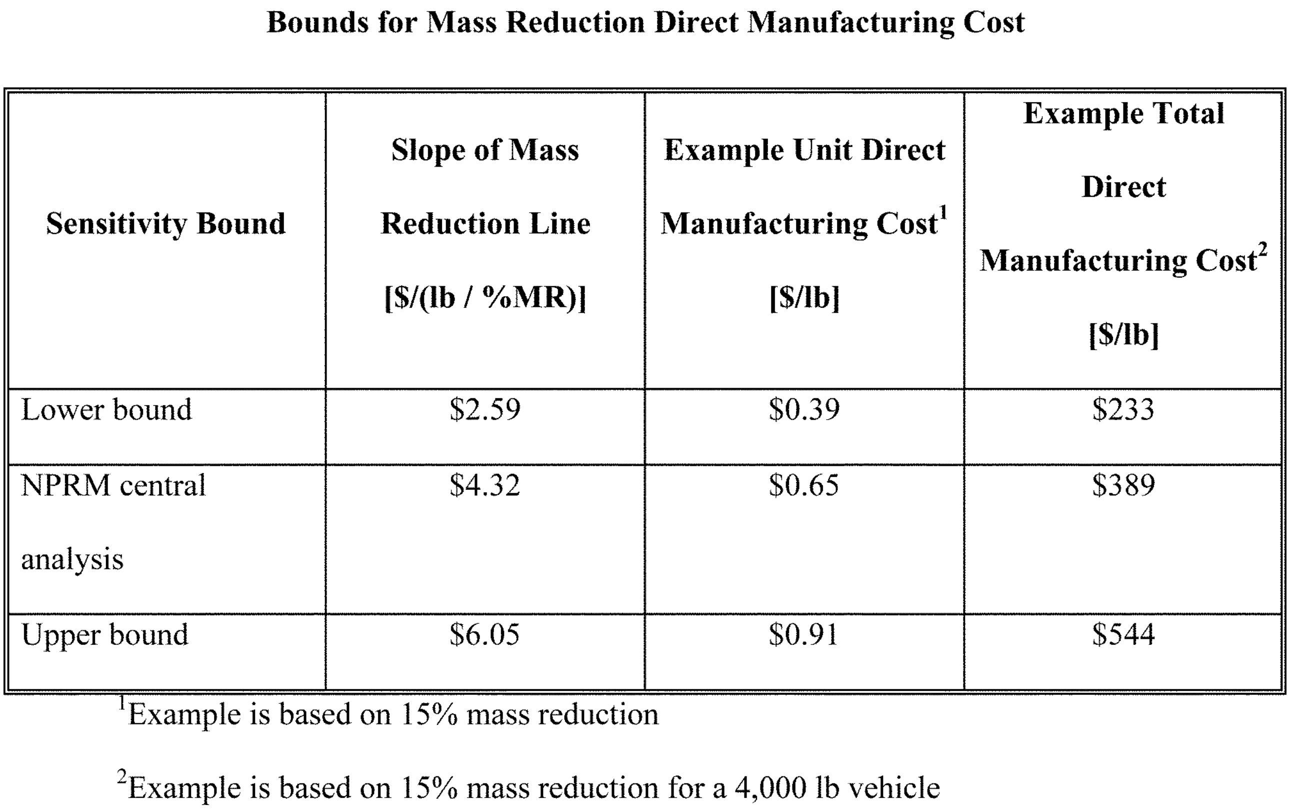
[778] Section 3.4.3.9 in Chapter 3 of the draft Joint TSD has a detailed description of the history of the BatPac model and how the agencies used it in this NPRM analysis.

for the range of mass reduction cost are shown in the table below:



Bounds for Mass Reduction Direct Manufacturing Cost

Sensitivity Bound	Slope of Mass Reduction Line [$/(lb / %MR)]	Example Unit Direct Manufacturing Cost[1] [$/lb]	Example Total Direct Manufacturing Cost[2] [$/lb]
Lower bound	$2.59	$0.39	$233
NPRM central analysis	$4.32	$0.65	$389
Upper bound	$6.05	$0.91	$544

[1] Example is based on 15% mass reduction

[2] Example is based on 15% mass reduction for a 4,000 lb vehicle

(8) Market-driven response: The baseline for the central analysis is based on the MY 2016 CAFE standards and assumes that manufacturers will make no changes in the fuel economy from that level through MY 2025. A sensitivity analysis was performed to simulate potential increases in fuel economy over the compliance level required if MY 2016 standards were to remain in place. The assumption is that the market would drive manufacturers to put technologies into their vehicles that they believe consumers would value and be willing to pay for. Using parameter values consistent with the central analysis, the agency simulated a market-driven response by applying a payback period of one year for purposes of calculating the value of future fuel savings when simulating whether manufacturers would apply additional technology to an already CAFE-compliant fleet. In other words we assumed that manufacturers that were above their MY 2016 CAFE level would compare the cost to consumers to the fuel savings in the first year of operation and decide to voluntarily apply those technologies to their vehicles when benefits for the first year exceeded costs for the consumer. For a manufacturer's fleet that has not yet achieved compliance with CAFE standards, the agency continued to apply a five-year payback period. In other words, for this sensitivity analysis the agency assumed that manufacturers that have not yet met CAFE standards for future model years will apply technology as if buyers were willing to pay for the technologies as long as the fuel savings throughout the first five years of vehicle ownership exceeded their costs. Once having complied with those standards, however, manufacturers are assumed to consider making further improvements in fuel economy as if buyers were only willing to pay for fuel savings to be realized during the first year of vehicle ownership. The 'market-driven response' assumes that manufacturers will overcomply if additional technology is sufficiently cost-effective. Because this assumption has a greater impact under the baseline standards, its application reduces the incremental costs, effects, and benefits attributable to the new standards. This does not mean that costs, effects, and benefits would actually be smaller with a market-driven response; rather, it means that costs, effects, and benefits would be at least as great, but would be partially attributable not to the new standards, but instead to the market.

Varying each of these eight parameters in isolation results in a variety of economic scenarios, in addition to the Reference case. These are listed in Table IV–87 below.

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Table IV-87. Sensitivity Analyses Evaluated in NHTSA's PRIA

Name	Fuel Price	Discount Rate	Rebound Effect	SCC	Military Security
Reference	Reference	3%	10%	$22	0¢/gal
High Fuel Price	High	3%	10%	$22	0¢/gal
Low Fuel Price	Low	3%	10%	$22	0¢/gal
5% Rebound Effect	Reference	3%	5%	$22	0¢/gal
15% Rebound Effect	Reference	3%	15%	$22	0¢/gal
20% Rebound Effect	Reference	3%	20%	$22	0¢/gal
12¢/gal Military Security Value	Reference	3%	10%	$22	12¢/gal
$5/ton CO_2 Value	Reference	3%	10%	$5	0¢/gal
$36/ton CO_2 Value	Reference	3%	10%	$36	0¢/gal
$67/ton CO_2 Value	Reference	3%	10%	$67	0¢/gal
50% Consumer Benefit	Reference	3%	10%	$22	0¢/gal
75% Consumer Benefit	Reference	3%	10%	$22	0¢/gal
Low Battery Cost	Reference	3%	10%	$22	0¢/gal
High Battery Cost	Reference	3%	10%	$22	0¢/gal
Low Cost Mass Reduction	Reference	3%	10%	$22	0¢/gal
High Cost Mass Reduction	Reference	3%	10%	$22	0¢/gal
Market-Driven Response	Reference	3%	10%	$22	0¢/gal

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The basic results of this sensitivity analysis are contained in Chapter X of the PRIA, but several selected findings are as follows:

(1) Varying the economic assumptions has almost no impact on achieved mpg. The mass reduction cost sensitivities, battery cost reduction sensitivities, and the market-based baseline are the only cases in which achieved mpg differs from the Reference Case of the Preferred Alternative. None of these alter the outcome by more than 0.2 mpg for either fleet.

(2) Varying the economic assumptions has, at most, a small impact on per-vehicle costs, fuel saved, and CO_2 emissions reductions, with none of the variations impacting the outcomes by more than 10 percent from their central analysis levels, save for several exceptions including alternate fuel price sensitivities and the sensitivity involving a 20 percent rebound effect.

(3) The category most affected by variations in the economic parameters considered in these sensitivity analyses is net benefits. The sensitivity analyses examining the AEO Low and High fuel price scenarios demonstrate the potential to negatively impact net benefits by up to 40.3 percent or to increase net benefits by 29.5 percent relative to those of the Preferred Alternative. Other large impacts on net benefits occurred with the 20 percent rebound effect (-38.4%), valuing benefits at 50 and 75 percent (−63.0% and −31.5%, respectively), and valuing the reduction in CO_2 emissions at $67/ton (+28.1%).

(4) Even if consumers value the benefits achieved at 50% of the main analysis assumptions, total benefits still exceed costs.

Regarding the lower fuel savings and CO_2 emissions reductions predicted by the sensitivity analysis as fuel price increases, which initially may seem counterintuitive, we note that there are some counterbalancing factors occurring. As fuel price increases, people will drive less and so fuel savings and CO_2 emissions reductions may decrease.

The agency performed two additional sensitivity analyses presented in Tables IV–88 and IV–89. First, the agency analyzed the impact that having a retail price equivalent (RPE) factor of 1.5 for all technologies would have on the various alternatives instead of using the indirect cost methodology (ICM). The ICM methodology in an overall markup factor of 1.2 to 1.25 compared to the RPE markup factor from variable cost of 1.5. Next, the agency conducted a separate sensitivity analysis using values that were derived from the 2011 NAS Report. This analysis used an RPE markup factor of 1.5 for non-electrification technologies, which is consistent with the NAS estimation for technologies manufactured by suppliers, and an RPE markup factor of 1.33 for electrification technologies (HEV, PHEV, and EV); three types of learning which include no learning for mature technologies, 1.25 percent annual learning for evolutionary technologies, and 2.5 percent annual learning for revolutionary technologies; technology cost estimates for 52 percent (33 out of 63) technologies; and technology effectiveness estimates for 56 percent (35 out of 63) technologies. Cost learning was applied to technology costs in a manner similar to how cost learning is applied in the central analysis for many technologies which have base costs that are applicable to recent or near-term future model years. As noted above, the cost learning factors used for the sensitivity case are different from the values used in the central analysis. For the other inputs in the sensitivity case, where the NAS study has inconsistent information or lacks projections, NHTSA used the same input values that were used in the central analysis.

Table IV-88. Achieved mpg Level, MY 2025, Comparing Different Cost Mark-up Methodologies (3% Discount Rate)

	ICM Method (Main Analysis Costs)	RPE Method (Main Analysis Costs)	Difference (mpg)
Passenger Cars			
Preferred Alternative	52.70	52.24	-0.46
Max Net Benefits	49.09	48.47	-0.61
Light trucks			
Preferred Alternative	39.59	39.38	-0.21
Max Net Benefits	44.31	44.17	-0.14

Table IV-89. Achieved mpg level, MY 2025, Comparing ICM Method with Main Analysis Costs vs. NAS Costs (3% Discount Rate)

	ICM Method (Main Analysis Costs)	ICM Method (NAS Cost Estimates)	Difference (mpg)
Passenger Cars			
Preferred Alternative	52.70	52.11	-0.59
Max Net Benefits	49.09	48.28	-0.80
Light trucks			
Preferred Alternative	39.59	39.08	-0.51
Max Net Benefits	44.31	44.48	0.18

Table IV-90. Sensitivity Analyses (Achieved mpg, Per-Vehicle Cost, Net Benefits, Fuel Saved, & CO_2 Emissions Reduced)

Cost Method and Set of Cost Estimates	MY 2025 Achieved mpg	Average MY 2025 Per-Vehicle Technology Cost	MY 2017-2025 Net Benefits, Discounted 3%, in Billions of $	MY 2017-2025 Fuel Saved, in Billions of Gallons	MY 2017-2025 CO2 Emissions Reduced, in mmT
Passenger Cars					
ICM w/Main Analysis Costs	52.70	$2,023	$190	100	1,059
RPE w/Main Analysis Costs	52.24	$2,509	$164	101	1,062
ICM w/NAS Costs	52.11	$2,811	$149	101	1,074
Light trucks					
ICM w/Main Analysis Costs	39.59	$1,578	$161	69	729
RPE w/Main Analysis Costs	39.38	$2,038	$148	68	722
ICM w/NAS Costs	39.08	$2,405	$139	66	660

For today's rulemaking analysis, the agency has also performed a sensitivity analysis where manufacturers are allowed to voluntarily apply more technology than would be required to comply with CAFE standards for each model year. Manufacturers are assumed to do so as long as applying each additional technology would increase vehicle production costs (including markup) by less than it would reduce buyers' fuel costs during the first year they own the vehicle. This analysis makes use of the "voluntary overcompliance" simulation capability DOT has recently added to its CAFE model. This capability, which is discussed further above in section IV.C.4.c and in the CAFE model documentation, is a logical extension of the model's simulation of some manufacturers' decisions to respond to EPCA by paying civil penalties once additional technology becomes economically unattractive. It attempts to simulate manufacturers' responses to buyers' demands for higher fuel economy levels than prevailing CAFE standards would require when fuel costs are sufficiently high, and technologies that manufacturers have not yet fully utilized are available to improve fuel economy at relatively low costs.

NHTSA performed this analysis because some stakeholders commenting on the recently-promulgated standards for medium- and heavy-duty vehicles indicated that it would be unrealistic for the agency to assume that in the absence of new regulations, technology and fuel economy would not improve at all in the future. In other words, these stakeholders argued that market forces are likely to result in some fuel economy improvements over time, as potential vehicle buyers and manufacturers respond to changes in fuel prices and in the availability and costs of technologies to increase fuel economy. NHTSA agrees that, in principle, its analysis should estimate a potential that manufacturers will apply technology as if buyers place some value on fuel economy improvements. Considering current uncertainties discussed below regarding the *degree* to which manufacturers will do so, the agency currently judges it appropriate to conduct its central rulemaking analysis without attempting to simulate these effects. Nonetheless, the agency believes that voluntary overcompliance is sufficiently plausible that corresponding sensitivity analysis is warranted.

NHTSA performed this analysis by simulating potential overcompliance under the no-action alternative, the preferred alternative, and other regulatory alternatives. In doing so, the agency used all the same parameter values as in the agency's central analysis, but applied a payback period of one year for purposes of calculating the value of future fuel savings when simulating whether a manufacturer would apply additional technology to an already CAFE-compliant fleet. For technologies applied to a manufacturer's fleet that has not yet achieved compliance with CAFE standards, the agency continued to apply a five-year payback period.

In other words, for this sensitivity analysis the agency assumed that manufacturers that have not yet met CAFE standards for future model years will apply technology as if buyers were willing to pay for fuel savings throughout the first five years of vehicle ownership. Once having complied with those standards, however, manufacturers are assumed to consider making further improvements in fuel economy as if buyers were only willing to pay for fuel savings to be realized during the first year of vehicle ownership. This reflects the agency's assumptions for this sensitivity analysis, that (1) civil penalties, though legally available, carry a stigma that manufacturers will strive to avoid, and that (2) having achieved compliance with CAFE standards, manufacturers will avoid competitive risks entailed in charging higher prices for vehicles that offer additional fuel economy, rather than offering additional performance or utility.

Since CAFE standards were first introduced, some manufacturers have consistently exceeded those standards, and the industry as a whole has consistently overcomplied with both the passenger car and light truck standards. Although the combined average fuel economy of cars and light trucks declined in some years, this resulted from buyers shifting their purchases from passenger cars to light trucks, not from undercompliance with either standard. Even with those declines, the industry still overcomplied with both passenger car and light truck standards. In recent years, between MYs 1999 and 2009, fuel economy overcompliance has been increasing on average for both the passenger car and the light truck fleets. NHTSA considers it impossible to say with certainty why past fuel economy levels have followed their observed path. If the agency could say with certainty how fuel economy would have changed in the absence of CAFE standards, it might be able to answer this question; however, NHTSA regards this ''counterfactual'' case as simply unknowable.

NHTSA has, however, considered other relevant indications regarding manufacturers' potential future decisions. Published research regarding how vehicle buyers have previously viewed fuel economy suggests that they have only a weak quantitative understanding of the relationship between fuel economy and future fuel outlays, and that potential buyers value fuel economy improvements by less than theoretical present-value calculations of lifetime fuel savings would suggest. These findings are generally consistent with manufacturers' confidential and, in some cases, public statements. Manufacturers have tended to communicate not that buyers absolutely ''don't care'' about fuel economy, but that buyers have, in the past, not been willing to pay the full cost of most fuel economy improvements. Manufacturers have also tended to indicate that sustained high fuel prices would provide a powerful incentive for increased fuel economy; this implies that manufacturers believe buyers are willing to pay for some fuel economy increases, but that buyers' willingness to do so depends on their expectations for future fuel prices. In their confidential statements to the agency, manufacturers have also tended to indicate that in their past product planning processes, they have assumed buyers would only be willing to pay for technologies that ''break even'' within a relatively short time—generally the first two to four years of vehicle ownership.

NHTSA considers it not only feasible but appropriate to simulate such effects by calculating the present value of fuel savings over some ''payback period.'' The agency also believes it is appropriate to assume that specific improvements in fuel economy will be implemented voluntarily if manufacturers' costs for adding the technology necessary to implement them to specific models would be lower than potential buyers' willingness to pay for the resulting fuel savings. This approach takes fuel costs directly into account, and is therefore responsive to manufacturers' statements regarding the role that fuel prices play in influencing buyers' demands and manufacturers' planning processes. Under this approach, a short payback period can be employed if manufacturers are expected to act as if buyers place little value on fuel economy. Conversely, a longer payback period can be used if manufacturers are expected to act as if buyers will place comparatively greater value on fuel economy.

NHTSA cannot be certain to what extent vehicle buyers will, in the future, be willing to pay for fuel economy improvements, or to what extent manufacturers would, in the future, voluntarily apply more technology than needed to comply with fuel economy standards. The agency is similarly hopeful that future vehicle buyers will be more willing to pay for fuel economy improvements than has historically been the case. In meetings preceding today's proposed standards, two manufacturers stated they expected fuel economy to increase two percent to three percent per year after MY 2016, absent more stringent regulations. And in August 2010, one manufacturer stated its combined fleet would achieve 50 mpg by MY 2025, supporting that at a minimum some manufacturers believe that exceeding fuel economy standards will provide them a competitive advantage. The agency is hopeful that future vehicle buyers will be better-informed than has historically been the case, in part because recently-promulgated requirements regarding vehicle labels will provide clearer information regarding fuel economy and the dollar value of resulting fuel savings. The agency is similarly hopeful that future vehicle buyers will be more willing to pay for fuel economy improvements than past buyers. In meetings preceding today's proposed standards, many manufacturers indicated significant shifts in their product plans—shifts consistent with expectations that compared to past buyers, future buyers will ''care more'' about fuel economy.

Nevertheless, considering the uncertainties mentioned above, NHTSA continues to consider it appropriate to conduct its central rulemaking analysis in a manner that ignores the possibility that in the future, manufacturers will voluntarily apply more technology than the minimum necessary to comply with CAFE standards. Also, in conducting its sensitivity analysis to simulate voluntary overcompliance with the proposed standards, the agency has applied the extremely conservative assumption that when considering whether to employ ''extra'' technology, manufacturers will act as if buyers' value the resulting savings in fuel costs only during their first year of ownership (*i.e.,* as if a 1-year payback period applies).

Results of the agency's analysis simulating this potential for voluntary overcompliance are summarized below. Compared to results from the agencies' central analysis presented above, differences are greatest for the baseline scenario (*i.e.,* the No-Action Alternative), under which CAFE standards remain unchanged after MY 2016. These results also suggest, as the agency would expect, that because increasingly stringent standards require progressively more technology than the market will demand, the likelihood of voluntary overcompliance will decline with increasing stringency. Achieved fuel economy levels under baseline standards are as follows:

Table IV-91. Average Achieved Fuel Economy (mpg) under Baseline Standards – MYs 2017-2021 (including voluntary overcompliance)

	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
PC	37.2	38.4	38.7	38.9	39.0
LT	29.3	29.6	29.8	29.9	30.0
Combined	34.3	34.7	35.0	35.1	35.3

Table IV-92. Average Achieved Fuel Economy (mpg) under Baseline Standards – MYs 2022-2025 (including voluntary overcompliance)

	MY 2022	MY 2023	MY 2024	MY 2025
PC	39.1	39.1	39.2	39.3
LT	30.0	30.2	30.4	30.8
Combined	35.4	35.6	35.8	36.0

With no change in standards after MY 2016, while combined average fuel economy is the same in MY 2017 both with and without simulated voluntary overcompliance, differences grow over time, reaching 0.8 mpg in MY 2025. In other words, without simulating voluntary overcompliance, the agency estimated that combined average achieved fuel economy would reach 35.2 mpg in MY 2025, whereas the agency estimates that it would reach 36.0 mpg in that year if voluntary overcompliance occurred.

In contrast, the effect on achieved fuel economy levels of allowing voluntary overcompliance with the proposed standards was minimal. Allowing manufacturers to overcomply with the proposed standards for MY 2025 led to combined average achieved fuel economy levels approximately equal to levels of values obtained without simulating voluntary overcompliance:

Table IV-93. Average Achieved Fuel Economy (mpg) under Proposed Standards – MYs 2017-2021

(including voluntary overcompliance)

	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Passenger cars	39.5	41.6	43.6	45.3	47.0
Light trucks	29.6	30.8	32.6	33.9	35.8
Combined	35.2	36.9	38.9	40.5	42.3

Table IV-94. Average Achieved Fuel Economy (mpg) under Proposed Standards – MYs 2022-2025

(including voluntary overcompliance)

	MY 2022	MY 2023	MY 2024	MY 2025
Passenger cars	48.2	49.4	51.2	52.6
Light trucks	36.8	37.7	38.6	39.6
Combined	43.5	44.7	46.2	47.5

As a result, NHTSA estimates that, when the potential for voluntary overcompliance is taken into account, fuel savings attributable to more stringent standards will total 162 billion gallons—6.4 percent less than the 173 billion gallons estimated when potential voluntary overcompliance is not taken into account:

Table IV-95. Fuel Saved (billion gallons) under Proposed Standards – MYs 2017-2021 (including voluntary overcompliance)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Passenger cars	4	2	5	7	9	11
Light trucks	1	0	2	4	6	8
Combined	5	3	7	11	15	19

Table IV-96. Fuel Saved (billion gallons) under Proposed Standards – MYs 2022-2025 (including voluntary overcompliance)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger cars	12	14	17	18	99
Light trucks	9	10	11	11	63
Combined	22	24	27	30	162

The agency is not projecting, however, that fuel consumption will be greater when voluntary overcompliance is taken into account. Rather, under today's proposed standards, the agency's analysis shows virtually identical fuel consumption (0.2 percent less over the useful lives of MY 2017–2025 vehicles) when potential voluntary overcompliance is taken into account. Simulation of voluntary overcompliance, therefore, does not reduce the agency's estimate of future fuel savings over the baseline scenario. Rather it changes the attribution of those fuel savings to the proposed standards, because voluntary overcompliance attributes some of the fuel savings to the market. The same holds for the attribution of costs, other effects, and monetized benefits—inclusion of voluntary overcompliance does not necessarily change their amounts, but it does attribute some of each cost, effect, or benefit to the workings of the market, rather than to the proposed standards.

The agency similarly estimates CO_2 emissions reductions attributable to today's proposed standards will total 1,726 million metric tons (mmt), 5.8 percent less than the 1,834 mmt estimated when potential voluntary overcompliance is not taken into account:[779]

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[779] Differences in the application of diesel engines and plug-in hybrid electric vehicles lead to differences in the incremental percentage changes in fuel consumption and carbon dioxide emissions.

Table IV-97. Avoided Carbon Dioxide Emissions (mmt) under Proposed Standards – MYs 2017-2021 (including voluntary overcompliance)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Passenger cars	41	25	48	72	94	116
Light trucks	6	5	22	45	63	88
Combined	47	30	70	117	157	204

Table IV-98. Avoided Carbon Dioxide Emissions (mmt) under Proposed Standards – MYs 2022-2025 (including voluntary overcompliance)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger cars	133	150	174	192	1,047
Light trucks	101	110	118	122	679
Combined	234	260	292	314	1,726

Conversely, this analysis indicates slightly greater outlays for additional technology under the proposed standards when potential voluntary overcompliance is taken into account. This increase is attributable to slight increases in technology application when potential voluntary overcompliance is taken into account. Tables IV–99 and 100 below show that total technology costs attributable to today's proposed standards are estimated to increase to $159 billion, or 1.3 percent more than the $157 billion estimated when potential voluntary overcompliance was not taken into account:

Table IV-99. Incremental Technology Outlays ($ billion) under Proposed Standards – MYs 2017-2021 (including voluntary overcompliance)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Passenger cars	3.5	2	5	7	9	12
Light trucks	0	0	1	2	4	5
Combined	4	3	6	9	13	18

Table IV-100. Incremental Technology Outlays ($ billion) under Proposed Standards – MYs 2022-2025 (including voluntary overcompliance)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger cars	14	18	22	24	116
Light trucks	6	7	8	9	43
Combined	21	25	30	33	159

Because NHTSA's analysis indicated that voluntary overcompliance with baseline standards will slightly reduce the share of fuel savings attributable to today's standards, the agency's estimate of the present value of total benefits will be $484 billion when discounted at a 3 percent annual rate, as Tables IV–101 and 102 following report. This estimate of total benefits is $31 billion, or about 6 percent, lower than the $515 billion reported previously for the analysis in which potential voluntary overcompliance was not taken into account:

Table IV-101. Present Value of Benefits ($ billion) under Proposed Standards Using a 3 Percent Discount Rate – MYs 2017-2021 (including voluntary overcompliance)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Passenger cars	10	7	13	20	26	32
Light trucks	2	1	6	12	17	24
Combined	12	8	19	32	43	56

Table IV-102. Present Value of Benefits ($ billion) under Proposed Standards Using a 3 Percent Discount Rate – MYs 2022-2025 (including voluntary overcompliance)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger cars	38	43	50	56	295
Light trucks	28	31	33	35	189
Combined	66	74	84	91	484

Similarly, when accounting for potential voluntary overcompliance, NHTSA estimates that the present value of total benefits will decline from its previous estimate when future fuel savings and other benefits are discounted at the higher 7 percent rate. Tables IV–103 and 104 report that the present value of benefits from requiring higher fuel economy for MY 2017–25 cars and light trucks will total $394 billion when discounted using a 7 percent rate, about $25 billion (or 6 percent) below the previous $419 billion estimate of total benefits when potential voluntary overcompliance is not taken into account:

Table IV-103. Present Value of Benefits ($ billion) under Proposed Standards Using a 7 Percent Discount Rate – MYs 2017-2021 (including voluntary overcompliance)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Passenger cars	8	5	11	16	21	26
Light trucks	1	1	5	10	14	19
Combined	10	6	15	26	35	46

Table IV-104. Present Value of Benefits ($ billion) under Proposed Standards Using a 7 Percent Discount Rate – MYs 2022-2025 (including voluntary overcompliance)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger cars	31	35	41	46	242
Light trucks	23	25	27	28	152
Combined	53	60	68	74	397

Based primarily on the reduction of benefits attributable to the proposed standards when voluntary overcompliance is taken into account, the agency estimates, as shown in Tables IV–105 and 106, that net benefits from the proposed CAFE standards will be $325 billion—or 9.2 percent—less than the previously-reported estimate of $358 billion, which did not incorporate the potential for voluntary overcompliance.

Table IV-105. Present Value of Net Benefits ($ billion) under Proposed Standards Using a 3 Percent Discount Rate – MYs 2017-2021 (including voluntary overcompliance)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Passenger cars	7	4	8	13	17	20
Light trucks	1	1	5	10	13	19
Combined	8	5	13	23	30	39

Table IV-106. Present Value of Net Benefits ($ billion) under Proposed Standards Using a 3 Percent Discount Rate – MYs 2022-2025 (including voluntary overcompliance)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger cars	23	26	29	33	180
Light trucks	22	23	25	26	145
Combined	45	49	54	59	325

Similarly, Tables IV–107 and 108 immediately below show that NHTSA estimates voluntary overcompliance could reduce net benefits attributable to today's proposed standards to $235 billion if a 7 percent discount rate is applied to future benefits. This estimate is $24 billion—or 10.3 percent—lower than the previously-reported $262 billion estimate of net benefits when potential voluntary overcompliance is not taken into account, using that same discount rate.

Table IV-108. Present Value of Net Benefits ($ billion) under Proposed Standards Using a 7 Percent Discount Rate – MYs 2017-2021 (including voluntary overcompliance)

	Earlier	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021
Passenger cars	5	3	6	9	12	14
Light trucks	1	1	4	7	10	14
Combined	6	4	9	17	22	28

Table IV-109. Present Value of Net Benefits ($ billion) under Proposed Standards Using a 7 Percent Discount Rate – MYs 2022-2025 (including voluntary overcompliance)

	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger cars	17	18	20	23	126
Light trucks	16	18	19	19	108
Combined	33	35	39	42	234

As discussed above, these reductions in fuel savings and avoided CO_2 emissions (and correspondingly, in total and net benefits) attributable to today's proposed standards, do not indicate that fuel consumption and CO_2 emissions will be higher when potential voluntary overcompliance with standards is taken into account than when it is set aside. Rather, these reductions reflect differences in attribution; when potential voluntary overcompliance is taken into account, portions of the avoided fuel consumption and CO_2 emissions (and, correspondingly, in total and net benefits) are effectively attributed to the actions of the market, rather than to the proposed CAFE standards.

NHTSA invites comment on this sensitivity analysis, in particular regarding the following questions:

- Is it reasonable to assume that, having achieved compliance with CAFE standards, a manufacturer might consider further fuel economy improvements, depending on technology costs and fuel prices?
- If so, does the agency's approach—comparing technology costs to the present value of fuel savings over some payback period—provide a reasonable means to simulate manufacturers' decisions? DOT's consideration of any alternative methods will be facilitated by specific suggestions regarding their integration into DOT's CAFE model.
- Is it appropriate to assume different effective payback periods before and after compliance has been achieved? Why, or why not?
- What payback period is (or, if more than one, are) most likely to reflect manufacturers' decisions regarding technology application through MY 2025?

For more detailed information regarding NHTSA's sensitivity analyses for this proposed rule, please see Chapter X of NHTSA's PRIA.

Additionally, due to the uncertainty and difficulty in projecting technology cost and efficacy through 2025, and consistent with Circular A–4, NHTSA conducted a full probabilistic uncertainty analysis, which is included in Chapter XII of the PRIA. Results of the uncertainty analysis are summarized below for model years 2017–2025 passenger car and light truck fleets combined:

- Total Benefits at 7% discount rate: Societal benefits will total $46 billion to $725 billion, with a mean estimate of $373 billion.
- Total Benefits at 3% discount rate: Societal benefits will total $53 billion to $877 billion, with a mean estimate of $453 billion.
- Total Costs at 7% discount rate: Costs will total between $125 billion and $247 billion, with a mean estimate of $175 billion.
- Total Costs at 3% discount rate: Costs will total between $109 billion and $294 billion, with a mean estimate of $175 billion

5. How would these proposed standards impact vehicle sales?

In past fuel economy analyses, the agency has made estimates of sales impacts comparing increases in vehicle price to the savings in fuel over a 5 year period. We chose 5 years because this is the average length of time of a financing agreement.[780] As discussed below, for this analysis we have conducted a fresh search of the literature for additional estimates of consumer valuation of fuel savings, in order to determine whether the 5 year assumption was accurate or whether it should be revised. That search has led us to the conclusion for this proposed rule that consumer valuation of future fuel savings is highly uncertain. A negative impact on sales is certainly possible, because the proposed rule will lead to an increase in the initial price of vehicles. A positive impact is also possible, because the proposed rule will lead to a significant decrease in the lifetime cost of vehicles, and with consumer learning over time, this effect may produce an increase in sales. In light of the relevant uncertainties, the agency therefore decided not to include a quantitative sales estimate and requests comments on all of the discussion here, including the question whether a quantitative estimate (or range) is possible.

The effect of this rule on sales of new vehicles depends largely 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. At the same time, the rule will require manufacturers to improve the fuel economy of many of their models, which will lower their operating costs. The initial cost of vehicles will increase but the overall cost will decrease. The net effect on sales will depend on the extent to which consumers are willing to pay for fuel economy.

The earlier discussion of consumer welfare suggests that by itself, a net decrease in overall cost may not produce a net increase in sales, because many consumers are more affected by upfront cost than by overall cost, and will not be willing to purchase vehicles with greater fuel economy even when it appears to be in their economic interest to do so (assuming standard discount rates). But there is considerable uncertainty in the economics literature about the extent to which consumers value fuel savings from increased fuel economy, and there is still more uncertainty about possible changes in consumer behavior over time (especially with the likelihood of consumer learning). The effect of this proposed regulation on vehicle sales will depend upon whether the overall value that potential buyers place on the increased fuel economy is greater or less than the increase in vehicle prices and how automakers factor that into price setting for the various models.

Two economic concepts bear on how consumers might value fuel savings. The first relates to the length of time that consumers consider when valuing fuel savings and the second relates to the discount rate that consumers apply to future savings. These two concepts are used together to determine consumer valuation of future fuel savings. The length of time that consumers consider when valuing future fuel savings can significantly affect their decision when they compare their estimates of fuel savings with the increased cost of purchasing higher fuel economy. There is a significant difference in fuel savings if you consider the savings over 1 year, 3 years, 5 years, 10 years, or the lifetime of the vehicle. The discount rate that consumers use to discount future fuel savings to present value can also have a significant impact. If consumers value fuel savings over a short period, such as 1 to 2 years, then the discount rate is less important. If consumers value fuel savings over a long period, then the discount rate is important.

The Length of Time Consumers Consider When Valuing Fuel Savings

Information regarding the number of years that consumers value fuel savings (or undervalue fuel savings) come from several sources. In past analyses NHTSA has used five years as representing the average new vehicle loan. A recent paper by David Greene[781] examined studies from the past 20 years of consumers' willingness to pay for fuel economy and found that ''the available literature does not provide a reasonable consensus.'' In his paper Greene states that ''manufacturers have repeatedly stated that consumers will pay, in increased vehicle price, for only 2–4 years in fuel savings.'' These estimates were derived from manufacturer's own market research. And the National Research Council[782] used a 3 year payback period as one of its ways to compare benefits to a full lifetime discounting. A survey conducted for the Department of Energy in 2004,[783] which asked 1,000 households how much they would pay for a vehicle that saved them $400 or $1,200 per year in fuel costs, found implied payback periods of 1.5 to 2.5 years In reviewing this survey, Greene concluded: ''The striking similarity of the implied payback periods from the two subsamples would seem to suggest that consumers understand the questions and are giving consistent and reliable responses: They require payback in 1.5 to 2.5 years.''

However, Turrentine and Kurani's[784] in-depth interviews of 57 households found almost no evidence that consumers think about fuel economy in terms of payback periods. When asked such questions, some consumers became confused while others offered time periods that were meaningful to them for other reasons, such as the length of their car loan or lease.

The Discount Rate That Consumers Apply to Future Fuel Savings

The effective discount rate that consumers have used in the past to value future fuel economy savings has been studied in many different ways and by many different economists. Greene[785] examined and compiled many of these analyses and found: ''Implicit consumer discount rates were estimated by Greene (1983) based on eight early mutinomial logit choice models. * * * The estimates range from 0 to 73% * * * Most fall between 4 and 40%.'' Greene added: ''The more recent studies exhibit as least a wide a range as the earlier studies.''

With such uncertainty about how consumers value future fuel savings and the discount rates they might use to determine the present value of future fuel savings, NHTSA would utilize the standard 3 and 7 percent discount rates. It is true that some consumers appear to show higher discount rates, which would affect the analysis of likely sales consequences; NHTSA invites comments on the nature and extent of that effect.

In past analyses, NHTSA assumed that consumers would consider the fuel savings they would obtain over the first

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[780] National average financing terms for automobile loans are available from the Board of Governors of the Federal Reserve System G.19 ''Consumer Finance'' release. *See http://www.federalreserve.gov/releases/g19/* (last accessed August 25, 2011). The average new car loan at an auto finance company in the first quarter of 2011 is for 62 months at 4.73%.

[781] ''Why the Market for New Passenger Cars Generally Undervalues Fuel Economy'', David Greene, Oak Ridge National Laboratory, 2010, Pg. 17, *http://www.internationaltransportforum.org/jtrc/DiscussionPapers/DP201006.pdf*

[782] National Research Council (2002) ''Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards'', National Academies Press, Washington DC.

[783] Opinion Research Corporation (2004), ''CARAVAN'' ORC study #7132218, for the National Renewable Energy Laboratory Princeton, New Jersey, May 20, 2004.

[784] Turrentine, T.S. and K.S. Kurani, 2007. ''Car Buyers and Fuel Economy,'' *Energy Policy,* vol. 35, pp. 1213–1223.

[785] ''Why the Market for New Passenger Cars Generally Undervalues Fuel Economy'', David Greene, Oak Ridge National Laboratory, 2010.

five years of vehicle ownership, which is consistent with the average loan rates and the average length of first vehicle ownership. The five-year span is somewhat longer than the period found to be used by consumers in some studies, but use of a shorter period may also reflect a lack of salience or related factors, and as noted, use of the five-year span has the advantage of tracking the average length of first vehicle ownership. NHTSA continues to use the five-year period here. As with discount rates, NHTSA invites comments on this issue and in particular on the possible use of a shorter period.

It is true that the payback period and discount rate are conceptual proxies for consumer decisions that may often be made without any corresponding explicit quantitative analysis. For example, some buyers choosing among some set of vehicles may know what they have been paying recently for gasoline, may know what they are likely to pay to buy each of the vehicles consider, and may know some of the attributes—including labeled fuel economies—of those vehicles. Such buyers may then make a choice without actually trying to estimate how much they would pay to fuel each of the vehicles they are considering buying. In other words, for such buyers, the idea of a payback period and discount rate may have no explicit meaning. This does not, however, limit the utility of these concepts for the agency's analysis. If, as a group, buyers behave as if they value fuel consumption considering a payback period and discount rate, these concepts remain useful as a basis for estimating the market response to increases in fuel economy accompanied by increases in price.

NHTSA's Previous Analytical Approach Updated

There is a broad consensus in the economic literature that the price elasticity for demand for automobiles is approximately −1.0.[786] [787] [788] 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. This elasticity is generally considered to be a short-run elasticity, reflecting the immediate impacts of a price change on vehicle sales.

For a durable good such as an auto, the elasticity may be smaller in the long run: though people may be able to change the timing of their purchase when price changes in the short run, they must eventually make the investment. Using a smaller elasticity would reduce the magnitude of the estimates presented here for vehicle sales, but it would not change the direction. A short-run elasticity is more valid for initial responses to changes in price, but, over time, a long-run elasticity may better reflect behavior; thus, the results presented for the initial years of the program may be more appropriate for modeling with the short-run elasticity than the later years of the program. A search of the literature has not found studies more recent than the 1970s that specifically investigate long-run elasticities.[789]

One approach to determine the breakeven point between vehicle prices and fuel savings is to look at the payback periods shown earlier in this analysis. For example at a 3 percent discount rate, the payback period for MY 2025 vehicles is 2 years for light trucks and 4 years for passenger cars.

In determining the payback period we make several assumptions. For example, we follow along with the calculations that are used for a 5 year payback period, as we have used in previous analyses. For the fuel savings part of the equation, we assumed as a starting point that the average purchaser considers the fuel savings they would receive over a 5 year timeframe. The present values of these savings were calculated using a 3 and 7 percent discount rate. We used a fuel price forecast (see Table VIII–3) 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.

The agency believes that consumers may consider several other factors over the 5 year horizon when contemplating the purchase of a new vehicle. The agency 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. We took sales taxes in 2010 by state and weighted them by population by state to determine a national weighted-average sales tax of 5.5 percent.[790]

Second, we 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[791] provides the average value of collision plus comprehensive insurance in 2006 as $448, which is $480 in 2009$. The average consumer expenditure for a new passenger car in 2010, according to the Bureau of Economic Analysis was $24,092 and the average price of a new light truck $30,641 in $2009.[792] Using sales volumes from the Bureau, we determined an average passenger car and an average light truck price was $27,394 in $2009 dollars. 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 1.75% of the price of a vehicle. If we assume that this premium is proportional to the new vehicle price, it represents about 1.75 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 8.0 percent of the vehicle's price at a 3 percent discount rate.

Third, we considered that 70 percent of new vehicle purchasers take out loans

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[786] 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.

[787] 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.

[788] 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

[789] E.g., Hymans, Saul H. ''Consumer Durable Spending: Explanation and Prediction.'' Brookings Papers on Economic Activity 1 (1970): 173–206.

http://www.brookings.edu/~/media/Files/Programs/ES/BPEA/1970_2_bpea_papers/1970b_bpea_hymans_ackley_juster.pdf finds a short-run elasticity of auto expenditures (not sales) with respect to price of 0.78 to 1.17, and a long-run elasticity of 0.3 to 0.46.

[790] Based on data found in *http://www.api.org/statistics/fueltaxes/*

[791] 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 4, 2010).

[792] U.S. Department of Commerce, Bureau of Economic Analysis, Table 7.2.5S. Auto and Truck Unit Sales, Production, Inventories, Expenditures, and Price, available at *http://www.bea.gov/national/nipaweb/nipa_underlying/TableView.asp?SelectedTable=55&ViewSeries=NO&Java=.*

to finance their purchase. The average new vehicle loan in the first quarter of 2011 is 5.3 percent.[793] At these terms the average person taking a loan will pay 14 percent more for their vehicle over the 5 years than a consumer paying cash for the vehicle at the time of purchase.[794] Discounting the additional 2.8 percent (14 percent/5 years) per year over the 5 years using a 3 percent mid-year discount rate [795] results in a discounted present value of 12.73 percent higher for those taking a loan. Multiplying that by the 70 percent that take a loan, means that the average consumer would pay 8.9 percent more than the retail price for loans the consumer discounted at a 3 percent discount rate.

Fourth, we considered the residual value (or resale value) of the vehicle after 5 years and expressed this as a percentage of the new vehicle price. 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% [796] of the original purchase price. Discounting the residual value back 5 years using a 3 percent discount rate (35 percent * .8755) gives an effective residual value of 30.6 percent. Note that added CAFE technology could also result in more expensive or more frequent repairs. However, we do not have data to verify the extent to which this would be a factor during the first 5 years of vehicle life.

We add these four factors together. At a 3 percent discount rate, the consumer considers he could get 30.6 percent back upon resale in 5 years, but will pay 5.5 percent more for taxes, 8.1 percent more in insurance, and 8.9 percent more for loans, results in a 8.1 percent return on the increase in price for fuel economy technology (30.6 percent − 5.5 percent − 8.1 percent − 8.9 percent). Thus, the increase in price per vehicle would be multiplied by 0.919 (1 − 0.081) before subtracting the fuel savings to determine the overall net consumer valuation of the increase of costs on this purchase decision. This process results in estimates of the payback period for MY 2025 vehicles of 2 years for light trucks and 4 years for passenger cars at a 3 percent discount rate.

A General Discussion of Consumer Considerations

If consumers do not value improved fuel economy at all, and consider nothing but the increase in price in their purchase decisions, then the estimated impact on sales from price elasticity could be applied directly. However, the agency anticipates that consumers will place some value improved fuel economy, because they reduce the operating cost of the vehicles, and because, based on recently-promulgated EPA and DOT regulations, vehicles sold during through 2025 will display labels that more clearly communicate to buyers the fuel savings, economic, and environmental benefits of more efficient vehicles. The magnitude of this effect remains unclear, and how much consumers value fuel economy is an ongoing debate. We know that different consumers value different aspects of their vehicle purchase,[797] but we do not have reliable evidence of consumer behavior on this issue. Several past consumer surveys lead to different conclusions (and surveys themselves, as opposed to actual behavior, may not be entirely informative). We also expect that consumers will consider other factors that affect their costs, and have included these in the analysis.

One issue that significantly affects this sales analysis is: How much of the retail price increase needed to cover the fuel economy technology investments will manufacturers be able to pass on to consumers? NHTSA typically assumes that manufacturers will be able to pass all of their costs to improve fuel economy on to consumers. Consumer valuation of fuel economy improvements often depends upon the price of gasoline, which has recently been very volatile.

Sales losses would occur only if consumers fail to value fuel economy improvements at least as much as they pay in higher prices. If manufacturers are unable to raise prices beyond the level of consumer's valuation of fuel savings, then manufacturer's profit levels would fall but there would be no impact on sales. Likewise, if fuel prices rise beyond levels used in this analysis, consumer's valuation of improved fuel economy could increase to match or exceed their initial investment, resulting in no impact or even an increase in sales levels.

The agency has been exploring the question why there is not more consumer demand for higher fuel economy today when linked with our methodology that results in projecting increasing sales for the future when consumers are faced with rising vehicle prices and rising fuel economy. Some of the discussion of salience, focus on the short-term, loss aversion, and related factors (see above) bears directly on that question. It is possible, in that light, that consumers will not demand increased fuel economy even when such increases would produce net benefits for them.

Nonetheless, some current vehicle owners, including those who currently drive gas guzzlers, will undoubtedly realize the net benefits to be gained by purchasing a more efficient vehicle. Some vehicle owners may also react to persistently higher vehicle costs by owning fewer vehicles, and keeping existing vehicles in service for somewhat longer. For these consumers, the possibility exists that there may be permanent sales losses, compared with a situation in which vehicle prices are lower.

There is a wide variety in the number of miles that owners drive per year. Some drivers only drive 5,000 miles per year and others drive 25,000 miles or more. Rationally those that drive many miles have more incentive to buy vehicles with high fuel economy levels

In summary, there are a variety of types of consumers that are in different financial situations and drive different mileages per year. Since consumers are different and use different reasoning in purchasing vehicles, and we do not yet have an account of the distribution of their preferences or how that may change over time as a result of this rulemaking — in other words, the answer is quite ambiguous. Some may be induced by better fuel economy to purchase vehicles more often to keep up with technology, some may purchase no new vehicles because of the increase in vehicle price, and some may purchase fewer vehicles and hold onto their vehicles longer. There is great uncertainty about how consumers value fuel economy, and for this reason, the impact of this fuel economy proposal on sales is uncertain.

For years, consumers have been learning about the benefits that accrue to them from owning and operating vehicles with greater fuel efficiency. Consumer demand has thus shifted towards such vehicles, not only because of higher fuel prices but also because

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[793] New car loan rates in the first quarter of 2011 averaged 5.86 percent at commercial banks and 4.73 percent at auto finance companies, so their average is close to 5.3 percent.

[794] Based on *www.bankrate.com* auto loan calculator for a 5 year loan at 5.3 percent.

[795] For a 3 percent discount rate, the summation of 2.8 percent × 0.9853 in year one, 2.8 × 0.9566 in year two, 2.8 × 0.9288 in year three, 2.8 × 0.9017 in year 4, and 2.8 × 0.8755 in year five.

[796] 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 March 4, 2010).

[797] For some consumers there will be a cash-flow problem in that the vehicle is purchased at a higher price on day 1 and fuel savings occur over the lifetime of the vehicle. Increases in prices have sometimes led to longer loan periods, which would lead to higher overall costs of the loan.

many consumers are learning about the value of purchases based not only on initial costs but also on the total cost of owning and operating a vehicle over its lifetime. This type of learning is expected to continue before and during the model years affected by this rule, particularly given the new fuel economy labels that clarify potential economic effects and should therefore reinforce that learning. Therefore, some increase in the demand for, and production of, more fuel efficient vehicles is incorporated in the alternative baseline (*i.e.,* without these rules) developed by NHTSA. The agency requests comment on the appropriateness of using a flat or rising baseline after 2016.

Today's proposed rule, combined with the new and easier-to-understand fuel economy label required to be on all new vehicles beginning in 2012, may increase sales above baseline levels by hastening this very type of consumer learning. As more consumers experience, as a result of the rule, the savings in time and expense from owning more fuel efficient vehicles, demand may shift yet further in the direction of the vehicles mandated under the rule. This social learning can take place both within and across households, as consumers learn from one another.

First and most directly, the time and fuel savings associated with operating more fuel efficient vehicles will be more salient to individuals who own them, causing their subsequent purchase decisions to shift closer to minimizing the total cost of ownership over the lifetime of the vehicle. Second, this appreciation may spread across households through word of mouth and other forms of communications. Third, as more motorists experience the time and fuel savings associated with greater fuel efficiency, the price of used cars will better reflect such efficiency, further reducing the cost of owning more efficient vehicles for the buyers of new vehicles (since the resale price will increase).

If these induced learning effects are strong, the rule could potentially increase total vehicle sales over time. These increased sales would not occur in the model years first affected by the rule, but they could occur once the induced learning takes place. It is not possible to quantify these learning effects years in advance and that effect may be speeded or slowed by other factors that enter into a consumer's valuation of fuel efficiency in selecting vehicles.

The possibility that the rule will (after a lag for consumer learning) increase sales need not rest on the assumption that automobile manufacturers are failing to pursue profitable opportunities to supply the vehicles that consumers demand. In the absence of the rule, no individual automobile manufacturer would find it profitable to move toward the more efficient vehicles mandated under the rule. In particular, no individual company can fully internalize the future boost to demand resulting from the rule. If one company were to make more efficient vehicles, counting on consumer learning to enhance demand in the future, that company would capture only a fraction of the extra sales so generated, because the learning at issue is not specific to any one company's fleet. Many of the extra sales would accrue to that company's competitors.

In the language of economics, consumer learning about the benefits of fuel efficient vehicles involves positive externalities (spillovers) from one company to the others.[798] These positive externalities may lead to benefits for manufacturers as a whole.

We emphasize that this discussion has been tentative and qualified. To be sure, social learning of related kinds has been identified in a number of contexts.[799] Comments are invited on the discussion offered here, with particular reference to any relevant empirical findings.

How does NHTSA plan to address this issue for the final rule?

NHTSA seeks comment on how to attempt to quantify sales impacts of the proposed MYs 2017–2025 CAFE standards in light of the uncertainty discussed above. The agency is currently sponsoring work to develop a vehicle choice model for potential use in the agency's future rulemaking analysis—this work may help to better estimate the market's effective valuation of future fuel economy improvements. The agency hopes to evaluate those potential impacts through use of a "market shift" or "consumer vehicle choice" model, discussed in Section IV of the NPRM preamble. With an integrated market share model, the CAFE model would then estimate how the sales volumes of individual vehicle models would change in response to changes in fuel economy levels and prices throughout the light vehicle market, possibly taking into account interactions with the used vehicle market. Having done so, the model would replace the sales estimates in the original market forecast with those reflecting these model-estimated shifts, repeating the entire modeling cycle until converging on a stable solution. We seek comment on the potential for this approach to help the agency estimate sales effects for the final rule.

Others Studies of the Sales Effect of This CAFE Proposal

We outline here other relevant studies and seek comment on their assumptions and projections.

A recent study on the effects on sales, attributed to regulatory programs, including the fuel economy program was undertaken by the Center for Automotive Research (CAR).[800] CAR examined the impacts of alternative fuel economy increases of 3%, 4%, 5%, and 6% per year on the general outlook for the U.S. motor vehicle market, the likely increase in costs for fuel economy (based on the NAS report, which estimates higher costs than NHTSA's current estimates) and required safety features, the technologies used and how they would affect the market, production, and automotive manufacturing employment in the year 2025. The required safety mandates were assumed to cost $1,500 per vehicle in 2025, but CAR did not value the safety benefits from those standards. NHTSA does not believe that the assumed safety mandates should be a part of this analysis without estimating the benefits achieved by the safety mandates.

There are many factors that go into the CAR analysis of sales. CAR assumes a 22.0 mpg baseline, two gasoline price scenarios of $3.50 and $6.00 per gallon, VMT schedules by age, and a rebound rate of 10 percent (although it appears that the CAR report assumes a rebound effect even for the baseline and thus negates the impact of the rebound effect). Fuel savings are assumed to be valued by consumers over a 5 year period at a 10 percent discount rate. The impact on sales varies by scenario, the estimates of the cost of technology, the price of gasoline, etc. At $3.50 per gallon, the net change in consumer savings (costs minus the fuel savings

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[798] Industry-wide positive spillovers of this type are hardly unique to this situation. In many industries, companies form trade associations to promote industry-wide public goods. For example, merchants in a given locale may band together to promote tourism in that locale. Antitrust law recognizes that this type of coordination can increase output.

[799] See Hunt Alcott, Social Norms and Energy Conservation, Journal of Public Economics (forthcoming 2011), available at *http://web.mit.edu/allcott/www/Allcott%202011%20JPubEc%20-%20Social%20Norms%20and%20Energy%20Conservation.pdf*; Christophe Chamley, Rational Herds: Economic Models of Social Learning (Cambridge, 2003).

[800] "The U.S. Automotive Market and Industry in 2025", Center for Automotive Research, June 2011. *http://www.cargroup.org/pdfs/ami.pdf.*

valued by consumers) is a net cost to consumers of $359 for the 3% scenario, a net cost of $1,644 for the 4% scenario, a net cost of $2,858 for the 5% scenario, and a net consumer cost of $6,525 for the 6% scenario. At $6.00 per gallon, the net change in consumer savings (costs minus the fuel savings valued by consumers) is a net savings to consumers of $2,107 for the 3% scenario, a net savings of $1,131 for the 4% scenario, a net savings of $258 for the 5% scenario, and a net consumer cost of $3,051 for the 6% scenario. Thus, the price of gasoline can be a significant factor in affecting how consumers view whether they are getting value for their expenditures on technology.

Table 14 on page 42 of the CAR report presents the results of their estimates of the 4 alternative mpg scenarios and the 2 prices of gasoline on light vehicle sales and automotive employment. The table below shows these estimates. The baseline for the CAR report is 17.9 million sales and 877,075 employees. The price of gasoline at $6.00 per gallon, rather than $3.50 per gallon results in about 2.1 million additional sales per year and 100,000 more employees in year 2025.

Gasoline at $3.50	**CAFE requirement of a 3% increase in mpg per year**	**CAFE requirement of a 4% increase in mpg per year**	**CAFE requirement of a 5% increase in mpg per year**	**CAFE requirement of a 6% increase in mpg per year**
Sales (millions)	16.4	15.5	14.7	12.5
Employment	803,548	757,700	717,626	612,567
Gasoline at $6.00				
Sales	18.5	17.6	16.9	14.5
Employment	903,135	861,739	826,950	711,538

Figure 13 on page 44 of the CAR report shows a graph of historical automotive labor productivity, indicating that there has been a long term 0.4 percent productivity growth rate from 1960–2008, to indicate that there will be 12.26 vehicles produced in the U.S. per worker in 2025 (which is higher than NHTSA's estimate—see below). In addition, the CAR report discusses the jobs multiplier. For every one automotive manufacturing job, they estimate the economic contribution to the U.S. economy of 7.96 jobs[801] stating "In 2010, about 1 million direct U.S. jobs were located at an auto and auto parts manufacturers; these jobs generated an additional 1.966 million supplier jobs, largely in non-manufacturing sectors of the economy. The combined total of 2.966 million jobs generated a further spin-off of 3.466 million jobs that depend on the consumer spending of direct and supplier employees, for a total jobs contribution from U.S. auto manufacturing of 6.432 million jobs in 2010. The figure actually rises to 7.96 million when direct jobs located at new vehicle dealerships (connected to the sale and service of new vehicles) are considered."

CAR uses econometric estimates of the sensitivity of new vehicle purchases to prices and consumer incomes and forecasts of income growth through 2025 to translate these estimated changes in net vehicle prices to estimates of changes in sales of MY 2025 vehicles; higher net prices—which occur when increases in vehicle prices exceeds the value of fuel savings—reduce vehicle sales, while lower net prices increase new vehicle sales in 2025. We do not have access to the statistical models that CAR develops to estimate the effects of price and income changes on vehicle sales. CAR's analysis assumes continued increases in labor productivity over time and then translates the estimated impacts of higher CAFE standards on net vehicle prices into estimated impacts on sales and employment in the automobile production and related industries. The agency disagrees with the cost estimates in the CAR report for new technologies, the addition of safety mandates into the costs, and various other assumptions.

An analysis conducted by Ceres and Citigroup Global Markets Inc.[802] examined the impact on automotive sales in 2020, with a baseline assumption of an industry fuel economy standard of 42 mpg, a $4.00 price of

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[801] Kim Hill, Debbie Menk, and Adam Cooper, "Contribution of the Automotive Industry to the Economies of All Fifty States and the United States", The Center for Automotive Research, Ann Arbor MI, April 2010.

[802] "U.S. Autos, CAFE and GHG Emissions", March 2011, Citi Ceres, UMTRI, Baum and Associates, Meszler Engineering Services, and the Natural Resources Defense Council. *http://www.ceres.org/resources/reports/fuel-economy-focus.*

gasoline, a 12.2 percent discount rate and an assumption that buyers value 48% of fuel savings over seven years in purchasing vehicles. The main finding on sales was that light vehicle sales were predicted to increase by 6% from 16.3 million to 17.3 million in 2020. Elasticity is not provided in the report but it states that they use a complex model of price elasticity and cross elasticities developed by GM. A fuel price risk factor[803] was utilized. Little rationale was provided for the baseline assumptions, but sensitivity analyses were examined around the price of fuel ($2, $4, and $7 per gallon), the discount rate (5.2%, 12.2%, 17.2%), purchasers consider fuel savings over (3, 7, or 15 years), fuel price risk factor of (30%, 70%, or 140%), and VMT of (10,000, 15,000, and 20,000 in the first year and declining thereafter).

6. Social Benefits, Private Benefits, and Potential Unquantified Consumer Welfare Impacts of the Proposed Standards

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. In order to appreciate how these viewpoints may diverge, it is important 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 (identified as ''social benefits'') that are not limited to automobile purchasers, and that extend throughout the U.S. economy. Examples of these benefits include reductions in the energy security costs associated with U.S. petroleum imports, and in the economic damages expected to result from air pollution (including, but not limited to, climate change). In contrast, other categories of benefits—principally future fuel savings projected to result from higher fuel economy, but also, for example, time savings—will be experienced exclusively by the initial purchasers and subsequent owners of vehicle models whose fuel economy manufacturers elect to improve (''private benefits'').

The economy-wide or ''social'' benefits from requiring higher fuel economy represent an important share of the total economic benefits from raising CAFE standards. At the same time, NHTSA estimates that benefits to vehicle buyers themselves will significantly exceed vehicle manufacturers' costs for complying with the stricter fuel economy standards this rule establishes. In short, consumers will benefit on net. Since the agency also assumes that the costs of new technologies manufacturers will employ to improve fuel economy will ultimately be borne by vehicle buyers in the form of higher purchase prices, NHTSA concludes that the benefits to potential vehicle buyers from requiring higher fuel efficiency will far outweigh the costs they will be required to pay to obtain it. NHTSA also recognizes that this conclusion raises certain issues, addressed directly below; NHTSA also seeks public comment on its discussion here.

As an illustration, Tables IV–110 and 111 report the agency's estimates of the average lifetime values of fuel savings for MY 2017–2025 passenger cars and light trucks calculated using projected future retail fuel prices. The table compares NHTSA's estimates of the average lifetime value of fuel savings for cars and light trucks to the price increases it expects to occur as manufacturers attempt to recover their costs for complying with increased CAFE standards. 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 2025, NHTSA projects that average lifetime fuel savings will exceed the average price increase by more than $2,900 for cars, and by more than $5,200 for light trucks.

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[802] ''U.S. Autos, CAFE and GHG Emissions'', March 2011, Citi Ceres, UMTRI, Baum and Associates, Meszler Engineering Services, and the Natural Resources Defense Council. *http://www.ceres.org/resources/reports/fuel-economy-focus.*

Table IV-110. Value of Lifetime Fuel Savings vs. Vehicle Price Increases – MYs 2017-2021

Fleet	Measure	Model year				
		2017	2018	2019	2020	2021
Passenger cars	Value of fuel savings	$668	$1,409	$2,035	$2,643	$3,186
	Average price increase	$228	$467	$652	$885	$1,108
	Difference	$440	$942	$1,383	$1,758	$2,078
Light trucks	Value of fuel savings	$228	$999	$2,278	$3,104	$4,400
	Average price increase	$44	$187	$427	$688	$965
	Difference	$184	$812	$1,851	$2,416	$3,435

Table IV-111. Value of Lifetime Fuel Savings vs. Vehicle Price Increases – MYs 2022-2025

Fleet	Measure	Model year			
		2022	2023	2024	2025
Passenger cars	Value of fuel savings	$3,568	$4,010	$4,600	$4,999
	Average price increase	$1,259	$1,536	$1,927	$2,023
	Difference	$2,309	$2,474	$2,673	$2,976
Light trucks	Value of fuel savings	$5,114	$5,675	$6,215	$6,804
	Average price increase	$1,102	$1,284	$1,428	$1,578
	Difference	$4,012	$4,391	$4,787	$5,226

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 raising CAFE standards should be necessary to increase the fuel economy of new cars and light trucks. They also raise the question of whether it is appropriate to assume that manufacturers would not elect to provide higher fuel economy even in the absence of increases in CAFE standards, since the comparisons in Tables IV–109 and 110 suggest that doing so would increase the market value (and thus the selling prices) of many new vehicle models by far more than it would raise the cost of producing them. Thus, increasing fuel economy would be expected to increase sales of new vehicles and manufacturers' profits. More specifically, why would potential buyers of new vehicles hesitate to purchase models offering higher fuel economy, when doing so would produce the substantial economic returns illustrated by the comparisons presented in Tables IV–109 and 110? And why would manufacturers voluntarily forego opportunities to increase the attractiveness, value, and competitive positioning of their car and light truck models—and thus their own profits—by improving their fuel economy?

One explanation for why this situation might persist is that the market for vehicle fuel economy does not appear to work perfectly, in which case properly designed CAFE standards would be expected to increase consumer welfare. Some of these imperfections might stem from standard market failures, such as limited availability of information to consumers about the value of higher fuel economy. It is true, of course, that such information is technically available and that new fuel economy and environment vehicle labels, emphasizing economic effects, will provide a wide range of relevant information. Other explanations would point to phenomena observed elsewhere in the field of behavioral economics, including loss aversion, inadequate consumer attention to long-term savings, or a lack of salience of relevant benefits (such as fuel savings, or time savings associated with refueling) to consumers at the time they make purchasing decisions. Both theoretical and empirical research suggests that many consumers are unwilling to make energy-efficient investments even when those investments appear to pay off in the relatively short-term.[804] This research is in line with related findings that consumers may undervalue benefits or costs that are less salient, or that they will realize only in the future.[805]

Previous research provides some support for the agency's conclusion that the benefits buyers will receive from requiring manufacturers to increase fuel economy outweigh the costs they will pay to acquire those benefits, even if private markets have not provided that amount of fuel economy. This research identifies aspects of normal behavior that may explain the market not providing vehicles whose higher fuel economy appears to offer an attractive economic return. For example, consumers' aversion to the prospect of losses (''loss aversion'') and especially immediate, certain losses, may affect their decisions when they also have a sense of uncertainty about the value of future fuel savings. Loss aversion, accompanied with a sense of uncertainty about gains, may make purchasing a more fuel-efficient vehicle seem unattractive to some potential buyers, even when doing so is likely to be a sound economic decision. As an illustration, Greene et al. (2009) calculate 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 and buyers' reluctance to accept the risk of losses are taken into account.[806]

The well-known finding that as gas prices rise, consumers show more willingness to pay for fuel-efficient vehicles is not necessarily inconsistent with the possibility that many consumers undervalue potential savings in gasoline costs and fuel economy when purchasing new vehicles. In ordinary circumstances, such costs may be a relatively ''shrouded'' attribute in consumers' decisions, in part because the savings from purchasing a more fuel efficient vehicle are cumulative and extend over a significant period of time. At the same time, it may be difficult for potential buyers to disentangle the cost of purchasing a more fuel-efficient vehicle from its overall purchase price, or to isolate the value of higher fuel economy form accompanying differences in other vehicle attributes. This possibility is consistent with recent evidence to the effect that many consumers are willing to pay less than $1 upfront to obtain a $1 reduction in the discounted present value of future gasoline costs.[807]

Some research suggests that the market's apparent unwillingness to provide more fuel efficient vehicles stems from consumers' 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 (MPG), into resulting changes in fuel consumption, measured for example in gallons 100 miles traveled or per month or year.[808] It is true that the recently redesigned fuel economy and environment label should help overcome this difficulty, because it draws attention to purely economic effects of fuel economy, but MPG remains a prominent measure. Sanstad and Howarth (1994) argue that consumers often resort to imprecise but convenient rules of thumb to compare vehicles that offer different fuel economy ratings, and that this can cause many buyers to underestimate the value of fuel savings, particularly from significant increases in fuel economy.[809] 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 may be consistent with private markets not providing that fuel economy level.

The agency projects that the typical vehicle buyer will experience net savings from the proposed standards, yet it is not simple to reconcile this projection with the fact that the average fuel economy of new vehicles sold currently falls well short of the level those standards would require. The foregoing discussion offers several possible explanations. One possible explanation for this apparent inconsistency is that many of the technologies projected by the agency to be available through MY 2025 offer significantly improved efficiency per unit of cost, but were not available for application to new vehicles sold currently. Another is that the perceived and real values of future savings resulting from the proposed standards will vary widely among potential

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[803] Fuel price risk factor measures the rate at which consumers are willing to trade reductions in fuel costs for increases in purchase price. For example, a fuel price risk factor of 1.0 would indicate the consumers would be willing to pay $1 for an improvement in fuel economy that resulted in reducing by $1 the present value of the savings in fuel costs.

[804] 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 (2009), available at *http://web.mit.edu/allcott/www/Allcott%20and%20Wozny%202010%20-%20Gasoline%20Prices,%20Fuel%20Economy,%20and%20the%20Energy%20Paradox.pdf* (last accessed Sept. 26, 2011). For relevant background, with an emphasis on the importance of salience and attention, see Kahneman, D. Thinking, Fast and Slow (2011).

[805] Mutulinggan, S., C. Corbett, S. Benzarti, and B. Oppenheim. ''Investment in Energy Efficiency by Small and Medium-Size Firms: An Empirical Analysis of the Adoption of Process Improvement Recommendations'' (2011), *available at http://papers.ssrn.com/sol3/papers/cfm?abstract_id=1947330.* 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.

[807] *See, e.g.,* Alcott and Wozny. On shrouded attributes and their importance, see Gabaix, Xavier, and David Laibson, 2006. ''Shrouded Attributes, Consumer Myopia, and Information Suppression in Competitive Markets.'' *Quarterly Journal of Economics* 121(2): 505–540.

[808] Larrick, R. P., and J. B. Soll (2008). ''The MPG illusion'' *Science* 320: 1593–1594.

[809] Sanstad, A., and R. Howarth (1994). '' 'Normal' Markets, Market Imperfections, and Energy Efficiency.'' Energy Policy 22(10): 811–818.

vehicle buyers. When they purchase a new vehicle, some buyers value fuel economy very highly, and others value fuel economy very little, if at all. These differences undoubtedly reflect variation in the amount they drive, differences in their driving styles affect the fuel economy they expect to achieve, and varying expectations about future fuel prices, but they may also partly reflect differences in buyers' understanding of what increased fuel economy is likely to mean to them financially, or in buyers' preferences for paying lower prices today versus anticipated savings over the future.

Unless the agency has overestimated their average value, however, the fact that the value of fuel savings varies among potential buyers cannot explain why typical buyers do not currently purchase what appear to be cost-saving increases in fuel economy. A possible explanation for this situation is that the effects of differing fuel economy levels are relatively modest when compared to those provided by other, more prominent features of new vehicles, such as passenger and cargo-carrying capacity, performance, or safety. In this situation, it may simply not be in many shoppers' interest to spend the time and effort necessary to determine the economic value of higher fuel economy, 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 this 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, yet those savings may not be large enough to lead a sufficient number of buyers to purchase vehicles with higher fuel economy to raise average fuel economy above 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 compensate manufacturers for providing it. To be sure, the market for new automobiles as a whole exhibits a great deal of competition. But this apparently vigorous competition among manufacturers may not extend to the provision of some individual vehicle attributes. Incomplete or ''asymmetric'' access to information about vehicle attributes such as fuel economy—whereby manufacturers of new cars and light trucks or sellers of used models have more complete knowledge about vehicles' actual fuel economy performance than is available to their potential buyers—may also prevent sellers of new or used vehicles from being able to capture 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 well-informed potential buyers.

Constraints on the combinations of fuel economy, carrying capacity, and performance that manufacturers can offer in individual vehicle models using current technologies undoubtedly limit the range of fuel economy available within certain vehicle classes, particularly those including larger vehicles. However, it is also possible that deliberate decisions by manufacturers of cars and light trucks further limit the range of fuel economy available to buyers within individual vehicle market segments, such as large automobiles, SUVs, or minivans. Manufacturers may deliberately limit the range of fuel economy levels they offer in those market segments (by choosing not to invest in fuel economy and investing instead in providing a range of other vehicle attributes) because they underestimate the premiums that prospective buyers of those models are willing to pay for improved fuel economy, and thus mistakenly believe it will be unprofitable for them to offer more fuel-efficient models within those segments. 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 to shoppers in those particular market segments. As an illustration, once a potential buyer has decided to purchase a minivan, the range of highway fuel economy ratings among current models extends from 22 to 28 mpg, while their combined city and highway ratings extend only from 18 to 20 mpg.[810] If this phenomenon is widespread, the average fuel efficiency of their entire new vehicle fleet could remain below the levels that potential buyers demand and are willing to pay for.

Another possible explanation for the paradox posed by buyers' apparent unwillingness to invest in higher fuel economy when it appears to offer such large financial returns is that NHTSA's estimates of benefits and costs from requiring manufacturers to improve fuel efficiency do not match potential buyers' assessment of the likely benefits and costs from purchasing models with higher fuel economy ratings. 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 from those of buyers, or simply 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 agency's calculations suggest, because they have shorter time horizons than the full vehicle lifetimes NHTSA uses in these calculations, or because they discount future fuel 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' MPG ratings and their own actual on-road fuel economy than the 20 percent gap (30 percent for HEVs) the agency estimates.

To illustrate the first of these possibilities, Table IV–111 shows the effect of differing assumptions about vehicle buyers' time horizons on their assessment of the value of future fuel savings. Specifically, the table reports the value of fuel savings consumers might consider when purchasing a MY 2025 car or light truck that features the higher fuel economy levels required by the proposed rule, when those fuel savings are evaluated over different time horizons. The table then compares these values to the agency's estimates of the increases in these vehicles' prices that are likely to result from the standards proposed for MY 2025. This table shows that when fuel savings are evaluated over the average lifetime of a MY 2025 car (approximately 14 years) or light truck (about 16 years), their present value (discounted at 3 percent) exceeds the estimated average price increase by more than $2,500 for cars and by over $4,500 for light trucks.

If buyers are instead assumed to consider fuel savings over only a 10-year time horizon, Table IV–112 shows that this reduces the difference between the present value of fuel savings and the projected price increase for a MY 2025 car to about $1,800, and to about $3,350 for a MY 2025 light truck. Finally, Table IV–112 shows that if buyers consider fuel savings only over the length of time for which they typically finance new car

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[810] This is the range of combined city and highway fuel economy levels from lowest (Toyota Sienna AWD) to highest (Honda Odyssey) available for model year 2010; *http://www.fueleconomy.gov/feg/bestworstEPAtrucks.htm* (last accessed September 26, 2011).

purchases (slightly more than 5 years during 2011), the value of fuel savings exceeds the estimated increase in the price of a MY 2025 car by only about $200, while the corresponding difference is reduced to slightly more than $1,200 for a MY 2025 light truck.

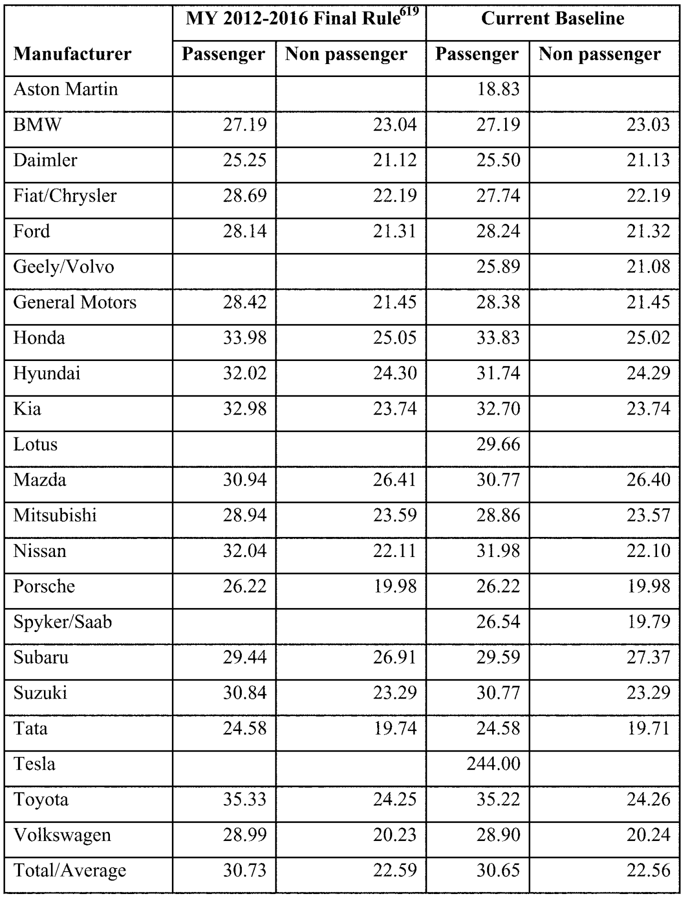

Table IV-2. Current Baseline CAFE Levels in MY 2016 versus MY 2012-2016 Rulemaking CAFE Levels

Manufacturer	MY 2012-2016 Final Rule[619]		Current Baseline	
	Passenger	Non passenger	Passenger	Non passenger
Aston Martin			18.83	
BMW	27.19	23.04	27.19	23.03
Daimler	25.25	21.12	25.50	21.13
Fiat/Chrysler	28.69	22.19	27.74	22.19
Ford	28.14	21.31	28.24	21.32
Geely/Volvo			25.89	21.08
General Motors	28.42	21.45	28.38	21.45
Honda	33.98	25.05	33.83	25.02
Hyundai	32.02	24.30	31.74	24.29
Kia	32.98	23.74	32.70	23.74
Lotus			29.66	
Mazda	30.94	26.41	30.77	26.40
Mitsubishi	28.94	23.59	28.86	23.57
Nissan	32.04	22.11	31.98	22.10
Porsche	26.22	19.98	26.22	19.98
Spyker/Saab			26.54	19.79
Subaru	29.44	26.91	29.59	27.37
Suzuki	30.84	23.29	30.77	23.29
Tata	24.58	19.74	24.58	19.71
Tesla			244.00	
Toyota	35.33	24.25	35.22	24.26
Volkswagen	28.99	20.23	28.90	20.24
Total/Average	30.73	22.59	30.65	22.56

Potential vehicle buyers may also discount future fuel savings using higher rates than those typically used to evaluate Federal regulations. OMB guidance prescribes that future benefits and costs of regulations that mainly 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.[811] 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, buyers comparing models with different fuel economy ratings are likely to discount the future fuel savings from purchasing one that offers higher fuel economy at rates well above the 3% assumed in NHTSA's evaluation.

Table IV–113 shows the effects of higher discount rates on vehicle buyers' evaluation of the fuel savings projected to result from the CAFE standards proposed in this NPRM, again using MY 2025 passenger cars and light trucks as an example. As Table IV–112 showed previously, average future fuel savings discounted at the OMB 3 percent consumer rate exceed the agency's estimated price increases by more than $2,500 for MY 2025 passenger cars and by about $4,500 for MY 2025 light trucks. If vehicle buyers instead discount future fuel savings at the typical new-car loan rate prevailing during 2010 (approximately 5.2 percent), however, these differences decline to slightly more than $2,000 for cars and $3,900 for light trucks, as Table IV–113 illustrates. This is a 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 almost 14 percent during 2010) reduces these differences to less than $900 for a MY 2025 passenger car and about $2,250 for the typical MY 2025 light truck. Even at these significantly higher discount rates, however, the table shows that the private net benefits from purchasing new vehicles with the levels of fuel economy this rule would

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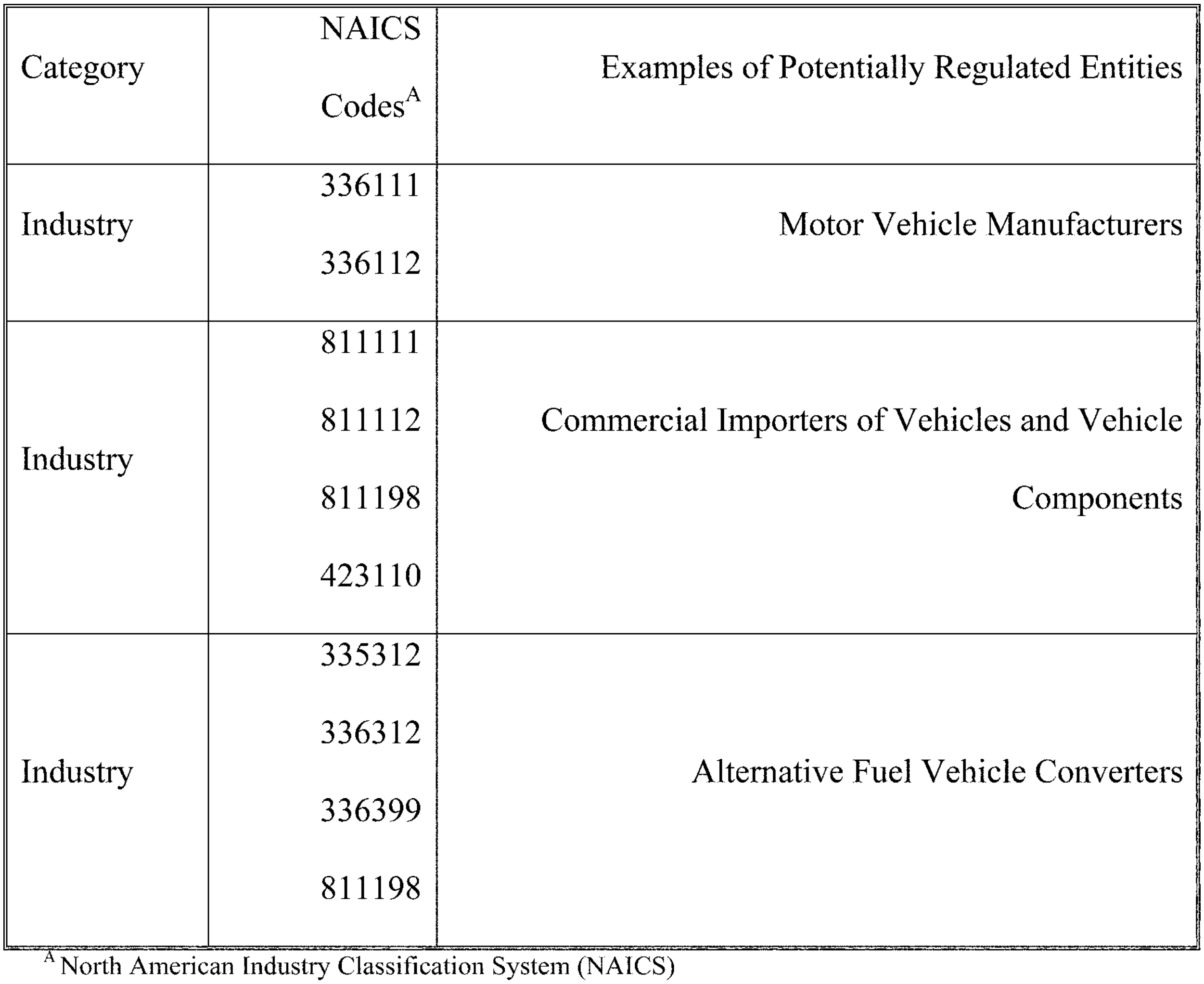
[811] Office of Management and Budget, Circular A–4, "Regulatory Analysis," September 17, 2003, 33. Available at *http://www.whitehouse.gov/omb/assets/regulatory_matters_pdf/a-4.pdf* (last accessed Sept. 26, 2010).

require—rather than those that would result from simply extending the MY 2016 CAFE standards to apply to future model years—remain large.



Category	NAICS Codes[A]	Examples of Potentially Regulated Entities
Industry	336111 336112	Motor Vehicle Manufacturers
Industry	811111 811112 811198 423110	Commercial Importers of Vehicles and Vehicle Components
Industry	335312 336312 336399 811198	Alternative Fuel Vehicle Converters

[A] North American Industry Classification System (NAICS)

Some evidence also suggests that vehicle buyers may employ combinations of high discount rates and short time horizons in 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 them to purchase it, and that even over this short time horizon they were likely to discount fuel savings using credit card-like rates.[814] Combinations of a shorter time horizon and a higher discount rate could further reduce—or potentially 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 2025 vehicles considerably further, to about $117 for passenger cars and $1,250 for light trucks.

As these comparisons illustrate, reasonable alternative assumptions about how consumers might evaluate future fuel savings, the major private benefit from requiring higher fuel economy, can significantly affect the benefits they consider when deciding whether to purchase more fuel-efficient vehicles. Readily 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 perhaps even unwilling—to purchase vehicles offering the increased fuel economy levels this proposed rule would require manufacturers to provide in future model years. Thus, vehicle buyers' assessment of the benefits and costs of this proposal in their purchase decisions may differ markedly from NHTSA's estimates.

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[812] Interest rates on 48-month new vehicle loans made by commercial banks during 2010 averaged 6.21%, while new car loan rates at auto finance companies averaged 4.26%; *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 September 27, 2011).

[813] The average rate on consumer credit card accounts at commercial banks during 2010 was 13.78%; *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 September 27, 2011).

[814] 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.

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 from higher fuel economy they are considering are not sufficient to justify the increase in purchase prices they expect to pay. In conjunction with the possibility that manufacturers misinterpret potential buyers' willingness to pay for improved fuel economy, this might explain why the current choices among available models do not result in average fuel economy levels approaching those this rule would require.

Another possibility is that achieving the fuel economy improvements required by stricter fuel economy standards might lead manufacturers to forego planned future improvements in performance, carrying capacity, safety, or other features of their vehicle models that provide important sources of utility to their owners, even if it is technologically feasible to have both improvements in those other features and improved fuel economy. Although the specific economic values that vehicle buyers attach to individual vehicle attributes such as fuel economy, performance, passenger- and cargo-carrying capacity, or other features are difficult to infer from vehicle prices or buyers' choices among competing models, changes in vehicle attributes can significantly affect the overall utility that vehicles offer to potential buyers. Thus if requiring manufacturers to provide higher fuel economy leads them to sacrifice improvements in these or other highly-valued attributes, potential buyers are likely to view these sacrifices as an additional cost of improving fuel economy. If those attributes are of sufficient value, or if the range of vehicles offered ensures that vehicles with those attributes will continue to be offered, then vehicle buyers will still have the opportunity to choose those attributes, though at increased cost compared to models without the fuel economy improvements.

As indicated in its previous discussion of technology costs, NHTSA has approached this potential problem by attempting to develop cost estimates for fuel economy-improving technologies that include allowances for any additional 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, in the majority of cases. The agency's continued specification of footprint-based CAFE standards also addresses this concern, by establishing less demanding fuel economy targets for larger cars and light trucks.

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 the higher overall fuel economy levels proposed in this NPRM. This explanation assumes that auto makers decide to change vehicle attributes other than price and fuel economy in response to this rule. 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. It leaves open the question, though, why auto makers would change those other vehicle characteristics if consumers liked them as they were; as noted, the assumption of ''constant performance and utility'' built into the cost estimates means that these changes are not necessary.

As the foregoing discussion makes clear, the agency cannot offer a complete answer to the question of why the apparently large differences between its estimates of private benefits from requiring higher fuel economy and the costs of supplying it would not result in higher fuel economy for new cars and light trucks in the absence of this rule. One explanation is that these estimates are reasonable, but that for the reasons outlined above, the market for fuel economy is not operating efficiently. NHTSA believes the existing literature offers some support for the view that various failures in the market for fuel economy prevent it from providing an economically desirable outcome, which implies that on balance there are likely to be substantial private gains from the proposed rule. The agency will continue to investigate new empirical literature addressing this question as it becomes available, and seeks comment on all of the relevant questions.

NHTSA acknowledges the possibility that it has incorrectly characterized the impact on the market of the CAFE standards this rule proposes, and that this could cause its estimates of benefits and costs to misrepresent the effects of the proposed rule. To recognize this possibility, this section presents an alternative accounting of the benefits and costs of CAFE standards for MYs 2017–2025 passenger cars and light trucks and discusses its implications. Table IV–114 displays the economic impacts of the rule as viewed from the perspective of potential buyers.

As the table shows, the proposed rule's total benefits to vehicle buyers (line 4) consist of the value of fuel savings over vehicles' full lifetimes 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, 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–114 also shows, the decline in fuel tax revenues (line 7) that results from reduced fuel purchases is a transfer of funds between consumers and government and is thus not a social cost.[815] (Thus the sum of lines 1 and 7 equals the savings in fuel production costs that were reported previously as the value of fuel savings at pre-tax prices in the agency's previous accounting of benefits and costs.) Lines 8 and 9 of Table IV–114 report the value of reductions in air pollution and climate-related externalities resulting from lower emissions of criteria air

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[815] 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.

pollutants and GHGs 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 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 external benefits from the proposed CAFE standards (line 13) are thus the sum of the change in fuel tax revenues, the reduction in environmental and energy security externalities, and increased external costs from added driving.

Line 14 of Table IV–114 shows manufacturers' technology outlays for meeting higher CAFE standards for passenger cars and light trucks, which represent the principal private and social cost of requiring higher fuel economy. The net social benefits (line 15 of the table) resulting from the proposed 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 Table IV–63.

Table IV–114 highlights several important features of this rule's economic impacts. First, comparing the rule's net private (line 6) and external (line 13) benefits makes it clear that a very large proportion of the proposed rule's benefits would be experienced by vehicle buyers, while the small remaining fraction would be experienced throughout the remainder of the U.S. economy. In turn, the vast majority of private benefits resulting from the higher fuel economy levels the proposed rule would require stem from fuel savings to vehicle buyers. Net external benefits from the proposed rule are expected to be small, because the value of reductions in environmental and energy security externalities is likely almost exactly offset by the increased costs associated with added vehicle use. As a consequence, the net social benefits of the rule mirror almost exactly its net private benefits to vehicle buyers, under the assumption that manufacturers will recover their technology outlays for achieving higher fuel economy by raising new car and light truck prices. Once again, this result highlights the extreme importance of accounting for any other effects of the rule on the economic welfare of vehicle buyers.

Table IV-114. Private, Social, and Total Benefits and Costs of MYs 2017-2021 CAFE Standards – Passenger Cars Plus Light Trucks (3% discount rate)

Entry	Model Year				
	2017	2018	2019	2020	2021
1. Value of fuel savings (at retail prices)	\$8.0	\$19.6	\$33.1	\$44.6	\$58.5
2. Savings in refueling time	\$0.4	\$0.7	\$1.1	\$1.2	\$1.7
3. Consumer surplus from added driving	\$0.1	\$0.2	\$0.5	\$0.7	\$1.0
4. Total private benefits (= 1 + 2 + 3)	\$8.50	\$20.50	\$34.70	\$46.50	\$61.20
5. Reduction in private benefits from changes in other vehicle attributes	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
6. Net private benefits (= 4 + 5)	\$8.50	\$20.50	\$34.70	\$46.50	\$61.20
7. Change in fuel tax revenues	(\$0.9)	(\$2.1)	(\$3.5)	(\$4.6)	(\$6.0)
8. Reduced health damages from criteria emissions	\$0.2	\$0.4	\$0.8	\$1.2	\$1.5
9. Reduced climate damages from CO_2 emissions	\$0.7	\$1.8	\$3.1	\$4.2	\$5.6
10. Reduced energy security externalities	\$0.4	\$0.9	\$1.6	\$2.1	\$2.7
11. Reduction in externalities (= 8 + 9 + 10)	\$1.3	\$3.1	\$5.5	\$7.5	\$9.8
12. Increased costs of congestion, etc.	(\$0.9)	(\$1.9)	(\$3.2)	(\$4.4)	(\$5.7)
13. Net external benefits (= 7 + 11 + 12)	(\$0.50)	(\$0.90)	(\$1.20)	(\$1.50)	(\$1.90)
14. Technology costs	(\$2.0)	(\$4.4)	(\$7.7)	(\$11.3)	(\$15.2)
15. Net social benefits (= 6 + 13 – 14)	\$5.50	\$13.90	\$24.60	\$32.00	\$42.20

Table IV-115. Private, Social, and Total Benefits and Costs of MYs 2022-2025 and Total MYs 2017-2025 CAFE Standards – Passenger Cars Plus Light Trucks

Entry	Model Year				
	2022	2023	2024	2025	Total,2017-2025
1. Value of fuel savings (at retail fuel prices)	$67.5	$76.3	$87.1	$96.5	$491.1
2. Savings in refueling time	$2.0	$2.2	$2.5	$2.4	$14.3
3. Consumer surplus from added driving	$1.3	$1.6	$2.0	$2.4	$9.9
4. Total private benefits (= 1 + 2 + 3)	$70.80	$80.10	$91.60	$101.30	$515.30
5. Reduction in private benefits from changes in other vehicle attributes	$0.0	$0.0	$0.0	$0.0	$0.0
6. Net private benefits (= 4 +52)	$70.80	$80.10	$91.60	$101.30	$515.30
7. Change in fuel tax revenues	($6.8)	($7.7)	($8.7)	($9.5)	($49.9)
8. Reduced health damages from criteria emissions	$1.7	$1.9	$2	$2.3	$12.5
9. Reduced climate damages from CO_2 emissions	$6.6	$7.5	$8.7	$9.7	$48.0
10. Reduced energy security externalities	$3.1	$3.5	$4.0	$4.4	$22.8
11. Reduction in externalities (= 8 + 9 + 10)	$11.4	$12.9	$14.7	$16.4	$83.3
12. Increased costs of congestion, etc.	($6.5)	($7.3)	($8.4)	($9.3)	($48.8)
13. Net external benefits (= 7 + 11 + 12)	($1.90)	($2.10)	($2.40)	($2.40)	($15.40)
14. Technology costs	($19.8)	($24.2)	($29.8)	($32.4)	($153.3)
15. Net social benefits (= 6 + 13 – 14)	$49.10	$53.80	$59.40	$66.50	$346.60

As discussed in detail previously, NHTSA believes that the aggregate benefits from this proposed rule amply justify its total costs, but it remains possible that the agency has overestimated the role of fuel savings to buyers and subsequent owners of the cars and light trucks to which the higher CAFE standards it proposes would apply. It is also possible that the agency has failed to develop cost estimates that do not require manufacturers to make changes in vehicle attributes as part of their efforts to achieve higher fuel economy. To acknowledge these possibilities, NHTSA has examined their potential impact on its estimates of the proposed rule's benefits and costs. This analysis, which appears in Chapter VIII of the Preliminary RIA accompanying this proposed rule, shows the rule's economic impacts under alternative assumptions about the private benefits from higher fuel economy, and the value of potential changes in other vehicle attributes. One conclusion is that even if the private savings are significantly overstated, the benefits of the proposed standards continue to exceed the costs. We seek comment on that analysis and the discussion above.

7. What other impacts (quantitative and unquantifiable) will these proposed 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:

- How likely is it to occur, and can the magnitude of the impact reasonably be attributed to the outcome of this rulemaking?
- Would quantification of its physical magnitude or economic value help NHTSA and the public evaluate the CAFE standards that may be set in rulemaking?
- Is the impact readily quantifiable in physical terms?
- If so, can it readily be translated into an economic value?
- Is this economic value likely to be material?
- Can the impact be quantified 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 these considerations. In some cases, further research may yield estimates that are useful for future rulemakings.

Technology Forcing

The proposed rule will improve the fuel economy of the U.S. new vehicle fleet, but it will also increase the cost (and presumably, the price) of new passenger cars and light trucks built during MYs 2017–2025. We anticipate that the cost, scope, and duration of this rule, as well as the steadily rising standards it requires, will cause automakers and suppliers to devote increased attention to methods of improving vehicle fuel economy.

This increased attention will stimulate additional research and engineering, and we anticipate that, over time, innovative approaches to reducing the fuel consumption of light duty vehicles will emerge. These innovative approaches may reduce the cost of the proposed rule in its later years, and also increase the set of feasible technologies in future years. We have attempted to estimate the effect of learning effects on the costs of producing known technologies within the period of the rulemaking, which is one way that technologies become cheaper over time, and may reflect innovations in application and use of existing technologies to meet the proposed future. However, 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, or whether technologies considered but not applied in the current rulemaking, due to concern about the likelihood of their commercialization in the rulemaking timeframe, will in fact be helped towards commercialization as a result of the proposed standards. NHTSA seeks comment on whether there are quantifiable costs and benefits associated with the potential technology forcing effects of the proposed standards, and if so, how the agency should consider attempting to account for them in the final rule analysis.

Effects on Vehicle Costs

Actions that increases the cost of new vehicles could subsequently make such vehicles more costly to maintain, repair, and insure. In general, NHTSA expects that this effect to be a positive linear function of vehicle costs. In its central analysis, NHTSA estimates that the proposed rule could raise average vehicle technology costs by over $1,800 by 2025, and for some manufacturers, average costs will increase by more than $3,000 (for some specific vehicle models, we estimate that the proposed rule could increase technology costs by more than $10,000). 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 and collision 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. Also, although they represent economic transfers, sales and excise taxes would also increase with increases in vehicle prices (unless rates are reduced). 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. These costs are borne in part by vehicle manufacturers (through warranty costs, which are included in the indirect costs of production), and in part by vehicle owners. NHTSA believes that this effect is difficult to quantify for purposes of this proposed rule, but we seek comment on how we might attempt to do so for the final rule.

Related, to the extent that the proposed standards require manufacturers to build and sell more PHEVs and EVs, vehicle manufacturers and owners may face additional costs for charging infrastructure and battery disposal. While Chapter 3 of the draft Joint TSD discusses the costs of charging infrastructure, neither of these costs have been incorporated into the rulemaking analysis due to time constraints. We intend to attempt to quantify these additional costs for the final rule stage, but we believe that doing so will be difficult and we seek comment on how we might go about it. We also seek comment on other costs or cost savings that are not accounted for in this analysis and how we might go about quantifying them for the final rule.

And finally on the subject of vehicle operation, NHTSA has received comments in the past that premium (higher octane) fuel may be necessary if certain advanced fuel economy-improving technologies are required by stringent CAFE standards. The agencies have not assumed in our development of technology costs that premium fuel would be required. We seek comment on this assumption.

Effects on Vehicle Miles Traveled (VMT)

While NHTSA has estimated the impact of the rebound effect on the use of MY 2017–25 vehicles, we have not estimated how a change in new vehicle sales would impact aggregate vehicle use. Changes in new vehicle sales may be accompanied by complex but difficult-to-quantify effects on overall vehicle use and its composition by vehicle type and age, because the same factors affecting sales of new vehicles are also likely to influence their use, as well as how intensively older vehicles are used and when they are retired from service. These changes may have important consequences for total fleet-wide fuel consumption. NHTSA believes that this effect is difficult to quantify for purposes of this proposed rule, but we seek comment on how we might attempt to do so for the final rule, if commenters agree that attempting quantification of this effect could be informative.

Effect on Composition of Passenger Car and Light Truck Sales

To the extent that manufacturers pass on costs to buyers by raising prices for new vehicle models, they may distribute these price increases across their model lineups in ways that affect the composition of their total sales. 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 such 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 develop methods of estimating the effects of these proposed standards on the sales of individual vehicle models, and plans to apply these methods in analyzing the impacts of its final CAFE standards for MY 2017–25. In the meantime, the agency seeks comment on the possibility that significant shifts in the composition of new vehicle sales by type or model could occur, the potential effects of such shifts on fuel consumption and fuel savings from the proposed standards, and methods for analyzing the potential extent and patterns of shifts in sales.

Effects on the Used Vehicle Market

The effect of this rule on the lifetimes, use, and retirement dates (''scrappage'') of older vehicles will be related to its effects on new vehicle prices, the fuel efficiency of new vehicle models, and total sales of new vehicles. If the value of fuel savings resulting from improved fuel efficiency to the typical potential buyer of a new vehicle outweighs the average increase in new models' prices, sales of new vehicles will rise, while scrappage rates of used vehicles will increase slightly. This will cause the ''turnover'' of the vehicle fleet—that is, the retirement of used vehicles and their replacement by new models—to accelerate slightly, thus accentuating the anticipated effect of the rule on fleet-wide fuel consumption and CO_2 emissions. However, if potential buyers value future fuel savings resulting from the increased fuel efficiency of new models at less than the increase in their average selling price, sales of new vehicles will decline, as will the rate at which used vehicles are retired from service. This effect will slow the replacement of used vehicles by new models, and thus partly offset the anticipated effects of the final rules on fuel use and emissions.

Because the agencies are uncertain about how the value of projected fuel savings from the final rules to potential buyers will compare to their estimates of increases in new vehicle prices, we have not attempted to estimate explicitly the effects of the rule on scrappage of older vehicles and the turnover of the vehicle fleet.

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 offered for renewable fuels. 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 using renewable fuels in these blends. However, if the price of gasoline or diesel increases enough, the consumer could actually realize a savings through the increased usage of renewable fuels. By reducing total fuel consumption, the CAFE standards proposed in this rule 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 reflected 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 CAFE standards.

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 if the RFS makes blended gasoline relatively more expensive, and because fuels blended with more ethanol emit slightly fewer greenhouse gas emissions per gallon. In addition, there might be corresponding benefit 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.

Distributional Effects

The agency's analysis of the proposed rule reports impacts only as nationwide aggregate or per-vehicle average values. NHTSA also shows the effects of the EIA high and low fuel price forecasts on the aggregate benefits in its sensitivity analysis. Generally, this proposed rule would have its largest effects on individuals who purchase new vehicles produced during the model years it would affect (2017–25). New vehicle buyers who drive more than the agency's estimates of average vehicle use will experience larger fuel savings and economic benefits than the average values reported in this NPRM, while those who drive less than our average estimates will experience smaller fuel savings and benefits. NHTSA believes that this effect is difficult to quantify for purposes of this proposed rule, but we seek comment on how we might attempt to do so for the final rule, if commenters agree that attempting quantification of this effect could be informative.

H. Vehicle Classification

Vehicle classification, for purposes of the CAFE program, refers to whether NHTSA considers a vehicle to be a passenger car or a light truck, and thus subject to either the passenger car or the light truck standards.[816] As NHTSA explained in the MY 2011 rulemaking and in the MYs 2012–2016 rulemaking, vehicle classification is based in part on EPCA/EISA, and in part on NHTSA's regulations. EPCA categorizes some light 4-wheeled vehicles as ''passenger automobiles'' (cars) and the balance as ''non-passenger automobiles'' (light trucks). EPCA defines passenger

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[816] For the purpose of the MYs 2012–2016 standards and this NPRM for the MYs 2017–2025 standards, EPA has agreed to use NHTSA's regulatory definitions for determining which vehicles would be subject to which CO_2 standards.

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.[817] 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.[818] 49 CFR 523 directly tracks those two broad groups of non-passenger automobiles in subsections (a) and (b), respectively. We note that NHTSA tightened the definition of light truck in the MY 2011 rulemaking 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), which resulted in the reclassification of over 1 million vehicles from the truck fleet to the car fleet.

Since the original passage of EPCA, and consistently through the passage of EISA, Congress has expressed its intent that different vehicles with different characteristics and capabilities should be subject to different CAFE standards in two ways: first, through whether a vehicle is classified as a passenger car or as a light truck, and second, by requiring NHTSA to set separate standards for passenger cars and for light trucks.[819] Creating two categories of vehicles and requiring separate standards for each, however, can lead to two issues which may either detract from the fuel savings that the program is able to achieve, or increase regulatory burden for manufacturers simply because they are trying to meet market demand. Specifically,

(1) If the stringency of the standards that NHTSA establishes seems to favor either cars or trucks, manufacturers may have incentive to change their vehicles' characteristics in order to reclassify them and average them into the ''easier'' fleet; and

(2) ''Like'' vehicles, such as the 2WD and 4WD versions of the same CUV, may have generally similar fuel economy-achieving capabilities, but different targets due to differences in the car and truck curves.

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. 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 could possibly choose to make such changes before or during the model years covered by this rulemaking, either because of market demands or because of interest in changing the vehicle's classification.

NHTSA continues to believe that the definitions as they currently exist are consistent with the text of EISA and with Congress' original intent. However, the time frame of this rulemaking is longer than any CAFE rulemaking that NHTSA has previously undertaken, and no one can predict with certainty how the market will change between now and 2025. The agency therefore has less assurance than in prior rulemakings that manufacturers will not have greater incentives and opportunities during that time frame to make more deliberate redesign efforts to move vehicles out of the car fleet and into the truck fleet in order to obtain the lower target, and potentially reducing overall fuel savings. Recognizing this possibility, we seek comment on how best to avoid it while still classifying vehicles appropriately based on their characteristics and capabilities.

One of the potential options that we explored in the MYs 2012–2016 rulemaking for MYs 2017 and beyond was changing the definition of light truck to remove paragraph (5) of 49 CFR 523.5(a), which allows vehicles to be classified as light trucks if they have three or more rows of seats that can either be removed or folded flat to allow greater cargo-carrying capacity. NHTSA has received comments in the past arguing that vehicles with three or more rows of seats, unless they are capable of transporting more than 10 individuals, should be classified as passenger cars rather than as light trucks because they would not need to have so many seats if they were not intended primarily to carry passengers.

NHTSA recognizes that there are arguments both for and against maintaining the definition as currently written for MYs 2017 and beyond. The agency continues to believe that three or more rows of seats that can be removed or folded flat is a reasonable proxy for a vehicle's ability to provide expanded cargo space, consistent with the agency's original intent in developing the light truck definitions that expanded cargo space is a fundamentally ''truck-like'' characteristic. Much of the public reaction to this definition, which is mixed, tends to be visceral and anecdotal—for example, for parents with minivans and multiple children, the ability of seats to fold flat to provide more room for child-related cargo may have been a paramount consideration in purchasing the vehicle, while for CUV owners with cramped and largely unused third rows, those extra seats may seem to have sprung up entirely in response to the regulation, rather than in response to the consumer's need for utility. If we believe, for the sake of argument, that the agency's decision might be reasonable from both a policy and a legal perspective whether we decided to change the definition or to leave it alone, the most important questions in making the decision become (1) whether removing

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[817] EPCA 501(2), 89 Stat. 901, codified at 49 U.S.C. 32901(a).

[818] 49 U.S.C. 32901(a)(18). 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. We note that we 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. We also underscore, as we have in the past, that despite comments in prior rulemakings suggesting that any vehicle that appears to be manufactured ''primarily'' for transporting passengers must be classified as a passenger car, the statute as currently written clearly provides that vehicles that are off-highway capable are not passenger cars.

[819] *See, e.g.,* discussion of legislative history in 42 FR 38362, 38365–66 (Jul. 28, 1977).

523.5(a)(5), and thus causing vehicles with three or more rows to be classified as passenger cars in the future, will save more fuel, and (2) if more fuel will be saved, at what cost.

In considering these questions in the MYs 2012–2016 rulemaking, NHTSA conducted an analysis in the final rule to attempt to consider the impact of moving these vehicles. We identified all of the 3-row vehicles in the baseline (MY 2008) fleet,[820] 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. We then transferred those remaining 3-row vehicles from the light truck to the passenger car input sheets for the CAFE model, re-estimated the relative stringency of 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 agency's hypothesis had been that moving 3-row vehicles from the truck to the car fleet would 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.

As the agency found, however, 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, but it also resulted 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 was 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 net effect on technology costs 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, NHTSA estimated that vehicle prices would increase by an average of approximately $13 during MYs 2012–2016. With less fuel savings and higher costs, and a substantial disruption to the industry, removing 523.5(a)(5) did not seem advisable in the context of the MYs 2012–2016 rulemaking.

Looking forward, however, and given the considerable uncertainty regarding the incentive to reclassify vehicles in the MYs 2017 and beyond timeframe, the agency considered whether a fresh attempt at this analysis would be warranted, but did not believe that it would be informative given the uncertainty. One important point to note in the comparative analysis in the MYs 2012–2016 rulemaking 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, considering the vehicles in question, we might have obtained a somewhat steeper passenger car curve, and a somewhat flatter light truck curve, which could have affected the agency's findings. The same is true today. Without refitting the curves and changing the required levels of stringency for cars and trucks, simply moving vehicles from one fleet to another will not inform the agency in any substantive way as to the impacts of a change in classification. Moreover, even if we did attempt to make those changes, the results would be somewhat speculative; for example, the agencies continue to use the same MY 2008 baseline used in the MYs 2012–2016 rulemaking, which may have limited utility for predicting relatively small changes (moving only 40 vehicles, as noted above) in the fleet makeup during the rulemaking timeframe. As a result, NHTSA did not attempt to quantify the impact of such a reclassification of 3-row vehicles, but we seek comment on whether and how we should do so for the final rule. If commenters believe that we should attempt to quantify the impact, we specifically seek comment on how to refit the footprint curves and how the agency should consider stringency levels under such a scenario.

Another potential option that we explored in the MYs 2012–2016 rulemaking for MYs 2017 and beyond was 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.

NHTSA continues to believe that this would not be an appropriate solution for addressing either the risk of gaming or perceived regulatory inequity going forward. As explained in the MYs 2012–2016 final rule, 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

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[820] Of the 430 light truck models in the fleet, 175 of these had 3 rows.

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. At this time, however, since so little time has passed since our last rulemaking action, we do not believe that we have enough information about changes in the fleet to ascertain whether this is yet ripe for consideration. We seek comment on how the agency might go about reviewing this question as more information about manufacturer behavior is accumulated over time.

I. Compliance and Enforcement

1. Overview

NHTSA's CAFE enforcement program is largely established by statute—unlike the CAA, EPCA, as amended by EISA, is very prescriptive with regard to enforcement. EPCA and EISA also clearly specify a number of flexibilities that are available to manufacturers to help them comply with the CAFE standards. Some of those flexibilities are constrained by statute—for example, while Congress required that NHTSA allow manufacturers to transfer credits earned for over-compliance from their car fleet to their truck fleet and vice versa, Congress also limited the amount by which manufacturers could increase their CAFE levels using those transfers.[821] NHTSA believes Congress balanced the energy-saving purposes of the statute against the benefits of certain flexibilities and incentives and intentionally placed some limits on certain statutory flexibilities and incentives. With that goal in mind, of maximizing compliance flexibility while also implementing EPCA/EISA's overarching purpose of energy conservation as fully as possible, NHTSA has done its best in crafting the credit transfer and trading regulations authorized by EISA to ensure that total fuel savings are preserved when manufacturers exercise their statutorily-provided compliance flexibilities.

Furthermore, to achieve the level of standards described in this proposal for the 2017–2025 program, NHTSA expects automakers to continue increasing the use of innovative and advanced technologies as they evolve. Additional incentive programs may encourage early adoption of these innovative and advanced technologies and help to maximize both compliance flexibility and energy conservation. These incentive programs for CAFE compliance would not be under NHTSA's EPCA/EISA authority, but under EPA's EPCA authority—as discussed in more detail below and in Section III of this preamble, EPA measures and calculates manufacturer compliance with the CAFE standards, and it would be in the calculation of fuel economy levels that additional incentives would most appropriately be applied, as a practical matter. Specifically, to be included in the CAFE program, EPA is proposing: (1) Fuel economy performance adjustments due to improvements in air conditioning system efficiency; (2) utilization of ''game changing'' technologies installed on full size pick-up trucks including hybridization; and (3) installation of ''off-cycle'' technologies. In addition, for model years 2020 and later, EPA is proposing calculation methods for dual-fueled vehicles, to fill the gap left in EPCA/EISA by the expiration of the dual-fuel incentive. A more thorough description of the basis for the new incentive programs can be found in Section III.

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. The following sections also explain, for the reader's reference, the proposed new incentives and calculations, but we also refer readers to Section III.C for EPA's explanation of its authority and more specific detail regarding these proposed changes to the CAFE program.

2. How does NHTSA determine compliance?

a. Manufacturer Submission of Data and CAFE Testing by EPA

NHTSA begins to determine CAFE compliance by reviewing projected estimates in pre- and mid-model year reports submitted by manufacturers pursuant to 49 CFR part 537, Automotive Fuel Economy Reports.[822] Those reports for each compliance model year are submitted to NHTSA by December of the calendar year prior to the corresponding subsequent model year (for the pre-model year report) and in July of the given model year (for the mid-model year report). NHTSA has already received pre-and mid-model year reports from manufacturers for MY 2011. NHTSA uses these reports for reference to help the agency, and the manufacturers who prepare them, anticipate potential compliance issues as early as possible, and help manufacturers plan compliance strategies. NHTSA also uses the reports for auditing and testing purposes, which helps manufacturers correct errors prior to the end of the model year and facilitates acceptance of their final CAFE report by EPA. In addition, NHTSA issues reports to the public twice a year that provide a summary of manufacturers' fleet fuel economy projected performances using pre- and mid model year data. Currently, NHTSA receives manufacturers' CAFE reports in paper form. In order to facilitate submission by manufacturers, NHTSA amended part 537 to allow for electronic submission of the pre- and mid-model year CAFE reports in 2010 (see 75 FR 25324). Electronic reports are optional and must be submitted in a pdf format. NHTSA proposes to modify these provisions in this NPRM, as described below, in order to eliminate hardcopy submissions and help the agency more readily process and utilize the electronically-submitted data.

Throughout the model year, NHTSA audits manufacturers' reports and conducts vehicle testing to confirm the accuracy of track width and wheelbase measurements as a part of its footprint validation program,[823] which helps the agency understand better how manufacturers may adjust vehicle characteristics to change a vehicle's footprint measurement, and thus its fuel economy target. NHTSA resolve discrepancies with the manufacturer prior to the end of the calendar year corresponding to the respective model year with the primary goal of manufacturers submitting accurate final reports to EPA. NHTSA makes its ultimate determination of a manufacturer's CAFE compliance obligation based on official reported and verified CAFE data received from EPA. Pursuant to 49 U.S.C. 32904(e), EPA is responsible for calculating manufacturers' CAFE values so that NHTSA can determine compliance with its CAFE standards. The EPA-verified data is based on any considerations from NHTSA testing, its own vehicle testing, and final model year data

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[821] See 49 U.S.C. 32903(g).

[822] 49 CFR part 537 is authorized by 49 U.S.C. 32907.

[823] See *http://www.nhtsa.gov/DOT/NHTSA/Vehicle%20Safety/Test%20Procedures/Associated%20Files/TP–537–01.pdf*

submitted by manufacturers to EPA pursuant to 40 CFR 600.512. A manufacturer's final model year report must be submitted to EPA no later than 90 days after December 31st of the model year. EPA test procedures including those used to establish the new incentive fuel economy performance values for model year 2017 to 2025 vehicles are contained in sections 40 CFR Part 600 and 40 CFR Part 86.

b. NHTSA Then Analyzes EPA–Certified CAFE Values for Compliance

NHTSA's determination of CAFE compliance is fairly straightforward: after testing, EPA verifies the data submitted by manufacturers and issues final CAFE reports sent to manufacturers and to NHTSA in a pdf format 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. NHTSA plans to construct a new, more automated database system in the near future to store manufacturer data and the EPA data. The new database is expected to simplify data submissions to NHTSA, improve the quality of the agency's data, expedite public reporting, improve audit verifications and testing, and enable more efficient tracking of manufacturers' CAFE credits with greater transparency.

NHTSA uses the verified data from EPA to compare fleet average standards with performance. A manufacturer complies with NHTSA's fuel economy standard if its fleet average performance is greater than or equal to its required standard, or if it is able to use available compliance flexibilities to resolve its non-compliance difference. 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. The amount of credits earned in a given year are determined by multiplying the number of tenths of an 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 that model year. Credits may be used to offset shortfalls in other model years, subject to the three year ''carry-back'' and five-year ''carry-forward'' limitations specified in 49 U.S.C. 32903(a); NHTSA does not have authority to allow credits to be carried forward or back for periods longer than that specified in the statute. A manufacturer may also transfer credits to another compliance category, subject to the limitations specified in 49 U.S.C. 32903(g)(3), or trade them to another manufacturer. The value of each credit received via trade or transfer, when used for compliance, is adjusted using the adjustment factor described in 49 CFR 536.4, pursuant to 49 U.S.C. 32903(f)(1). As part of this rulemaking, NHTSA is proposing to set the VMT values that are part of the adjustment factor for credits earned in MYs 2017–2025 at a single level that does not change from model year to model year, as discussed further below.

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, or if it does not have sufficient credits available in that fleet, 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. 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 manufacturer's credit account accordingly. If a plan is rejected, NHTSA will notify the 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 assessment of civil penalties. The Act specifies a precise formula for determining the amount of civil penalties for noncompliance.[824] The penalty, as adjusted for inflation by law, is $5.50 for each tenth of a mpg that a manufacturer's average fuel economy falls short of the standard for a given model year multiplied by the total volume of those vehicles in the affected fleet (*i.e.,* import or domestic passenger car, or light truck), manufactured for that model year. The amount of the penalty may not be reduced except under the unusual or extreme circumstances specified in the statute. All penalties are paid to the U.S. Treasury and not to NHTSA itself.

Unlike the National Traffic and Motor Vehicle Safety Act, EPCA does not provide for recall and remedy in the event of a noncompliance. The presence of recall and remedy provisions[825] 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 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. If NHTSA receives and approves a manufacturer's carryback plan to earn future credits within the following three years in order to comply with current regulatory

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[824] See 49 U.S.C. 32912.

[825] 49 U.S.C. 30120, Remedies for defects and noncompliance.

obligations, NHTSA will defer levying fines for non-compliance until the date(s) when the manufacturer's approved plan indicates that credits will be earned or acquired to achieve compliance, and upon receiving confirmed CAFE data from EPA. If the manufacturer fails to acquire or earn sufficient credits by the plan dates, NHTSA will initiate compliance proceedings. 49 CFR part 536 contains the detailed regulations governing the use and application of CAFE credits authorized by 49 U.S.C. 32903.

3. What compliance flexibilities are available under the CAFE program and how do manufacturers use them?

There are three basic flexibilities outlined by EPCA/EISA that manufacturers can currently use to achieve compliance with CAFE standards beyond applying fuel economy-improving technologies: (1) Building dual- and alternative-fueled vehicles; (2) banking (carry-forward and carry-back), trading, and transferring credits earned for exceeding fuel economy standards; and (3) paying civil penalties. We note 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 statutorily-established 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 of those 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/diesel) vehicles. Consistent with the overarching purpose of EPCA/EISA, these statutory incentives help to reduce petroleum usage and thus improve our nation's energy security. Per EPCA, 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.[826] Thus, a 15 mpg dedicated alternative fuel vehicle would be rated as 100 mpg.

For dual-fueled vehicles, EPA measures the vehicle's fuel economy rating by determining the average of the fuel economy on gasoline or diesel and the fuel economy on the alternative fuel vehicle divided by 0.15.[827] This calculation procedure, provided in EPCA, 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:

$$\text{CAFE FE} = 1/\{0.5/(\text{mpg gas}) + 0.5/(\text{mpg alt fuel})\} = 1/\{0.5/25 + 0.5/100\} = 40 \text{ mpg}$$

In the case of natural gas, EPA's 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 CAFE fuel economy while operating on the natural gas is determined by dividing its fuel economy in equivalent miles per gallon of gasoline by 0.15.[828] Thus, if a vehicle averages 25 miles per 100 ft^3 of natural gas, then:

$$\text{CAFE FE} = (25/100) * (100/.823)*(1/0.15) = 203 \text{ mpg}$$

Congress extended the dual-fueled vehicle incentive in EISA for dual-fueled automobiles through MY 2019, but provided for its phase-out between MYs 2015 and 2019.[829] The maximum fleet fuel economy increase attributable to this statutory incentive is thus as follows:

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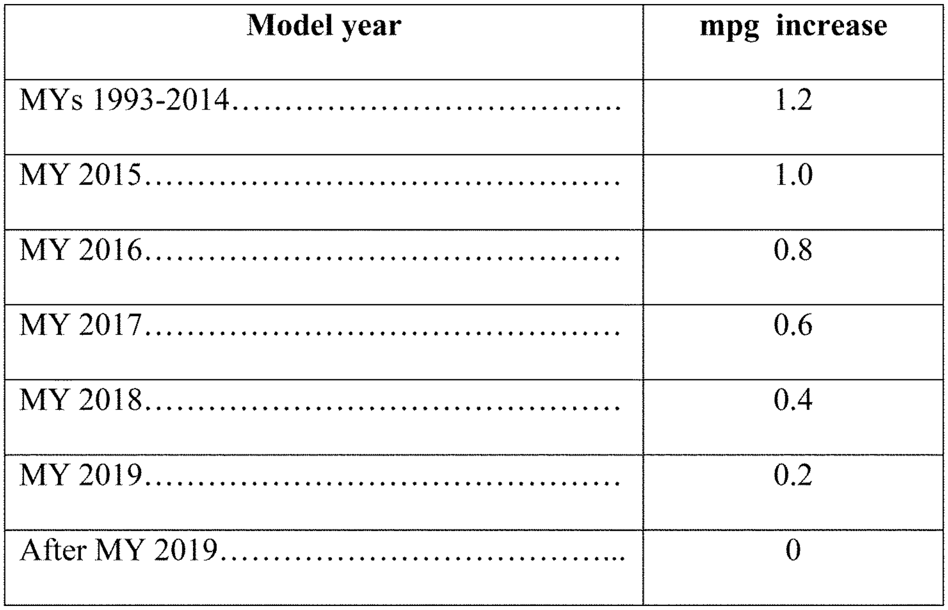
[826] 49 U.S.C. 32905(a).

[827] 49 U.S.C. 32905(b).

[828] 49 U.S.C. 32905(c).

[829] 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.

We note additionally and for the reader's reference that EPA will be treating dual- and alternative-fueled vehicles under its GHG program similarly to the way EPCA/EISA provides for CAFE through MY 2015, but for MY 2016, EPA established 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. Because EPCA/EISA provides the explicit CAFE measurement methodology for EPA to use for dedicated vehicles and dual-fueled vehicles through MY 2019, we explained in the MYs 2012–2016 final rule that the CAFE program would not require that vehicles manufactured for the purpose of obtaining the credit actually be run on the alternative fuel.



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 codifies in regulation the statutory alternative-fueled and dual-fueled automobile manufacturing incentive.

Given that the statutory incentive for dual-fueled vehicles in 49 U.S.C. 32906 and the measurement methodology specified in 49 U.S.C. 32905(b) and (d) expire in MY 2019, the question becomes, how should the fuel economy of dual-fueled vehicles be determined for CAFE compliance in MYs 2020 and beyond? NHTSA and EPA believe that the expiration of the dual-fueled vehicle measurement methodology in the statute leaves a gap to be filled, to avoid the absurd result of dual-fueled vehicles' fuel economy being measured like that of conventional gasoline vehicles. If the overarching purpose of the statute is energy conservation and reducing petroleum usage, the agencies believe that that goal is best met by continuing to reflect through CAFE calculations the reduced petroleum usage that dual-fueled vehicles achieve.

As discussed in more detail in Section III.B.10, for MYs 2020 and beyond, to fill the gap left by the expiration of the statutory CAFE measurement methodology for dual-fueled vehicles, EPA is proposing to harmonize with the approach it uses under the GHG program to measure the emissions of dual-fueled vehicles, to reflect the real-world percentage of usage of alternative fuels by dual-fueled vehicles, but also to continue to incentivize the use of certain alternative fuels in dual-fueled vehicles as appropriate under EPCA/EISA to reduce petroleum usage. Specifically, for MYs 2020 and beyond, EPA will calculate the fuel economy test values for a plug-in hybrid electric vehicle (PHEV, that runs on both gasoline and electricity) and for CNG-gasoline vehicles on both the alternative fuel and on gasoline, but rather than assuming that the dual-fueled vehicle runs on the alternative fuel 50 percent of the time as the current statutory measurement methodology requires, EPA will instead use the Society of Automotive Engineers (SAE) "utility factor" methodology (based on vehicle range on the alternative fuel and typical daily travel mileage) to determine the assumed percentage of operation on gasoline/diesel and percentage of operation on the alternative fuel for those vehicles. Using the utility factor, rather than making an a priori assumption about the amount of alternative fuel used by dual-fueled vehicles, recognizes that once a consumer has paid several thousand dollars to be able to use a fuel that is considerably cheaper than gasoline or diesel, it is very likely that the consumer will seek to use the cheaper fuel as much as possible. Consistent with this approach, however, EPA is not proposing to extend the utility factor method to flexible fueled vehicles (FFVs) that use E–85 and gasoline, since there is not a significant cost differential between an FFV and conventional gasoline vehicle and historically consumers have only fueled these vehicles with E85 a very small percentage of the time. Therefore, EPA is proposing for CAFE compliance in MYs 2020 and beyond to continue treatment of E85 and other FFVs as finalized in the MY 2016 GHG program, based on actual usage of the alternative fuel which represents a real-world reduction attributed to alternative fuels. For clarification in our regulations, NHTSA is proposing to add Part 536.10(d) which states that for model years 2020 and beyond a manufacturer must calculate the fuel economy of dual fueled vehicles in accordance with 40 CFR 600.500–12(c), (2)(v) and (vii), the sections of EPA's calculation regulations where EPA is proposing to incorporate these changes.

Additionally, to avoid manufacturers building only dedicated alternative fuel vehicles (which may be harder to refuel in some instances) because of the continued statutory 0.15 CAFE divisor under 49 U.S.C. 32905(a) and the calculation for EV fuel economy under 49 U.S.C. 32904, and declining to build dual-fueled vehicles which might not get a similar bonus, EPA is proposing to use the Petroleum Equivalency Factor (PEF) and a 0.15 divisor for calculating the fuel economy of PHEVs' electrical operation and for natural gas operation of CNG-gasoline vehicles.[830] This is consistent with the statutory approach for dedicated alternative fuel vehicles, and continues to incentivize the usage of alternative fuels and reduction of petroleum usage, but when combined with the utility factor approach described above, does not needlessly over-incentivize their usage—it gives credit for what is used, and does not give credit for what is not used. Because it does not give credit for what is not used, EPA would propose that manufacturers may increase their calculated fleet fuel economy for dual-

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[830] EPA is also seeking comment on an approach that would not use the PEF and 0.15 multiplier, as discussed above in Section III.

fueled vehicles by an unlimited amount using these flexibilities.

As an example, for MYs 2020 and beyond, the calculation procedure for a dual-fueled vehicle that uses both gasoline and CNG could result in a combined fuel economy value of 150 mpg for CAFE purposes. This assumes that (1) the ''utility factor'' for the alternative fuel is found to be 95 percent, and so the vehicle operates on gasoline for the remaining 5 percent of the time; (2) fuel economy while operating on natural gas is 203 mpg [(25/100) * (100/.823) * (1/0.15)] as shown above utilizing the PEF and the .15 incentive factor; and (3) fuel economy while operating on gasoline is 25 mpg. Thus:

$$\text{CAFE FE} = 1/\{0.05/(\text{mpg gas}) + 0.95/(\text{mpg CNG})\} = 1/\{0.05/25 + 0.95/203\} = 150 \text{ mpg}$$

The agencies seek comment on this approach.

b. Credit Trading and Transfer

As part of the MY 2011 final rule, NHTSA created 49 CFR 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.[831] 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 expiration date, if the credit holder so chooses. Traded and transferred credits are subject to an ''adjustment factor'' to ensure total oil savings are preserved, as required by EISA. EISA also prohibits credits earned before MY 2011 from being transferred, so NHTSA has developed several regulatory restrictions on trading and transferring to facilitate Congress' intent in this regard. As discussed above, EISA 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.

As part of this rulemaking, NHTSA is proposing to set the VMT estimates used in the credit adjustment factor at 195,264 miles for passenger car credits and 225,865 miles for light truck credits for credits earned in MYs 2017–2025. The VMT estimates for MYs 2012–2016 would not change. NHTSA is proposing these values in the interest of harmonizing with EPA's GHG program, and seeks comment on this approach as compared to the prior approach of adjustment factors with VMT estimates that vary by year. Additionally, NHTSA is proposing to include VMT estimates for MY 2011 which the agency neglected to include in Part 536 as part of the MYs 2012–2016 rulemaking. The proposed MY 2011 VMT estimate for passenger cars is 152,922 miles, and for light trucks is 172,552 miles.

c. Payment of Civil Penalties

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 $794,921,139.50 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 2009 fleets, six manufacturers paid CAFE fines for not meeting an applicable standard—Fiat, which included Ferrari, Maserati, and Alfa Romeo; Daimler (Mercedes-Benz); Porsche; and Tata (Jaguar Land Rover)—for a total of $9,148,425.00. As mentioned above, civil penalties paid for CAFE non-compliance go to the U.S. Treasury, and not to DOT or NHTSA.

NHTSA recognizes that some manufacturers may use the option to pay civil penalties as a CAFE compliance flexibility—presumably, when paying civil penalties 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 payment of civil penalties 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 civil penalties are motivational for manufacturers, and whether raising them would increase manufacturers' compliance with the standards. EPCA authorizes increasing the civil penalty very slightly up to $10.00, exclusive of inflationary adjustments, if NHTSA decides that the increase in the penalty ''will result in, or substantially further, substantial energy conservation for automobiles in the model years in which the increased penalty may be imposed; and will not have a substantial deleterious impact on the economy of the United States, a State, or a region of a State.'' 49 U.S.C. 32912(c).

To support a decision that increasing the penalty would result in ''substantial energy conservation'' without having ''a substantial deleterious impact on the economy,'' NHTSA would likely need to provide some reasonably certain quantitative estimates of the fuel that would be saved, and the impact on the economy, if the penalty were raised. Comments received on this issue in the past have not explained in clear quantitative terms what the benefits and drawbacks to raising the penalty might be. Additionally, it may be that the range of possible increase that the statute provides, *i.e.,* up to $10 per tenth of a mpg, is insufficient to result in substantial energy conservation, although changing this would require an amendment to the statute by Congress. NHTSA continues to seek to gain information on this issue and requests 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.

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[831] 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.

4. What new incentives are being added to the CAFE program for MYs 2017–2025?

All of the CAFE compliance incentives discussed below are being proposed by EPA under its EPCA authority to calculate fuel economy levels for individual vehicles and for fleets. Because they are EPA proposals, we refer the reader to Section III for more details, as well as Chapter 5 of the draft Joint TSD for more information on the precise mechanics of the incentives, but we present them here in summary form so that the reader may understand more comprehensively what compliance options are proposed to be available for manufacturers for meeting the MYs 2017–2025 CAFE standards.

As mentioned above with regard to EPA's proposed changes for the calculation of dual-fueled automobile fuel economy for MYs 2020 and beyond, NHTSA is proposing to modify its own regulations to reflect the fact that these incentives may be used as part of the determination of a manufacturer's CAFE level. The requirements for determining the vehicle and fleet average performance for passenger cars and light trucks inclusive of the proposed incentives are defined in 49 CFR part 531 and 49 CFR part 533, respectively. Part 531.6(a) specifies that the average fuel economy of all passenger automobiles that are manufactured by a manufacturer in a model year shall be determined in accordance with procedures established by the Administrator of the Environmental Protection Agency under 49 U.S.C. 32904 of the Act and set forth in 40 CFR part 600. Part 533.6 (b) specifies that the average fuel economy of all non-passenger automobiles is required to be determined in accordance with the procedures established by the Administrator of the Environmental Protection Agency under 49 U.S.C. 32904 and set forth in 40 CFR part 600. Proposed changes to these sections would simply clarify that in model years 2017 to 2025, manufacturers may adjust their vehicle fuel economy performance values in accordance with 40 CFR Part 600 for improvements due to the new incentives. We seek comment on this proposed change.

a. ''Game Changing'' Technologies For Full Size Pick-Up Trucks

EPA is proposing to adopt two new types of incentives for improving the fuel economy performance of full size pickup trucks. The first incentive would provide a credit to manufacturers that employ significant quantities of hybridization on full size pickup trucks. The second incentive would provide a performance-based incentive for full size pickup trucks that achieve a significant reduction in fuel consumption as compared to the applicable fuel economy target for the vehicle in question. These incentives are proposed due to the significant difficulty of large trucks, including full size pickup trucks, in meeting CAFE standards while still maintaining the levels of utility to which consumers have become accustomed, which require higher payload and towing capabilities and greater cargo volumes than other light-duty vehicles. Technologies that provide substantial fuel economy benefits are often not attractive to manufacturers of large trucks due to these tradeoffs in utility purposes, and therefore have not been taken advantage of to the same extent as they have in other vehicle classes. The goal of these incentives is to facilitate the application of these ''game changing'' technologies for large pickups, both to save more fuel and to help provide a bridge for industry to more stringent light truck standards in MYs 2022–2025—as manufacturers gain experience with applying more fuel-saving technology for these vehicles and consumers become more accustomed to certain advanced technologies in pickup trucks, the agencies anticipate that higher CAFE levels will be more feasible for the fleet as a whole.[832] In the context of the CAFE program, these incentives would be used as an adjustment to a full size pickup truck's fuel economy performance. The same vehicle would not be allowed to receive an adjustment to its calculated fuel economy for both the hybridization incentive and the performance-based incentive, to avoid double-counting.

To accommodate the proposed changes to the CAFE program, NHTSA is proposing to adopt new definitions into regulation, 49 CFR part 523, ''Vehicle Classification.'' Part 523 was established by NHTSA to include its regulatory definitions for passenger automobiles and trucks and to guide the agency and manufacturers in classifying vehicles. NHTSA proposes to add a definition in Part 523.2 defining the characteristics that identify full size pickup trucks. NHTSA believes that the definition is needed to help explain to readers which characteristics of full size pickup truck make them eligible to gain fuel economy improvement values allowed after a manufacturer meets either a minimum penetration of hybridized technologies or has other technologies that significantly reduce fuel consumption. The proposed improvement would be available on a per-vehicle basis for mild and strong HEVs, as well as for other technologies that significantly improve the efficiency of full sized pickup trucks. The proposed definition would specify that trucks meeting an overall bed width and length as well as a minimum towing or payload capacity could be qualified as full size pickup trucks. NHTSA is also proposing to modify Part 523 to include definitions for mild and strong hybrid electric full size pickup trucks, and to include the references in Part 533 mentioned above.

i. Pickup Truck Hybridization

One proposed incentive would provide an adjustment to the fuel economy of a manufacturer's full size pickup trucks if the manufacturer employs certain defined hybrid technologies on defined significant quantities of its full size pickup trucks. After meeting the minimum production percentages, manufacturers would gain an adjustment to the fuel economy performance for each ''mild'' or ''strong'' hybrid full size pickup truck it produces. Manufacturers producing mild hybrid pickup trucks, as defined in Chapter 5 of the draft Joint TSD, would gain the incentive by applying mild hybrid technology to at least 30 percent of the company's full sized pickups produced in MY 2017, which would increase each year up to at least 80 percent of the company's full size pickups produced in MY 2021, after which point the adjustment is no longer applicable. For strong hybrids, also defined in Chapter 5 of the draft Joint TSD, the strong hybrid technology must be applied to at least 10 percent of a company's full sized pickup production in each year for model years 2017–2025. The fuel economy adjustment for each mild hybrid full size pickup would be a decrease in measured fuel consumption of 0.0011gal/mi; for each strong hybrid full size pickup, the decrease in measured fuel consumption would be 0.0023 gal/mi. These adjustments are consistent with the GHG credits under EPA's program of 10 g/mi CO_2 for mild hybrid pickups and 20 g/mi CO_2 for strong hybrid pickups. A manufacturer would then be allowed to adjust the fuel economy performance of its light truck fleet by converting the benefit gained from those improvements in accordance with the procedures specified in 40 CFR part 600.

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[832] NHTSA is not prohibited from considering this availability of this incentive in determining the maximum feasible levels of stringency for the light truck standards, because it is not one of the statutory flexibilities enumerated in 49 U.S.C. 32902(h).

ii. Performance-Based Incentive for Full-Size Pickups

Another proposed incentive for full size pickup trucks would provide an adjustment to the fuel economy of a manufacturer's full sized pickup truck if it achieves a fuel economy performance level significantly above the CAFE target for that footprint. This incentive recognizes that not all manufacturers may wish to pursue hybridization for their pickup trucks, but still rewards them for applying fuel-saving technologies above and beyond what they might otherwise do. The fuel economy adjustment for each full size pickup that exceeds its applicable footprint curve target by 15 percent would be a decrease in measured fuel consumption of 0.0011gal/mi; for each full size pickup that exceeds its applicable footprint curve target by 20 percent, the decrease in measured fuel consumption would be 0.0023 gal/mi. These adjustments are consistent with the GHG credits under EPA's program of 10 g/mi CO_2 and 20 g/mi CO_2, respectively, for beating the applicable CO_2 targets by 15 and 20 percent, respectively.

The 0.0011 gal/mi performance-based adjustment would be available for MYs 2017 to 2021, and a vehicle meeting the requirement in a given model year would continue to receive the credit until MY 2021—that is, the credit remains applicable to that vehicle model if the target is exceeded in only one model year—unless its fuel consumption increases. The 0.0023 gal/mi adjustment would be available for a maximum of 5 years within model years 2017–2025, provided the vehicle model's fuel consumption does not increase. As explained above for the hybrid incentive, a manufacturer would then be allowed to adjust the fuel economy performance of its light truck fleet by converting the benefit gained from those improvements in accordance with the procedures specified in 40 CFR Part 600.

We note that in today's analyses, the agencies have projected that PHEV technology is not available to large pickups. While it is technically possible to electrify such vehicles, there are tradeoffs in terms of cost, electric range, and utility that may reduce the appeal of the vehicle to a narrower market. Due to this consideration, the agencies have not considered giving credit to PHEVs for large pickup truck. However, the agencies seek comments on this and will give further consideration during the final rule. Also, the agencies note that under today's proposal, a PHEV that captures a sufficient proportion of braking energy could quality for the HEV adjustment; alternatively, a PHEV pickup achieving sufficiently high fuel economy and low CO_2 emission could qualify for a performance-based adjustment.

b. A/C Efficiency-Improving Technologies

Air conditioning (A/C) use places excess load on an engine, which results in additional fuel consumption. A number of methods related to the A/C system components and their controls can be used to improve A/C system efficiencies. Starting in MY 2017, EPA is proposing to allow manufacturers to include fuel consumption reductions resulting from the use of improved A/C systems in their CAFE calculations. This will more accurately account for achieved real-world fuel economy improvements due to improved A/C technologies, and better fulfill EPCA's overarching purpose of energy conservation. Manufacturers would not be allowed to claim CAFE-related benefits for reducing A/C leakage or switching to an A/C refrigerant with a lower global warming potential, because while these improvements reduce GHGs consistent with the purpose of the CAA, they do not improve fuel economy and thus are not relevant to the CAFE program.

The improvements that manufacturers would likely use to increase A/C efficiency would focus primarily, but not exclusively, on the compressor, electric motor controls, and system controls which reduce load on the A/C system (such as reduced ''reheat'' of the cooled air and increased use of re-circulated cabin air).

Fuel consumption improvement values for CAFE resulting from A/C efficiency improvements would be quantified using a two-step process, the same as for the related CO_2 credits for EPA's GHG program. First, the vehicle with the improved A/C system would be tested in accordance with EPA testing guidelines, and compared with the baseline fuel consumption value for that vehicle. Second, the difference between the baseline fuel consumption value and the value for the vehicle with improved A/C technologies would be calculated, which would determine the fuel consumption improvement value.

In the GHG program for MYs 2012 to 2016, EPA finalized the idle test method for measuring CO_2reductions from improved AC systems. The idle test method measures CO_2 in grams per minute (g/min) while the vehicle is stationary and idling. For MYs 2017–2025, EPA is proposing that a new test called ''A/C 17'' replace the idle test to measure A/C related CO_2emissions reductions. Some aspects of the AC17 test are still being developed and improved, but the basic procedure is sufficiently complete for EPA to propose it as a reporting option alternative to the Idle Test threshold in 2014, and a replacement for the Idle Test in 2017, as a prerequisite for generating Efficiency Credits. Manufacturers will use this test to measure A/C-related CO_2 emissions from vehicles with improved A/C systems, which would be translated to fuel consumption to establish the ratio between the baseline vehicle and the improved-A/C vehicle to determine the value of the fuel consumption improvement. The A/C 17 test procedure is described briefly below.

i. What is the proposed testing approach?

The A/C 17 test is a more extensive test than the idle test and has four elements, including two drive cycles, US03 and the highway fuel economy cycle, which capture steady state and transient operating conditions. It also includes a solar soak period to measure the energy required to cool down a car that has been sitting in the sun, as well as a pre-conditioning cycle. The A/C 17 test cycle will be able to capture improvements in all areas related to efficient operation of a vehicle's A/C system. The A/C 17 test cycle measures CO_2 emissions in grams per mile (g/mi), and requires that baseline emissions be measured in addition to emissions from vehicles with improved A/C systems. EPA is taking comment on whether the A/C 17 test is appropriate for estimating the effectiveness of new efficiency-improving A/C technologies.

ii. How are fuel consumption improvement values then estimated?

Manufacturers would run the A/C 17 test procedure on each vehicle platform that incorporates the new technologies, with the A/C system off and then on, and then report these test results to the EPA. In addition to reporting the test results, EPA will require that manufacturers provide detailed vehicle and A/C system information for each vehicle tested (*e.g.* vehicle class, model type, curb weight, engine size, transmission type, interior volume, climate control type, refrigerant type, compressor type, and evaporator/condenser characteristics). For vehicle models which manufacturers are seeking to earn A/C related fuel consumption improvement values, the A/C 17 test would be run to validate that the performance and efficiency of a vehicle's A/C technology is commensurate to the level of improvement value that is being earned. To determine whether the efficiency improvements of these technologies are being realized, the results of an A/C 17 test performed on a new vehicle model will be compared to a ''baseline'' vehicle which does not incorporate the efficiency-improving technologies. The baseline vehicle is defined as one with characteristics which are similar to the new vehicle, only it is not equipped with efficiency-improving technologies (or they are de-activated).

Manufacturers then take the results of the A/C 17 test and access a credit menu (shown in the table below) to determine A/C related fuel consumption improvement values. The maximum value possible is limited to 0.000563 gal/mi for cars and 0.000810 gal/mi for trucks. As an example, a manufacturer uses two technologies listed in the table, for which the combined improvement value equals 0.000282 gal/mi. If the results of the A/C 17 tests for the baseline and vehicle with improved A/C system demonstrates a 0.000282 gal/mi improvement, then the full fuel consumption improvement value for those two technologies can be taken. If the A/C 17 test result falls short of the improvement value for the two technologies, then a fraction of the improvement value may be counted in CAFE calculations. The improvement value fraction is calculated in the following way: The A/C 17 test result for both the baseline vehicle and the vehicle with an improved A/C system are measured. The difference in the test result of the baseline and the improved vehicle is divided by the test result of the baseline vehicle. This fraction is multiplied by the fuel consumption improvement value for the specific technologies. Thus, if the A/C 17 test yielded an improvement equal to ⅔ of the summed values listed in the table, then ⅔ of the summed fuel consumption improvement values can be counted.

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Table IV-116. Efficiency Improving A/C Technologies and Improvement Values

Technology Description	A/C Fuel Consumption Reduction (% of total A/C improvement)	Car A/C Fuel Efficiency Improvement Value (gals/mi)	Truck A/C Fuel Efficiency Improvement Value (gals/mi)
Reduced reheat, with externally-controlled, variable-displacement compressor	30%	0.000169 (*30% of 5.0 g/mi impact*)	0.000248 (*30% of 7.2 g/mi impact*)
Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable displacement compressor	20%	0.000113	0.000158
Default to recirculated air with closed-loop control of the air supply (sensor feedback to control interior air quality) whenever the outside ambient temperature is 75 °F or higher	30%	0.000169	0.000248

Default to recirculated air with open-loop control of the air supply (no sensor feedback) whenever the outside ambient temperature is 75 °F or higher	20%	0.000113	0.000156
Blower motor control which limit wasted electrical energy (e.g. pulsewidth modulated power controller)	15%	0.000090	0.000124
Internal heat exchanger (or suction line heat exchanger)	20%	0.000113	0.000156

As stated above, if more than one technology is utilized by a manufacturer for a given vehicle model, the A/C fuel consumption improvement values can be added, but the maximum value possible is limited to 0.000563 gal/mi for cars and 0.000810 gal/mi for trucks. More A/C related fuel consumption improvement values are discussed in the off-cycle credits section of this chapter. The approach for determining the manufacturers' adjusted fleet fuel economy performance due to improvements in A/C efficiency is described in 40 CFR Part 600.

The agencies seek comment on the proposal to allow manufacturers to estimate fuel consumption reductions from the use of A/C efficiency-improving technologies and to apply these reductions to their CAFE calculations.

c. Off-Cycle Technologies and Adjustments

For MYs 2012–2016, EPA provided an optional credit for new and innovative "off-cycle" technologies that reduce vehicle CO_2 emissions, but for which the CO_2 reduction benefits are not recognized under the 2-cycle test procedure used to determine compliance with the fleet average standards. The off-cycle credit option was intended to encourage the introduction of off-cycle technologies that achieve real-world benefits. The off-cycle credits were to be determined using the 5-cycle methodology currently used to determine fuel economy label values, which EPA established 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. A manufacturer must determine whether the benefit of the technology could be captured using the 5-cycle test; if this determination is affirmative, the manufacture must follow the 5-cycle procedures to determine the CO_2 reductions. 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. The demonstration program must be robust, verifiable, and capable of demonstrating the real-world emissions benefit of the technology with strong statistical significance. The non-5-cycle approach includes an opportunity for public comment as part of the approval process.

EPA has been encouraged by automakers' interest in off-cycle credits since the program was finalized and believes that extending the program to MY 2017 and beyond may continue to encourage automakers to invest in off-cycle technologies that could have the benefit of realizing additional reductions in the light-duty fleet over the longer-term. Therefore, EPA is proposing to extend the off-cycle credits program to 2017 and later model years. EPA is also proposing, under its EPCA authority, to make available a comparable off-cycle technology incentive under the CAFE program beginning in MY 2017. However, instead of manufacturers gaining credits as done under the GHG program, a direct adjustment would be made to the manufacturer's fuel economy performance value.

Starting with MY 2017, manufacturers may generate fuel economy improvements by applying technologies listed on the pre-defined and pre-approved technology list provided in Table IV–117. These credits would be verified and approved as part of certification, with no prior approval process needed. This new option should significantly simplify the program for manufacturers and provide certainty that improvement values may be generated through the use of pre-approved technologies. For improvements from technologies not on the pre-defined list, EPA is proposing to clarify the step-by-step application process for demonstration of fuel consumption reductions and approval.

Table IV-117. Off-cycle technologies and proposed improvement values for passenger cars and light trucks

Technology	Improvement value for passenger cars(gal/mi)	Improvement value for light trucks (gal/mi)
High Efficiency Exterior Lighting	0.000124	0.000124
Engine Heat Recovery	0.000778	0.000778
Solar Roof Panels	0.000338	0.000338
Active Grill Shutters	0.000113	0.000113
Active Suspension Lowering		
Engine Start-Stop	0.000326	0.000506
Electric Heater Circulation Pump	0.000123	0.000169
Active Transmission Warm-Up	0.000203	0.000203
Active Engine Warm-Up	0.000203	0.000203
Solar Control	0.000338	0.000338
High Efficiency Exterior Lighting	0.0001	0.0001
Engine Heat Recovery	0.0001	0.0001
Solar Roof Panels	0.0003	0.0003
Active Grill Shutters	0.0001	0.0001
Active Suspension Lowering		
Engine Start-Stop	0.0003	0.0005
Electric Heater Circulation Pump	0.0001	0.0002
Active Transmission Warm-Up	0.0002	0.0002
Active Engine Warm-Up		
Solar Control	0.0002	0.0002

An example of technologies that could be used to generate off-cycle improvements are those that reduce electrical load and as a result, fuel consumption. The 2-cycle test does not require that all electrical components be turned on during testing. Headlights, for example, are always turned off during testing. Turning the headlights on during normal driving will add an additional load on the vehicle's electrical system and will affect fuel economy. More efficient electrical systems or technologies that offset electrical loads will have a real-world impact on fuel economy but are not captured in the 2-cycle test. Therefore, technologies that reduce or offset electrical loads related to the operation or safety of the vehicle should merit consideration for off-cycle improvements. Reducing the electrical load on a vehicle by 100W will result in an average of 0.000337 gallons/mile reduction in fuel consumption over the course of a 2-cycle test, or 0.00042 gallons/mile over a 5-cycle test. To determine the off-cycle benefit of certain 100W electrical load reduction technologies, the benefit of the technology on the 2-cycle test is subtracted from the benefit of the technology on the 5-cycle test. This determines the actual benefit of the technology not realized in the 2-cycle test methodology, which in this case is 0.000416 gal/mi minus 0.000337 gal/mi, or 0.000078 gal/mi. This method will avoid double-counting the benefit of the electrical load reduction, which is already counted on the 2-cycle test.

Regardless of whether the off-cycle technology fuel consumption benefit is obtained from the table (columns 2 or 3) above or is based on an approved testing protocol as indicated in the preceding example, under the CAFE program the benefit or credit is treated as an adjustment and subtracted from the subject vehicle's fuel consumption performance value determined from the required CAFE program 2-cycle test results. A manufacturer would then be allowed to adjust the fuel economy performance of its fleets by converting the benefit gained from those improvements in accordance with the procedures specified in 40 CFR Part 600.

Since one purpose of the off-cycle improvement incentive is to encourage market penetration of the technologies (see 75 FR at 25438), EPA is proposing to require minimum penetration rates for non-hybrid based listed technologies as a condition for generating improvements from the list as a way to further encourage their widespread adoption by MY 2017 and later. At the end of the model year for which the off-cycle improvement is claimed, manufacturers would need to demonstrate that production of vehicles equipped with the technologies for that model year exceeded the percentage thresholds in order to receive the listed improvement. EPA proposes to set the threshold at 10 percent of a manufacturer's overall combined car and light truck production for all technologies not specific to HEVs. 10 percent would seem to be an appropriate threshold as it would encourage manufacturers to develop technologies for use on larger volume models and bring the technologies into the mainstream. For solar roof panels and electric heat circulation pumps, which are HEV-specific, EPA is not proposing a minimum penetration rate threshold for credit generation. Hybrids may be a small subset of a manufacturer's fleet, less than 10 percent in some cases, and EPA does not believe that establishing a threshold for hybrid-based technologies would be useful and could unnecessarily complicate the introduction of these technologies. The agencies request comments on applying this type of threshold, the appropriateness of 10 percent as the threshold for listed technologies that are not HEV-specific, and the proposed treatment of hybrid-based technologies.

Because the proposed improvements are based on limited data, however, and because some uncertainty is introduced when credits are provided based on a general assessment of off-cycle performance as opposed to testing on the individual vehicle models, as part of the incentive EPA is proposing to cap the amount of improvement a manufacturer could generate using the above list to 0.001125 gal/mile per year on a combined car and truck fleet-wide average basis. The cap would not apply on a vehicle model basis, allowing manufacturers the flexibility to focus off-cycle technologies on certain vehicle models and generate improvements for that vehicle model in excess of 0.001125 gal/mile. If manufacturers wish to generate improvements in excess of the 0.001125 gal/mile limit using listed technologies, they could do so by generating necessary data and going through the approval process.

For more details on the testing protocols used for determining off-cycle technology benefits and the step-by-step EPA review and approval process, refer to Section III.C.5.b.iii and v. The approach for determining a manufacturer's adjusted fuel economy performance for off-cycle technologies is described in 40 CFR Part 600. NHTSA also proposes to incorporate references in Part 531.6 and 533.6 to allow manufacturers to adjust their fleet performance for off-cycle technologies as described above.

5. Other CAFE Enforcement Issues

a. Electronic Reporting

Pursuant to 49 CFR part 537, manufacturers submit pre-model year fuel economy reports to NHTSA by December 31st prior to the model year, and mid-model year reports by July 31st of the model year. Manufacturers may also provide supplemental reports whenever changes are needed to a previously submitted CAFE report. NHTSA receives both non-confidential and confidential versions of reports, the basic difference being the inclusion of projected upcoming production sales volumes in reports seeking confidentiality. Manufacturers must include a request for confidentiality, in accordance with 49 CFR part 512, along with the report for which confidential treatment is sought.[833] Manufacturers may submit reports either in paper form or electronically to a secure email address, *cafe@dot.gov*, that allows for the safe handling of confidential materials. All electronic submissions submitted to the CAFE email must be provided in a pdf format. NHTSA added electronic reporting to the 2012–2016 CAFE rule as an approach to simplify reporting for manufacturers and NHTSA alike. Currently, most manufacturers submit both electronic and paper reports.[834]

NHTSA is proposing to modify its reporting requirements to receive all CAFE reports in electronic format, thereby eliminating the requirement for paper submissions. In the revised requirements, a manufacturer could either submit its reports on a CD–ROM or through the existing email procedures. Under the proposal, the contents of the CD must include the manufacturer's request for confidentiality, the cover letter, and any other supporting documents in a pdf format. Any data included in the report must be provided in a Microsoft Excel spreadsheet format. The same approach is also proposed for submitting information by email. NHTSA emphasizes that submitting reports to the CAFE email address is completely voluntary, but if the option is selected, the manufacturer must follow the normal deadline dates as specified in 49 CFR 537.5. NHTSA believes that receiving CAFE data through electronic reports would be a significant improvement, improving the quality of its CAFE data, simplifying enforcement activities (*e.g.,* auditing the data), and helping to expedite the tracking and reporting of CAFE credits. The agency also plans to eventually develop an XML schema for submitting CAFE reports electronically that will available through its Web site. Ultimately, the XML schema would be used as part of the new database system NHTSA plans to construct in the future to store its

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[833] Pursuant to § 537.12, NHTSA's Office of Chief Counsel normally grants confidentiality to reports with projected production sales volumes until after the model year ends.

[834] For model year 2011, NHTSA received electronic mid-model year reports from 12 manufacturers. Each of the manufacturers also provided hardcopy reports.

CAFE data. NHTSA seeks comments on the appropriateness of ending paper submissions, as well as information on any other electronic formats that should be considered for submissions.

b. Reporting of How a Vehicle Is Classified as a Light Truck

As part of the reporting provisions in 49 CFR part 537, NHTSA requires manufacturers to provide information on some, but not all, of the functions and features that a manufacturer uses to classify an automobile as a light truck. The required data is distributed throughout the report, making it difficult for the agency to clearly and easily determine exactly what functions or features a manufacturer is actually using to make this determination. For example, related to the functions specified in 49 CFR 523.5(a) and discussed in Section IV.H above, manufacturers must provide the vehicles' passenger and cargo carrying volumes,[835] and identify whether their vehicles are equipped with three rows of seats that can be removed or folded flat for expanded cargo carrying purposes or if the vehicle includes temporary living quarters.[836] Manufacturers are not required to identify whether the vehicles can transport more than 10 persons or if the vehicles are equipped with an open cargo bed. Related to the functions specified in Section 523.5(b), for each model type classified as an automobile capable of off-highway operation, manufacturers are required to provide the five suspension parameter measurements and indicate the existence of 4-wheel drive,[837] but they are not required to identify a vehicle's GVWR, which is necessary for off-road determination when the vehicle is not equipped with 4-wheel drive. NHTSA proposes to eliminate the language requesting vehicle attribute information in Sections 537.7(c)(4)(xvi)(A)(3) to (6) and (B)(3) to (6) and to relocate that language into a revised Section 537.7(c)(5) to include identification of all the functions and features that can be used by a manufacturer for making a light truck classification determination. By incorporating all the requirements into one section, the agency believes the classification process will become significantly more accurate and efficient. NHTSA seeks comment on this proposed change.

c. Base Tire Definition

Beginning in model year 2011, manufacturers of light trucks and passenger cars are required to use vehicle footprint to determine the CAFE standards applicable to each of their vehicle fleets. To determine the appropriate footprint-based standards, a manufacturer must calculate each vehicle's footprint value, which is the product of the vehicle track width and wheelbase dimensions. Vehicle track width dimensions are determined with a vehicle equipped with ''base tires,'' [838] which NHTSA defines as the tire specified as standard equipment by a manufacturer on each vehicle configuration of a model type.

NHTSA is concerned that the definition for ''base tire'' is insufficiently descriptive, and may lead to inconsistencies among manufacturers' base tire selections. In meetings relating to CAFE enforcement, manufacturers have stated that various approaches in selecting base tires exist due to differences in the tires considered as standard equipment.[839] Standard equipment is defined by EPA regulation as those features or equipment which are marketed on a vehicle over which the purchaser can exercise no choice,[840] but NHTSA regulations have no comparable definition. NHTSA considered whether adding a definition for ''standard equipment'' would clarify and strengthen the NHTSA regulations, but some manufacturers indicated that the definition of standard equipment provided by EPA does not effectively prevent differences in their interpretations. Some manufacturers, for example, view the base tire as the tire equipped as standard equipment for each trim level of a model type, as each trim level has standard equipment over which the purchaser cannot exercise a choice. This view can allow multiple base tires and footprint values within each model type: A manufacturer may have two vehicle configurations for a particular model type, with each configuration having three trim levels with different standard tires sizes. In that scenario, the model type could have 6 different trim level vehicle configurations, each having three or more unique footprint values with slightly different targets. The additional target fuel economy values could allow the manufacturer to reduce its required fleet standard despite a vehicle model type not having any inherent differences in physical feature between vehicle configurations other than the tire sizes. Other manufacturers, in contrast, avoid designating multiple base tires and choose the standard tire equipped on the most basic vehicle configuration of a model type, even if the most basic vehicle is rarely actually sold. In this scenario, the tires being used to derive a manufacturer fleet standard are not the same size tire equipped on the representative number of vehicles being sold. Yet others designate the base tire as the tire most commonly installed on a model type having the highest production volume. This approach most realistically reflects the manufacturer's sales production fleet.

To attempt to reconcile the varied approaches for designating base tires, NHTSA is proposing to modify its definition for base tire in 49 CFR 523.2. The proposed modification changes the definition of the base tire by dropping the reference to ''standard equipment'' and adding a reference to the ''the tire installed by the vehicle manufacturer that is used on the highest production sales volume of vehicles within the configuration.'' This modification should ensure that the tires installed on the vehicle most commonly sold within a vehicle configuration become the basis for setting a manufacturer's fuel economy standards. It is NHTSA's goal that a change to the definition of base tire for purposes of CAFE will help to reduce inconsistencies and confusion for both the agency and the manufacturers. NHTSA seeks comments on this approach, as well as other approaches that could be used for selecting the base tire(s).

d. Confirming Target and Fleet Standards

NHTSA requires manufacturers to provide reports containing fleet and model type CAFE standards and projections of expected performance results for each model year.[841] The footprint, track width and wheelbase values are provided for each vehicle configuration within the model types making up the manufacturer's fleets, along with other model type-specific information. Because this information is organized by vehicle configuration, instead of by each vehicle with a unique model type and footprint combination, it is not in the format needed to calculate performance standards. EPA, in contrast, requires manufacturers to provide all of the information necessary

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[835] 49 CFR 537.7(c)(4)(xvi)(B).

[836] 49 CFR 537.7(c)(4)(xvii) and (xviii).

[837] 49 CFR 537.7(c)(5).

[838] See 49 CFR 523.2.

[839] NHTSA has confirmed these differences in approach for the designating base tire exist through review of manufacturer-submitted CAFE reports.

[840] In the EPA regulation 40 CFR 600.002–08, standard equipment means those features or equipment which are marketed on a vehicle over which the purchaser can exercise no choice.

[841] 49 CFR part 537.

to calculate footprint values and CAFE standards. EPA provides an additional calculator (in the form of an Excel spreadsheet), which all manufacturers use and submit as part of their end-of-the-year reports, which includes the appropriate breakdown of footprint values for calculating standards.

Since NHTSA only requires a breakdown of footprint values by vehicle configurations, instead of by each unique model type and footprint combination, NHTSA is currently unable to verify manufacturers' reported target standards. By standardizing with EPA's requirements for reported data, NHTSA would both simplify manufacturer reporting efforts and gain the necessary information for calculating attribute-based CAFE standards. Therefore, NHTSA is proposing to eliminate the language requesting information in § 537.7(c)(4)((xvi)(A)(*3*) through (*6*) and (B)(*3*) through (*6*), and to relocate that language into a revised § 537.7(b)(3).

NHTSA requests comment on this proposed change.

J. Regulatory Notices and Analyses

1. Executive Order 12866, Executive Order 13563, and DOT Regulatory Policies and Procedures

Executive Order 12866, ''Regulatory Planning and Review'' (58 FR 51735, Oct. 4, 1993), as amended by Executive Order 13563, ''Improving Regulation and Regulatory Review'' (76 FR 3821, Jan. 21, 2011), provides for making determinations whether a regulatory action is ''significant'' and therefore subject to OMB review and to the requirements of the Executive Order. The Order defines a ''significant regulatory action'' as one that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or Tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

The rulemaking proposed in this NPRM will be economically significant if adopted. Accordingly, OMB reviewed it under Executive Order 12866. The rule, if adopted, would also be significant within the meaning of the Department of Transportation's Regulatory Policies and Procedures.

The benefits and costs of this proposal are described above. Because the proposed rule would, if adopted, be economically significant under both the Department of Transportation's procedures and OMB guidelines, the agency has prepared a Preliminary Regulatory Impact Analysis (PRIA) and placed it in the docket and on the agency's Web site. Further, pursuant to Circular A–4, we have prepared a formal probabilistic uncertainty analysis for this proposal. The circular requires such an analysis for complex rules where there are large, multiple uncertainties whose analysis raises technical challenges or where effects cascade and where the impacts of the rule exceed $1 billion. This proposal meets these criteria on all counts.

2. National Environmental Policy Act

Concurrently with this NPRM, NHTSA is releasing a Draft Environmental Impact Statement (Draft EIS), pursuant to the National Environmental Policy Act, 42 U.S.C. 4321–4347, and implementing regulations issued by the Council on Environmental Quality (CEQ), 40 CFR part 1500, and NHTSA, 49 CFR part 520. NHTSA prepared the Draft EIS to analyze and disclose the potential environmental impacts of the proposed CAFE standards and a range of alternatives. The Draft EIS analyzes direct, indirect, and cumulative impacts and analyzes impacts in proportion to their significance.

Because of the link between the transportation sector and GHG emissions, the Draft EIS considers the possible impacts on climate and global climate change in the analysis of the effects of these proposed CAFE standards. The Draft EIS also describes potential environmental impacts to a variety of resources. Resources that may be affected by the proposed action and alternatives include water resources, biological resources, land use and development, safety, hazardous materials and regulated wastes, noise, socioeconomics, fuel and energy use, air quality, and environmental justice. These resource areas are assessed qualitatively in the Draft EIS.

For additional information on NHTSA's NEPA analysis, please see the Draft EIS.

3. Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.,* as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996), whenever an agency is required to publish a notice of rulemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the effect of the rule on small entities (*i.e.,* small businesses, small organizations, and small governmental jurisdictions). The Small Business Administration's regulations at 13 CFR part 121 define a small business, in part, as a business entity ''which operates primarily within the United States.'' 13 CFR 121.105(a). No regulatory flexibility analysis is required if the head of an agency certifies the rule will not have a significant economic impact of a substantial number of small entities.

I certify that the proposed rule would not have a significant economic impact on a substantial number of small entities. The following is NHTSA's statement providing the factual basis for the certification (5 U.S.C. 605(b)).

If adopted, the proposal would directly affect nineteen large single stage motor vehicle manufacturers.[842] Based on our preliminary assessment, the proposal would also affect a total of about 21 entities that fit the Small Business Administration's criteria for a small business. 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. There are about 4 small manufacturers, including 3 electric vehicle manufacturers, 8 independent commercial importers, and 9 alternative fuel vehicle converters in the passenger car and light truck market which are small businesses. We believe that the rulemaking would not have a significant economic impact on these small vehicle manufacturers because under 49 CFR part 525, passenger car manufacturers making fewer than 10,000 vehicles per year can petition NHTSA to have alternative standards set for those manufacturers. Manufacturers that produce only electric vehicles, or that modify vehicles to make them electric or some other kind of dedicated alternative fuel vehicle, will have average fuel economy values far beyond

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[842] BMW, Daimler (Mercedes), Fiat/Chrysler (which also includes Ferrari and Maserati for CAFE compliance purposes), Ford, Geely (Volvo), General Motors, Honda, Hyundai, Kia, Lotus, Mazda, Mitsubishi, Nissan, Porsche, Subaru, Suzuki, Tata (Jaguar Land Rover), Toyota, and Volkswagen/Audi.

those proposed today, so we would not expect them to need a petition for relief. A number of other small vehicle manufacturers already petition the agency for relief under Part 525. If the standard is raised, it has no meaningful impact on those manufacturers, because they are expected to still go through the same process to petition for relief. Given that there is already a mechanism for handling small businesses, which is the purpose of the Regulatory Flexibility Act, a regulatory flexibility analysis was not prepared, but we welcome comments on this issue for the final rule.

4. Executive Order 13132 (Federalism)

Executive Order 13132 requires NHTSA to develop an accountable process to ensure ''meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications.''[843] The Order defines the term ''Policies that have federalism implications'' to include regulations that have ''substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government.'' Under the Order, NHTSA may not issue a regulation that has federalism implications, that imposes substantial direct compliance costs, and that is not required by statute, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by State and local governments, or NHTSA consults with State and local officials early in the process of developing the proposed regulation.

NHTSA solicits comment on this proposed action from State and local officials. The agency believes that it is unnecessary to address the question of preemption further at this time because of the consistent and coordinated Federal standards that would apply nationally under the proposed National Program.

5. Executive Order 12988 (Civil Justice Reform)

Pursuant to Executive Order 12988, ''Civil Justice Reform,''[844] NHTSA has considered whether this rulemaking would have any retroactive effect. This proposed rule does not have any retroactive effect.

6. Unfunded Mandates Reform Act

Section 202 of the Unfunded Mandates Reform Act of 1995 (UMRA) requires Federal agencies to prepare a written assessment of the costs, benefits, and other effects of a proposed or final rule that includes a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of more than $100 million in any one year (adjusted for inflation with base year of 1995). Adjusting this amount by the implicit gross domestic product price deflator for 2009 results in $134 million (109.729/81.606 = 1.34). 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 of why that alternative was not adopted.

This proposed rule will not result in the expenditure by State, local, or tribal governments, in the aggregate, of more than $134 million annually, but it will result in the expenditure of that magnitude by vehicle manufacturers and/or their suppliers. In developing this proposal, NHTSA considered a variety of alternative average fuel economy standards lower and higher than those proposed. NHTSA is statutorily required to set standards at the maximum feasible level achievable by manufacturers based on its consideration and balancing of relevant factors, and has tentatively concluded that the proposed fuel economy standards are the maximum feasible standards for the passenger car and light truck fleets for MYs 2017–2025 in light of the statutory considerations.

7. 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.

8. Executive Order 13045

Executive Order 13045[845] 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 5 of NHTSA's DEIS notes that breathing PM can cause respiratory ailments, heart attack, and arrhythmias (Dockery *et al.* 1993, Samet *et al.* 2000, Pope *et al.* 1995, 2002, 2004, Pope and Dockery 2006, Dominici *et al.* 2006, Laden *et al.* 2006, all in Ebi *et al.* 2008). Populations at greatest risk could include children, the elderly, and those with heart and lung disease, diabetes (Ebi *et al.* 2008), and high blood pressure (Künzli *et al.* 2005, in Ebi *et al.* 2008). Chronic exposure to PM could decrease lifespan by 1 to 3 years (Pope 2000, in American Lung Association 2008). Increasing PM concentrations are expected to have a measurable adverse impact on human health (Confalonieri *et al.* 2007).

Additionally, the DEIS notes that substantial morbidity and childhood mortality has been linked to water- and food-borne diseases. Climate change is projected to alter temperature and the hydrologic cycle through changes in precipitation, evaporation, transpiration, and water storage. These changes, in turn, potentially affect water-borne and food-borne diseases, such as salmonellosis, campylobacter, leptospirosis, and pathogenic species of vibrio. They also have a direct impact on surface water availability and water quality. It has been estimated that more than 1 billion people in 2002 did not have access to adequate clean water (McMichael *et al.* 2003, in Epstein *et al.* 2006). Increased temperatures, greater evaporation, and heavy rain events have been associated with adverse impacts on drinking water through increased waterborne diseases, algal blooms, and toxins (Chorus and Bartram 1999, Levin *et al.* 2002, Johnson and Murphy 2004, all in Epstein *et al.* 2006). A seasonal signature has been associated with water-borne disease outbreaks (EPA 2009b). In the United States, 68 percent of all water-borne diseases between 1948 and 1994 were observed after

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[843] 64 FR 43255 (Aug. 10, 1999).

[844] 61 FR 4729 (Feb. 7, 1996).

[845] 62 FR 19885 (Apr. 23, 1997).

heavy rainfall events (Curriero *et al.* 2001a, in Epstein *et al.* 2006).

Climate change could further impact a pathogen by directly affecting its lifecycle (Ebi *et al. 2*008). The global increase in the frequency, intensity, and duration of red tides could be linked to local impacts already associated with climate change (Harvell *et al.* 1999, in Epstein *et al.* 2006); toxins associated with red tide directly affect the nervous system (Epstein *et al.* 2006).

Many people do not report or seek medical attention for their ailments of water-borne or food-borne diseases; hence, the number of actual cases with these diseases is greater than clinical records demonstrate (Mead *et al.* 1999, in Ebi *et al.* 2008). Many of the gastrointestinal diseases associated with water-borne and food-borne diseases can be self-limiting; however, vulnerable populations include young children, those with a compromised immune system, and the elderly.

Thus, as detailed in the DEIS, NHTSA has evaluated the environmental, health, and safety effects of the proposed rule on children. The DEIS also explains why the proposed regulation is preferable to other potentially effective and reasonably foreseeable alternatives considered by the agency.

9. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act (NTTAA) requires NHTSA 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.[846]

Voluntary consensus standards are technical standards developed or adopted by voluntary consensus standards bodies. Technical standards are defined by the NTTAA as ''performance-based or design-specific technical specification and related management systems practices.'' They pertain to ''products and processes, such as size, strength, or technical performance of a product, process or material.''

Examples of organizations generally regarded as voluntary consensus standards bodies include the American Society for Testing and Materials (ASTM), the Society of Automotive Engineers (SAE), and the American National Standards Institute (ANSI). If NHTSA does not use available and potentially applicable voluntary consensus standards, we are required by the Act to provide Congress, through OMB, an explanation of the reasons for not using such standards.

There are currently no voluntary consensus standards relevant to today's proposed CAFE standards.

10. Executive Order 13211

Executive Order 13211[847] 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 (OIRA) as a significant regulatory action. If the regulatory action meets either criterion, we must evaluate the adverse energy effects of the proposed rule and explain why the proposed regulation is preferable to other potentially effective and reasonably foreseeable alternatives considered by us.

The proposed rule seeks to establish passenger car and light truck fuel economy standards that will reduce the consumption of petroleum and will not have any adverse energy effects. Accordingly, this proposed rulemaking action is not designated as a significant energy action.

11. Department of Energy Review

In accordance with 49 U.S.C. 32902(j)(1), we submitted this proposed rule to the Department of Energy for review. That Department did not make any comments that we have not addressed.

12. Plain Language

Executive Order 12866 requires each agency to write all rules in plain language. Application of the principles of plain language includes consideration of the following questions:

- Have we organized the material to suit the public's needs?
- Are the requirements in the rule clearly stated?
- Does the rule contain technical jargon that isn't clear?
- Would a different format (grouping and order of sections, use of headings, paragraphing) make the rule easier to understand?
- Would more (but shorter) sections be better?
- Could we improve clarity by adding tables, lists, or diagrams?
- What else could we do to make the rule easier to understand?

If you have any responses to these questions, please include them in your comments on this proposal.

13. 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 Parts 523, 531, and 533

Fuel Economy.

49 CFR Parts 536 and 537

Fuel economy, Reporting and recordkeeping requirements.

Environmental Protection Agency

40 CFR Chapter I

For the reasons set forth in the preamble, the Environmental Protection Agency proposes to amend parts 85, 86, and 600 of title 40, Chapter I of the Code of Federal Regulations as follows:

PART 85—CONTROL OF AIR POLLUTION FROM MOBILE SOURCES

1. The authority citation for part 86 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

Subpart F—[Amended]

2. Section 85.525 is amended by adding paragraph (a)(2)(i)(D) to read as follows:

§ 85.525 Applicable standards.

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(a) * * *

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[846] 15 U.S.C. 272.

[847] 66 FR 28355 (May 22, 2001).

(2) * * *

(i) * * *

(D) Optionally, compliance with greenhouse gas emission requirements may be demonstrated by comparing the sum of CH_4 plus N_2O plus CO_2 emissions from the before fuel conversion FTP results to the after fuel conversion FTP results. This comparison is based on test results from the emission data vehicle (EDV) from the conversion test group at issue. The summation of the post fuel conversion test results must be lower than the summation of the before conversion greenhouse gas emission results. CO_2 emissions are calculated as specified in 40 CFR 600.113–12. CH_4 and N_2O emissions, before and after fuel conversion, are adjusted by applying multiplicative factors of 25 and 298, respectively, to account for their increased global warming potential. If statements of compliance are applicable and accepted in lieu of measuring N_2O, as permitted by EPA regulation, the comparison of the greenhouse gas results also need not measure or include N_2O in the before and after emission comparisons.

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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 revised to read as follows:

§ 86.1 Reference materials.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Environmental Protection Agency must publish a notice of the change in the **Federal Register** and the material must be available to the public. All approved material is available for inspection at U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave. NW., Room B102, EPA West Building, Washington, DC 20460, (202) 202–1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call (202) 741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html* and is available from the sources listed below:

(b) American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA, 19428–2959, (610) 832–9585, *http://www.astm.org/*.

(1) ASTM D 975–04c, Standard Specification for Diesel Fuel Oils, IBR approved for §§ 86.1910, 86.213–11.

(2) ASTM D1945–91, Standard Test Method for Analysis of Natural Gas by Gas Chromatography, IBR approved for §§ 86.113–94, 86.513–94, 86.1213–94, 86.1313–94.

(3) ASTM D2163–91, Standard Test Method for Analysis of Liquefied Petroleum (LP) Gases and Propane Concentrates by Gas Chromatography, IBR approved for §§ 86.113–94, 86.1213–94, 86.1313–94.

(4) ASTM D2986–95a, Reapproved 1999, Standard Practice for Evaluation of Air Assay Media by the Monodisperse DOP (Dioctyl Phthalate) Smoke Test, IBR approved for §§ 86.1310–2007.

(5) ASTM D5186–91, Standard Test Method for Determination of Aromatic Content of Diesel Fuels by Supercritical Fluid Chromatography, IBR approved for §§ 86.113–07, 86.1313–91, 86.1313–94, 86.1313–98, 1313–2007.

(6) ASTM E29–67, Reapproved 1980, Standard Recommended Practice for Indicating Which Places of Figures Are To Be Considered Significant in Specified Limiting Values, IBR approved for § 86.1105–87.

(7) ASTM E29–90, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications, IBR approved for §§ 86.609–84, 86.609–96, 86.609–97, 86.609–98, 86.1009–84, 86.1009–96, 86.1442, 86.1708–99, 86.1709–99, 86.1710–99, 86.1728–99.

(8) ASTM E29–93a, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications, IBR approved for §§ 86.098–15, 86.004–15, 86.007–11, 86.007–15, 86.1803–01, 86.1823–01, 86.1824–01, 86.1825–01, 86.1837–01.

(9) ASTM F1471–93, Standard Test Method for Air Cleaning Performance of a High-Efficiency Particulate Air-Filter System, IBR approved § 86.1310–2007.

(10) ASTM E903–96, Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005), IBR approved for § 86.1866–12.

(11) ASTM E1918–06, Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field, IBR approved for § 86.1866–12.

(12) ASTM C1549–09, Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer (2009) IBR approved for § 86.1866–12.

(c) Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096–0001, (877) 606–7323 (U.S. and Canada) or (724) 776–4970 (outside the U.S. and Canada), *http://www.sae.org*.

(1) SAE J1151, December 1991, Methane Measurement Using Gas Chromatography, 1994 SAE Handbook—SAE International Cooperative Engineering Program, Volume 1: Materials, Fuels, Emissions, and Noise; Section 13 and page 170 (13.170), IBR approved for §§ 86.111–94; 86.1311–94.

(2) SAE J1349, June 1990, Engine Power Test Code—Spark Ignition and Compression Ignition, IBR approved for §§ 86.094–8, 86.096–8.

(3) SAE J1850, July 1995, Class B Data Communication Network Interface, IBR approved for §§ 86.099–17, 86.1806–01.

(4) SAE J1850, Revised May 2001, Class B Data Communication Network Interface, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(5) SAE J1877, July 1994, Recommended Practice for Bar-Coded Vehicle Identification Number Label, IBR approved for §§ 86.095–35, 86.1806–01.

(6) SAE J1892, October 1993, Recommended Practice for Bar-Coded Vehicle Emission Configuration Label, IBR approved for §§ 86.095–35, 86.1806–01.

(7) SAE J1930, Revised May 1998, Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms, IBR approved for §§ 86.096–38, 86.004–38, 86.007–38, 86.010–38, 86.1808–01, 86.1808–07.

(8) SAE J1930, Revised April 2002, Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms—Equivalent to ISO/TR 15031–2: April 30, 2002, IBR approved for §§ 86.005–17, 86.007–17, 86.010–18, 86.1806–04, 86.1806–05.

(9) SAE J1937, November 1989, Engine Testing with Low Temperature Charge Air Cooler Systems in a Dynamometer Test Cell, IBR approved for §§ 86.1330–84, 86.1330–90.

(10) SAE J1939, Revised October 2007, Recommended Practice for a Serial Control and Communications Vehicle Network, IBR approved for §§ 86.010–18.

(11) SAE J1939–11, December 1994, Physical Layer—250K bits/s, Shielded Twisted Pair, IBR approved for §§ 86.005–17, 86.1806–05.

(12) SAE J1939–11, Revised October 1999, Physical Layer—250K bits/s, Shielded Twisted Pair, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(13) SAE J1939–13, July 1999, Off-Board Diagnostic Connector, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(14) SAE J1939–13, Revised March 2004, Off-Board Diagnostic Connector, IBR approved for § 86.010–18.

(15) SAE J1939–21, July 1994, Data Link Layer, IBR approved for §§ 86.005–17, 86.1806–05.

(16) SAE J1939–21, Revised April 2001, Data Link Layer, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(17) SAE J1939–31, Revised December 1997, Network Layer, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(18) SAE J1939–71, May 1996, Vehicle Application Layer, IBR approved for §§ 86.005–17, 86.1806–05.

(19) SAE J1939–71, Revised August 2002, Vehicle Application Layer—J1939–71 (through 1999), IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(20) SAE J1939–71, Revised January 2008, Vehicle Application Layer (Through February 2007), IBR approved for § 86.010–38.

(21) SAE J1939–73, February 1996, Application Layer—Diagnostics, IBR approved for §§ 86.005–17, 86.1806–05.

(22) SAE J1939–73, Revised June 2001, Application Layer—Diagnostics, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(23) SAE J1939–73, Revised September 2006, Application Layer—Diagnostics, IBR approved for §§ 86.010–18, 86.010–38.

(24) SAE J1939–81, July 1997, Recommended Practice for Serial Control and Communications Vehicle Network Part 81—Network Management, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(25) SAE J1939–81, Revised May 2003, Network Management, IBR approved for § 86.010–38.

(26) SAE J1962, January 1995, Diagnostic Connector, IBR approved for §§ 86.099–17, 86.1806–01.

(27) SAE J1962, Revised April 2002, Diagnostic Connector Equivalent to ISO/DIS 15031–3; December 14, 2001, IBR approved for §§ 86.005–17, 86.007–17, 86.010–18, 86.1806–04, 86.1806–05.

(28) SAE J1978, Revised April 2002, OBD II Scan Tool—Equivalent to ISO/DIS 15031–4; December 14, 2001, IBR approved for §§ 86.005–17, 86.007–17, 86.010–18, 86.1806–04, 86.1806–05.

(29) SAE J1979, July 1996, E/E Diagnostic Test Modes, IBR approved for §§ 86.099–17, 86.1806–01.

(30) SAE J1979, Revised September 1997, E/E Diagnostic Test Modes, IBR approved for §§ 86.096–38, 86.004–38, 86.007–38, 86.010–38, 86.1808–01, 86.1808–07.

(31) SAE J1979, Revised April 2002, E/E Diagnostic Test Modes—Equivalent to ISO/DIS 15031–5; April 30, 2002, IBR approved for §§ 86.099–17, 86.005–17, 86.007–17, 86.1806–01, 86.1806–04, 86.1806–05.

(32) SAE J1979, Revised May 2007, (R) E/E Diagnostic Test Modes, IBR approved for § 86.010–18, 86.010–38.

(33) SAE J2012, July 1996, Recommended Practice for Diagnostic Trouble Code Definitions, IBR approved for §§ 86.099–17, 86.1806–01.

(34) SAE J2012, Revised April 2002, (R) Diagnostic Trouble Code Definitions Equivalent to ISO/DIS 15031–6: April 30, 2002, IBR approved for §§ 86.005–17, 86.007–17, 86.010–18, 86.1806–04, 86.1806–05.

(35) SAE J2284–3, May 2001, High Speed CAN (HSC) for Vehicle Applications at 500 KBPS, IBR approved for §§ 86.096–38, 86.004–38, 86.007–38, 86.010–38, 86.1808–01, 86.1808–07.

(36) SAE J2403, Revised August 2007, Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature—Truck and Bus, IBR approved for §§ 86.007–17, 86.010–18, 86.010–38, 86.1806–05.

(37) SAE J2534, February 2002, Recommended Practice for Pass-Thru Vehicle Programming, IBR approved for §§ 86.096–38, 86.004–38, 86.007–38, 86.010–38, 86.1808–01, 86.1808–07.

(38) SAE J2534–1, Revised December 2004, (R) Recommended Practice for Pass-Thru Vehicle Programming, IBR approved for § 86.010–38.

(39) SAE J2064, Revised December 2005, R134a Refrigerant Automotive Air-Conditioned Hose, IBR approved for § 86.166–12.

(40) 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.

(41) SAE J1711, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles, June 2010, IBR approved for § 86.1811–04(n).

(42) SAE J1634, Electric Vehicle Energy Consumption and Range Test Procedure, Cancelled October 2002, IBR approved for § 86.1811–04(n).

(43) SAE J1100, November, 2009, Motor Vehicle Dimensions, IBR approved for § 86.1866–12(d).

(44) SAE J2064, Revised December 2005, R134a Refrigerant Automotive Air-Conditioned Hose, IBR approved for § 86.166–12(d).

(d) American National Standards Institute, 25 W 43rd Street, 4th Floor, New York, NY 10036, (212) 642–4900, *http://www.ansi.org.*

(1) ANSI/AGA NGV1–1994, Standard for Compressed Natural Gas Vehicle (NGV) Fueling Connection Devices, IBR approved for §§ 86.001–9, 86.004–9, 86.098–8, 86.099–8, 86.099–9, 86.1810–01.

(2) [Reserved]

(e) California Air Resources Board, (916) 322–2884, *http://www.arb.ca.gov.*

(1) California Regulatory Requirements Applicable to the ‘‘LEV II’’ Program, including:

(i) [Reserved]

(ii) California Non-Methane Organic Gas Test Procedures, August 5, 1999, IBR approved for §§ 86.1803–01, 86.1810–01, 86.1811–04.

(2) California Regulatory Requirements Applicable to the National Low Emission Vehicle Program, October 1996, IBR approved for §§ 86.113–04, 86.612–97, 86.1012–97, 86.1702–99, 86.1708–99, 86.1709–99, 86.1717–99, 86.1735–99, 86.1771–99, 86.1775–99, 86.1776–99, 86.1777–99, Appendix XVI, Appendix XVII.

(3) California Regulatory Requirements known as On-board Diagnostics II (OBD–II), Approved on April 21, 2003, Title 13, California Code Regulations, Section 1968.2, Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD–II), IBR approved for § 86.1806–05.

(4) California Regulatory Requirements known as On-board Diagnostics II (OBD–II), Approved on November 9, 2007, Title 13, California Code Regulations, Section 1968.2, Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD–II), IBR approved for §§ 86.007–17, 86.1806–05.

(f) International Organization for Standardization, Case Postale 56, CH–1211 Geneva 20, Switzerland, 41–22–749–01–11, *http://www.iso.org.*

(1) ISO 9141–2, February 1, 1994, Road vehicles—Diagnostic systems—Part 2: CARB requirements for interchange of digital information, IBR approved for §§ 86.099–17, 86.005–17, 86.007–17, 86.1806–01, 86.1806–04, 86.1806–05.

(2) ISO 14230–4:2000(E), June 1, 2000, Road vehicles—Diagnostic systems—

KWP 2000 requirements for Emission-related systems, IBR approved for §§ 86.099–17, 86.005–17, 86.007–17, 86.1806–01, 86.1806–04, 86.1806–05.

(3) ISO 15765–4.3:2001, December 14, 2001, Road Vehicles—Diagnostics on Controller Area Networks (CAN)—Part 4: Requirements for emissions-related systems, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(4) ISO 15765–4:2005(E), January 15, 2005, Road Vehicles—Diagnostics on Controller Area Networks (CAN)—Part 4: Requirements for emissions-related systems, IBR approved for §§ 86.007–17, 86.010–18, 86.1806–05.

(5) ISO 13837:2008, May 30, 2008, Road Vehicles—Safety glazing materials. Method for the determination of solar transmittance, IBR approved for § 86.1866–12.

(g) Government Printing Office, Washington, DC 20402, (202) 512–1800 *http://www.nist.gov.*

(1) NIST Special Publication 811, 1995 Edition, Guide for the Use of the International System of Units (SI), IBR approved for § 86.1901.

(2) [Reserved]

(h) Truck and Maintenance Council, 950 North Glebe Road, Suite 210, Arlington, VA 22203–4181, (703) 838–1754.

(1) TMC RP 1210B, Revised June 2007, WINDOWSTMCOMMUNICATION API, IBR approved for § 86.010–38.

(2) [Reserved]

(i) U.S. EPA, Office of Air and Radiation, 2565 Plymouth Road, Ann Arbor, MI 48105, *http://www.epa.gov*:

(1) EPA Vehicle Simulation Tool, Version x.x, November 2011; IBR approved for § 86.1866–12. The computer code for this model is available as noted in paragraph (a) of this section. A working version of this software is also available for download at *http://www.epa.gov/otaq/climate/ldst.htm.*

(2) [Reserved]

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. A heated flame ionization detector (HFID) is used for the continuous determination of THC from petroleum-fueled diesel-cycle vehicles (may also be used with methanol-fueled diesel-cycle vehicles), Figure B94–5 (or B94–6). The analytical system for methanol consists of a gas chromatograph (GC) equipped with a flame ionization detector. The analysis for formaldehyde is performed using high-pressure liquid chromatography (HPLC) of 2,4-dinitrophenylhydrazine (DNPH) derivatives using ultraviolet (UV) detection. The exhaust gas analytical system shall conform to the following requirements:

* * * * *

6. Section 86.135–12 is amended by revising paragraph (a) to read as follows:

§ 86.135–12 Dynamometer procedure.

(a) *Overview.* The dynamometer run consists of two tests, a ''cold'' start test, after a minimum 12-hour and a maximum 36-hour soak according to the provisions of §§ 86.132 and 86.133, and a ''hot'' start test following the ''cold'' start by 10 minutes. Engine startup (with all accessories turned off), operation over the UDDS, and engine shutdown make a complete cold start test. Engine startup and operation over the first 505 seconds of the driving schedule complete the hot start test. The exhaust emissions are diluted with ambient air in the dilution tunnel as shown in Figure B94–5 and Figure B94–6. A dilution tunnel is not required for testing vehicles waived from the requirement to measure particulates. Six particulate samples are collected on filters for weighing; the first sample plus backup is collected during the first 505 seconds of the cold start test; the second sample plus backup is collected during the remainder of the cold start test (including shutdown); the third sample plus backup is collected during the hot start test. Continuous proportional samples of gaseous emissions are collected for analysis during each test phase. For gasoline-fueled, natural gas-fueled and liquefied petroleum gas-fueled Otto-cycle vehicles, the composite samples collected in bags are analyzed for THC, CO, CO_2, CH_4, NO_X, and 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 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 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 N_2O.

* * * * *

7. Section 86.165–12 is amended by revising paragraphs (c)(1) and (2) to read as follows:

§ 86.165–12 Air conditioning idle test procedure.

* * * * *

(c) * * *

(1) Ambient humidity within the test cell during all phases of the test sequence shall be controlled to an average of 40–60 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 73–80 °F on average and 75 ± 5 °F as an instantaneous measurement. Air temperature shall be recorded continuously at a minimum of 30 second intervals.

* * * * *

8. Section 86.166–12 is amended as follows:

a. By revising paragraph (b) introductory text.

b. By revising paragraph (b).

c. By revising paragraph (d).

§ 86.166–12 Method for calculating emissions due to air conditioning leakage.

* * * * *

(b) *Rigid pipe connections.* For 2017 and later model years, manufacturers may test the leakage of system connections by pressurizing the system with Helium and using a mass spectrometer to measure the leakage of the connections within the system. Connections that are demonstrated to be free of leaks using Helium mass spectrometry are considered to have a relative emission factor of 10 and are accounted for separately in the equation in paragraph (b)(2) of this section.

(1) The following equation shall be used for the 2012 through 2016 model years, and for 2017 and later model years in cases where the connections are not demonstrated to be leak-free using Helium mass spectrometry:

$$\text{Grams/YR}_{RP} = 0.00522 \times [(125 \times SO) + (75 \times SCO) + (50 \times MO) + (10 \times SW) + (5 \times SWO) + (MG)]$$

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.

(2) For 2017 and later model years, manufacturers may test the leakage of system connections by pressurizing the system with Helium and using a mass spectrometer to measure the leakage of the connections within the system. Connections that are demonstrated to be free of leaks using Helium mass spectrometry are considered to have a relative emission factor of 10 and are accounted for separately in the following equation:

$$\text{Grams/YR}_{RP} = 0.00522 \times [(125 \times SO) + (75 \times SCO) + (50 \times MO) + (10 \times SW) + (10 \times LTO) + (5 \times SWO) + (MG)]$$

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.
LTO = The total number of O-ring connections (single, single captured, and multiple) that have demonstrated no leakage using Helium mass spectrometry. Connections included here should not be counted elsewhere in the equation, and all connections counted here must be tested using Helium mass spectrometry and demonstrated as free of leaks.
SWO = The number of seal washer with O-ring connections.
MG = The number of metal gasket connections.

* * * * *

(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, selected from the following table, or, for 2017 and later model years, calculated according to SAE J2064 "R134a Refrigerant Automotive Air-Conditioned Hose" (incorporated by reference; see 86.1):

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

* * * * *

9. Section 86.167–17 is added to read as follows:

§ 86.167–17 AC17 Air Conditioning Efficiency Test Procedure.

(a) *Overview.* The dynamometer operation consists of four elements: a pre-conditioning cycle, a 30-minute soak period under simulated solar heat, an SC03 drive cycle, and a Highway Fuel Economy Test (HFET) drive cycle. The vehicle is preconditioned with the UDDS to bring the vehicle to a warmed-up stabilized condition. This preconditioning is followed by a 30 minute vehicle soak (engine off) that proceeds directly into the SC03 driving schedule, during which continuous proportional samples of gaseous emissions are collected for analysis. The SC03 driving schedule is followed immediately by the HFET cycle, during which continuous proportional samples of gaseous emissions are collected for analysis. The entire test, including the preconditioning driving, vehicle soak, and SC03 and HFET official test cycles, is conducted in an environmental test facility. The environmental test facility must be capable of providing the following nominal ambient test conditions of: 77 °F air temperature, 50 percent relative humidity, a solar heat load intensity of 850 W/m^2, and vehicle cooling air flow proportional to vehicle speed. Section 86.161–00 discusses the minimum facility requirements and corresponding control tolerances for air conditioning ambient test conditions. The entire test sequence is run twice; with and without the vehicle's air conditioner operating during the SC03 and HFET test cycles. For gasoline-fueled Otto-cycle vehicles, the composite samples collected in bags are analyzed for THC, CO, CO_2, and CH_4. For petroleum-fueled diesel-cycle vehicles, THC is sampled and analyzed continuously according to the provisions of § 86.110. Parallel bag samples of dilution air are analyzed for THC, CO, CO_2, and CH_4. The following figure shows the basic sequence of the test procedure.

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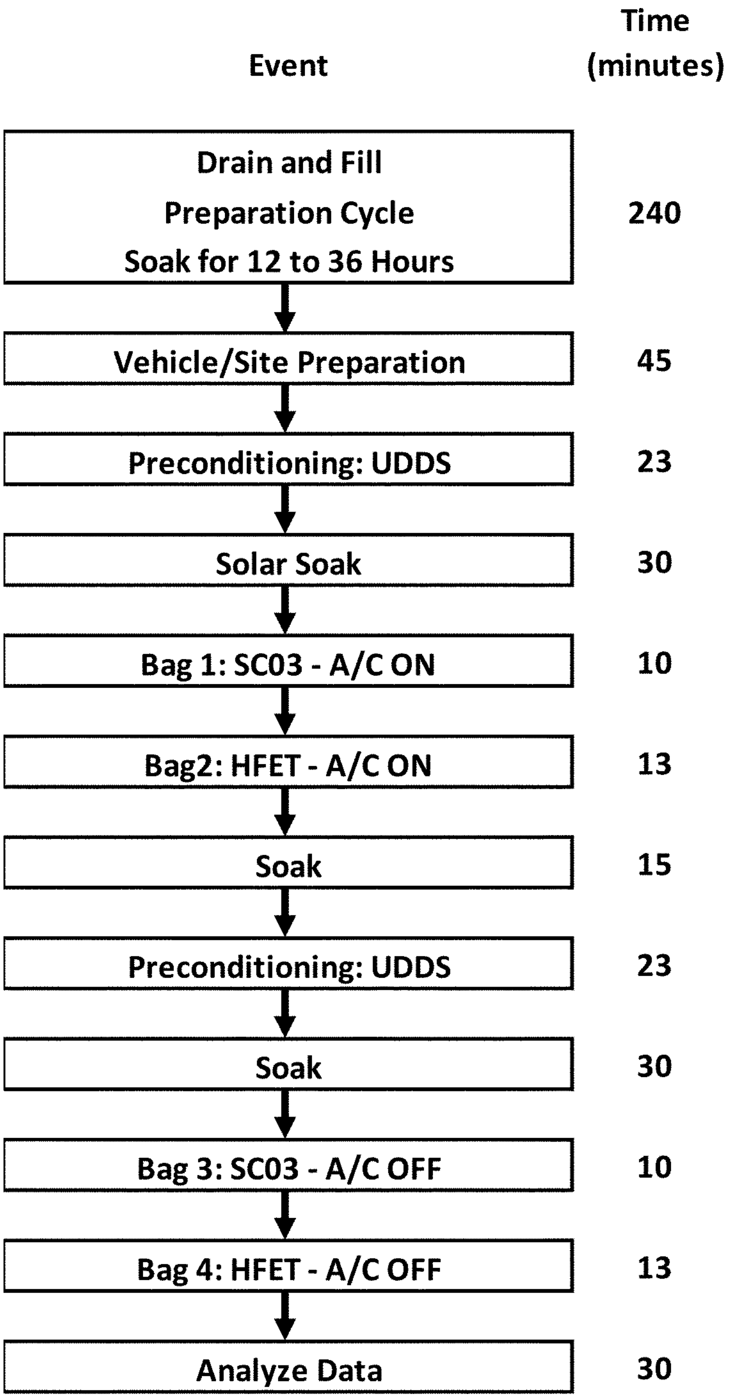

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(b) *Dynamometer requirements.* (1) Tests shall be run on a large single roll electric dynamometer or an equivalent dynamometer configuration that satisfies the requirements of § 86.108–00.

(2) Position (vehicle can be driven) the test vehicle on the dynamometer and restrain.

(3) Required dynamometer inertia weight class selections are determined by the test vehicle's test weight basis and corresponding equivalent weight as listed in the tabular information of § 86.129–00(a) and discussed in § 86.129–00(e) and (f).

(4) Set the dynamometer test inertia weight and roadload horsepower requirements for the test vehicle (see § 86.129–00 (e) and (f)). The dynamometer's horsepower adjustment settings shall be set such that the force imposed during dynamometer operation matches actual road load force at all speeds.

(5) 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 at request of the Administrator.

(6) The drive wheel tires may be inflated up to a gauge pressure of 45 psi (310 kPa), or the manufacturer's recommended pressure if higher than 45 psi, in order to prevent tire damage. The drive wheel tire pressure shall be reported with the test results.

(7) The driving distance, as measured by counting the number of

dynamometer roll or shaft revolutions, shall be determined for the test.

(8) 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.

(c) *Test cell ambient conditions.* (1) *Ambient air temperature.* (i) Ambient air temperature is controlled, within the test cell, during all phases of the test sequence to 77 ±2 °F on average and 77 ±5 °F as an instantaneous measurement.

(ii) Air temperature is recorded continuously at a minimum of 30 second intervals. Records of cell air temperatures and values of average test temperatures are maintained by the manufacturer for all certification related programs.

(2) *Ambient humidity.* (i) Ambient humidity is controlled, within the test cell, during all phases of the test sequence to an average of 69 ±5 grains of water/pound of dry air.

(ii) Humidity is recorded continuously at a minimum of 30 second intervals. Records of cell humidity and values of average test humidity are maintained by the manufacturer for all certification related programs.

(3) *Solar heat loading.* The requirements of 86.161–00(d) regarding solar heat loading specifications shall apply. The solar load of 850 W/m^2 is applied only during specified portions of the test sequence.

(d) *Interior temperature measurement.* The interior temperature of the vehicle shall be measured during the emission sampling phases of the test(s).

(1) Interior temperatures shall be measured by placement of thermocouples at the following locations:

(i) The outlet of the center duct on the dash.

(ii) Behind the driver and passenger seat headrests. The location of the temperature measuring devices shall be 30 mm behind each headrest and 330 mm below the roof.

(2) The temperature at each location shall be recorded a minimum of every 5 seconds.

(e) *Air conditioning system settings.* For the portion of the test where the air conditioner is required to be operating the settings shall be as follows:

(1) Automatic systems shall be set to automatic and the temperature control set to 72 deg F.

(2) Manual systems shall be set at the start of the SC03 drive cycle to full cool with the fan on the highest setting and the airflow setting to ''recirculation.'' Within the first idle period of the SC03 drive cycle (186 to 204 seconds) the fan speed shall be reduced to the setting closest to 6 volts at the motor, the temperature setting shall be adjusted to provide 55 deg F at the center dash air outlet, and the airflow setting changed to ''outside air.''

(f) *Vehicle and test activities.* The AC17 air conditioning test in an environmental test cell is composed of the following sequence of activities.

(1) Drain and fill the vehicle's fuel tank to 40 percent capacity with test fuel. If a vehicle has gone through the drain and fuel sequence less than 72 hours previously and has remained under laboratory ambient temperature conditions, this drain and fill operation can be omitted (see § 86.132–00(c)(2)(ii)).

(2)(i) Position the variable speed cooling fan in front of the test vehicle with the vehicle's hood down. This air flow should provide representative cooling at the front of the test vehicle (air conditioning condenser and engine) during the driving cycles. See § 86.161–00(e) for a discussion of cooling fan specifications.

(ii) In the case of vehicles with rear engine compartments (or if this front location provides inadequate engine cooling), an additional 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 m^3/s). If, however, it can be demonstrated that during road operation the vehicle receives additional cooling, and that such additional cooling is needed to provide a representative test, the fan capacity may be increased or additional fans used if approved in advance by the Administrator.

(3) Open all vehicle windows.

(4) Connect the emission test sampling system to the vehicle's exhaust tail pipe(s).

(5) Set the environmental test cell ambient test conditions to the conditions defined in paragraph (c) of this section, except that the solar heat shall be off.

(6) Set the air conditioning system controls to off.

(7) Start the vehicle (with air conditioning system off) and conduct a preconditioning EPA urban dynamometer driving cycle (§ 86.115).

(i) If engine stalling should occur during any air conditioning test cycle operation, follow the provisions of § 86.136–90 (Engine starting and restarting).

(ii) For manual transmission vehicles, the vehicle shall be shifted according the provisions of § 86.128–00.

(8) Following the preconditioning cycle, the test vehicle and cooling fan(s) are turned off, all windows are rolled up, and the vehicle is allowed to soak in the ambient conditions of paragraph (c)(1) of this section for 30 ±1 minutes. The solar heat system must be turned on and generating 850 W/m^2 within 1 minute of turning the engine off.

(9) *Air conditioning on test.* (i) Start engine (with air conditioning system also running). Fifteen seconds after the engine starts, place vehicle in gear.

(ii) Eighteen seconds after the engine starts, begin the initial vehicle acceleration of the SC03 driving schedule.

(iii) Operate the vehicle according to the SC03 driving schedule, as described in appendix I, paragraph (h), of this part, while sampling the exhaust gas.

(iv) At the end of the deceleration which is scheduled to occur at 594 seconds, simultaneously switch the sample flows from the SC03 bags and samples to the ''HFET'' bags and samples, switch off gas flow measuring device No. 1, switch off the No. 1 petroleum-fueled diesel hydrocarbon integrator, mark the petroleum-fueled diesel hydrocarbon recorder chart, and start gas flow measuring device No. 2, and start the petroleum-fueled diesel hydrocarbon integrator No. 2.

(v) Allow the vehicle to idle for 14–16 seconds. Before the end of this idle period, record the measured roll or shaft revolutions and reset the counter or switch to a second counter. As soon as possible transfer the SC03 exhaust and dilution air samples to the analytical system and process the samples according to § 86.140 obtaining a stabilized reading of the bag exhaust sample on all analyzers within 20 minutes of the end of the sample collection phase of the test. Obtain methanol and formaldehyde sample analyses, if applicable, within 24 hours of the end of the sample collection phase of the test.

(vi) Operate the vehicle according to the HFET driving schedule, as described in 40 CFR 600.109–08, while sampling the exhaust gas.

(vii) Turn the engine off 2 seconds after the end of the last deceleration.

(viii) Five seconds after the engine stops running, simultaneously turn off gas flow measuring device No. 2 and if applicable, turn off the petroleum-fueled diesel hydrocarbon integrator No. 2, mark the hydrocarbon recorder chart, and position the sample selector valves to the ''standby'' position. Record the measured roll or shaft revolutions (both gas meter or flow measurement instrumentation readings), and re-set the counter. As soon as possible, transfer the ''HFET'' exhaust and dilution air samples to the analytical system and process the samples according to § 86.140, obtaining a stabilized reading of the exhaust bag sample on all analyzers within 20 minutes of the end of the sample collection phase of the test. Obtain methanol and formaldehyde sample analyses, if applicable, within 24 hours of the end of the sample period.

(10) *Air conditioning off test.* The air conditioning off test is identical to the steps identified in paragraphs (d)(1) through (9) of this section, except that the air conditioning system and fan speeds are set to complete off or the lowest. It is preferred that the air conditioning off test be conducted sequentially after the air conditioning on test, following a 10–15 minute soak.

(g) *Records required and reporting requirements.* For each test the manufacturer shall record the information specified in 86.142–90. Emission results must be reported for each phase of the test. The manufacturer must also report the following information for each vehicle tested: vehicle class, model type, carline, curb weight engine displacement, transmission class and configuration, interior volume, climate control system type and characteristics, refrigerant used, compressor type, and evaporator/condenser characteristics.

Subpart S—[Amended]

10. Section 86.1801–12 is amended by revising paragraphs (b), (j), and (k) introductory text to read as follows:

§ 86.1801–12 Applicability.

* * * * *

(b) *Clean alternative fuel conversions.* The provisions of this subpart apply to clean alternative fuel conversions as 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.

(j) *Exemption from greenhouse gas emission standards for small businesses.* (1) 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. This exemption applies to both U.S.-based and non-U.S.-based businesses. 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.

(i) Vehicle manufacturers (NAICS code 336111).

(ii) Independent commercial importers (NAICS codes 811111, 811112, 811198, 423110, 424990, and 441120).

(iii) Alternate fuel vehicle converters (NAICS codes 335312, 336312, 336322, 336399, 454312, 485310, and 811198).

(2) Effective for the 2014 and later model years, a manufacturer that would otherwise be exempt under the provisions of paragraph (j)(1) of this section may optionally comply with the greenhouse gas emission standards specified in § 86.1818. A manufacturer making this choice is required to comply with all the applicable standards and provisions in § 86.1818 and in associated provisions in this part and in part 600 of this chapter. Manufacturers may optionally earn early credits in the 2012 and/or 2013 model years by demonstrating CO_2 emission levels below the fleet average CO_2 standard that would have been applicable in those model years if the manufacturer had not been exempt. Manufacturers electing to earn these early credits must comply with the model year reporting requirements in § 600.512–12 for each model year.

(k) *Conditional exemption from greenhouse gas emission standards.* Manufacturers meeting the eligibility requirements described in paragraphs (k)(1) and (2) of this section may request a conditional exemption from compliance with the emission standards described in § 86.1818–12(c) through (e) and associated provisions in this part and in part 600 of this chapter. A conditional exemption under this paragraph (k) may be requested for the 2012 through 2016 model years. 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).

* * * * *

11. Section 86.1803–01 is amended as follows:

a. By revising the definition for ''footprint.''

b. By adding a definition for ''good engineering judgment.''

c. By adding a definition for ''gross combination weight rating.''

d. By revising the definition for ''gross vehicle weight rating.''

e. By adding a definition for ''platform.''

The revisions and additions read as follows:

§ 86.1803–01 Definitions.

* * * * *

Footprint is the product of average track width (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, where the average track width is the average of the front and rear track widths, where each is measured in inches and rounded to the nearest tenth of an inch.

* * * * *

Good engineering judgment has the meaning given in 40 CFR 1068.30. *See* 40 CFR 1068.5 for the administrative process we use to evaluate good engineering judgment.

Gross combination weight rating (GCWR) means the value specified by the vehicle manufacturer as the maximum weight of a loaded vehicle and trailer, consistent with good engineering judgment.

* * * * *

Gross vehicle weight rating (GVWR) means the value specified by the manufacturer as the maximum design loaded weight of a single vehicle, consistent with good engineering judgment.

* * * * *

Platform means a group of vehicles with common body floor plan and construction, chassis construction and components, basic engine, and transmission class. Platform does not consider any level of décor or opulence, or characteristics such as roof line, number of doors, seats, or windows. A single platform may include multiple fuel economy label classes or car lines, and may include both cars and trucks.

* * * * *

12. Section 86.1818–12 is amended as follows:

a. By adding paragraph (b)(4).

b. By revising paragraphs (c)(2)(i)(A) through (C).

c. By revising paragraphs (c)(3)(i)(A) through (C).

d. By adding paragraph (c)(3)(i)(D).

e. By adding paragraph (c)(4).

f. By revising paragraph (f) introductory text.

g. By revising paragraph (f)(3).

h. By adding paragraph (g).

i. By adding paragraph (h).

The additions and revisions read as follows:

§ 86.1818–12 Greenhouse gas emission standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles.

* * * * *

(b) * * *

(4) *Emergency vehicle* means a motor vehicle manufactured primarily for use as an ambulance or combination ambulance-hearse or for use by the United States Government or a State or local government for law enforcement.

(c) * * *

(2) * * *

(i) * * *

(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	206.0
2017	195.0
2018	185.0
2019	175.0
2020	166.0
2021	157.0
2022	150.0
2023	143.0
2024	137.0
2025 and later	131.0

(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	277.0
2017	263.0
2018	250.0
2019	238.0
2020	226.0
2021	215.0
2022	205.0
2023	196.0
2024	188.0
2025 and later	179.0

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(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:

Target $CO_2 = [a \times f\,] + b$

Where:

f is the vehicle footprint, as defined in § 86.1803; and

a and b are selected from the following table for the appropriate model year:

Model year	a	*b*
2012	4.72	50.5
2013	4.72	43.3
2014	4.72	34.8
2015	4.72	23.4
2016	4.72	12.7
2017	4.53	8.9
2018	4.35	6.5
2019	4.17	4.2
2020	4.01	1.9
2021	3.84	-0.4
2022	3.69	-1.1
2023	3.54	-1.8
2024	3.4	-2.5
2025 and later	3.26	-3.2

* * * * *

(3) * * *

(i) * * *

(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	247.0
2017	238.0
2018	227.0
2019	220.0
2020	212.0
2021	195.0
2022	186.0
2023	176.0
2024	168.0
2025 and later	159.0

(B) For light trucks with a footprint that is greater than 41 square feet and less than or equal to the maximum footprint value specified in the table below for each model year, the gram/mile CO_2 target value shall be calculated using the following equation and rounded to the nearest 0.1 grams/mile:

Target $CO_2 = (a \times f) + b$

Where:

f is the footprint, as defined in § 86.1803; and
a and b are selected from the following table for the appropriate model year:

Model year	Maximum Footprint	a	b
2012	66.0	4.04	128.6
2013	66.0	4.04	118.7
2014	66.0	4.04	109.4
2015	66.0	4.04	95.1
2016	66.0	4.04	81.1
2017	50.7	4.87	38.3
2018	60.2	4.76	31.6
2019	66.4	4.68	27.7
2020	68.3	4.57	24.6
2021	73.5	4.28	19.8
2022	74.0	4.09	17.8
2023	74.0	3.91	16.0
2024	74.0	3.74	14.2
2025 and later	74.0	3.58	12.5

(C) For light trucks with a footprint that is greater than the minimum footprint value specified in the table below and less than or equal to the maximum footprint value specified in the table below for each model year, the gram/mile CO_2 target value shall be calculated using the following equation and rounded to the nearest 0.1 grams/mile:

Target $CO_2 = (a \times f) + b$

Where:

f is the footprint, as defined in § 86.1803; and

a and b are selected from the following table for the appropriate model year:

Model year	Minimum Footprint	Maximum Footprint	a	b
2017	50.7	66.0	4.04	80.5
2018	60.2	66.0	4.04	75.0

(D) For light trucks with a footprint greater than the minimum value specified in the table below for each model year, the gram/mile CO_2 target value shall be selected for the appropriate model year from the following table:

Model year	Minimum Footprint	CO_2 target value (grams/mile)
2012	66.0	395.0
2013	66.0	385.0
2014	66.0	376.0
2015	66.0	362.0
2016	66.0	348.0
2017	66.0	347.0
2018	66.0	342.0
2019	66.4	339.0
2020	68.3	337.0
2021	73.5	335.0
2022	74.0	321.0
2023	74.0	306.0
2024	74.0	291.0
2025 and later	74.0	277.0

* * * * *

(4) *Emergency vehicles.* Emergency vehicles may be excluded from the fleet average CO_2 exhaust emission standards described in paragraph (c) of this section. The manufacturer should notify the Administrator that they are making such an election in the model year reports required under § 600.512 of this chapter. Such vehicles should be excluded from both the calculation of the fleet average standard for a manufacturer under this paragraph (c) and from the calculation of the fleet average carbon-related exhaust emissions in 86.510–12.

* * * * *

(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), (2), or (3) of this section. Except with prior EPA approval, a manufacturer may not use the provisions of both paragraphs (f)(1) and (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. The manufacturer may use the provisions of both paragraphs (f)(1) and (3) of this section in a model year. For example, a manufacturer may meet the N_2O standard in paragraph (f)(1)(i) of this section and an alternative CH_4 standard determined under paragraph (f)(3) of this section.

* * * * *

(3) *Optional use of alternative N_2O and/or CH_4 standards.* Manufacturers may select an alternative standard applicable to a test group, for either N_2O or CH_4, or both. For example, a manufacturer may choose to meet the N_2O standard in paragraph (f)(1)(i) of this section and an alternative CH_4 standard in lieu of the standard in paragraph (f)(1)(ii) of this section. The alternative standard for each pollutant must be greater than the applicable exhaust emission standard specified in paragraph (f)(1) of this section. Alternative N_2O and CH_4 standards apply to emissions measured according to the Federal Test Procedure (FTP) described in Subpart B of this part for the full useful life, and become the applicable certification and in-use emission standard(s) for the test group. Manufacturers using an alternative standard for N_2O and/or CH_4 must calculate emission debits according to the provisions of paragraph (f)(4) of this section for each test group/alternative standard combination. Debits must be included in the calculation of total credits or debits generated in a model year as required under § 86.1865–12(k)(5). For flexible fuel vehicles (or other vehicles certified for multiple fuels) you must meet these alternative standards when tested on any applicable test fuel type.

* * * * *

(g) *Alternative fleet average standards for manufacturers with limited U.S. sales.* Manufacturers meeting the criteria in this paragraph (g) may request that the Administrator establish alternative fleet average CO_2 standards that would apply instead of the standards in paragraph (c) of this section. The provisions of this paragraph (g) are applicable only to the 2017 and later model years.

(1) *Eligibility for alternative standards.* Eligibility as determined in this paragraph (g) shall be based on the total sales of combined passenger automobiles and light trucks. The terms ‘‘sales’’ and ‘‘sold’’ as used in this paragraph (g) 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). To be eligible for alternative standards established under this paragraph (g), 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 4,999, the manufacturer will no longer be eligible for exemption and must meet applicable emission standards starting with the model year according to the provisions in this paragraph (g)(1).

(i) If a manufacturer's average sales for three consecutive model years exceeds 4,999, 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(c) and (d), 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 4,999 and is less than 50,000, and if the increase in sales is solely the result of the manufacturer's expansion in vehicle production (not the result of corporate acquisitions, mergers, or purchase by another manufacturer), the manufacturer shall comply with the emission standards described in § 86.1818–12(c) through (e), as applicable, beginning with the second model year after the last year of the three consecutive model years.

(2) *Requirements for new entrants into the U.S. market.* New entrants are those manufacturers without a prior record of automobile sales in the United States and without prior certification to (or exemption from, under § 86.1801–12(k)) greenhouse gas emission standards in § 86.1818–12. In addition to the eligibility requirements stated in paragraph (g)(1) of this section, new entrants must meet the following requirements:

(i) In addition to the information required under paragraph (g)(4) of this section, new entrants must provide documentation that shows a clear intent by the company to actually enter the U.S. market in the years for which alternative standards are requested. Demonstrating such intent could include providing documentation that shows the establishment of a U.S. dealer network, documentation of work underway to meet other U.S. requirements (*e.g.,* safety standards), or other information that reasonably establishes intent to the satisfaction of the Administrator.

(ii) Sales of vehicles in the U.S. by new entrants must remain below 5,000 vehicles for the first two model years in the U.S. market and the average sales for any three consecutive years within the first five years of entering the U.S. market must remain below 5,000 vehicles. Vehicles sold in violation of these limits will be considered not covered by the certificate of conformity and the manufacturer will be subject to penalties on an individual-vehicle basis for sale of vehicles not covered by a certificate. In addition, violation of these limits will result in loss of eligibility for alternative standards until such point as the manufacturer demonstrates two consecutive model years of sales below 5,000 automobiles.

(iii) A manufacturer with sales in the most recent model year of less than 5,000 automobiles, but where prior model year sales were not less than 5,000 automobiles, is eligible to request alternative standards under this paragraph (g). However, such a manufacturer will be considered a new entrant and subject to the provisions regarding new entrants in this paragraph (g), except that the requirement to demonstrate an intent to enter the U.S. market it paragraph (g)(2)(i) of this section shall not apply.

(3) *How to request alternative fleet average standards.* Eligible manufacturers may petition for alternative standards for up to five consecutive model years if sufficient information is available on which to base such standards.

(i) To request alternative standards starting with the 2017 model year, eligible manufacturers must submit a completed application no later than July 30, 2013.

(ii) To request alternative standards starting with a model after 2017, eligible manufacturers must submit a completed request no later than 36 months prior to the start of the first model year to which the alternative standards would apply.

(iii) The request must contain all the information required in paragraph (g)(4) of this section, and must be signed by a chief officer of the company. If the Administrator determines that the content of the request is incomplete or insufficient, the manufacturer will be notified and given an additional 30 days to amend the request.

(4) *Data and information submittal requirements.* Eligible manufacturers requesting alternative standards under this paragraph (g) must submit the following information to the Environmental Protection Agency. The Administrator may request additional information as she deems appropriate. The completed request 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.

(i) *Vehicle model and fleet information.* (A) The model years to which the requested alternative standards would apply, limited to five consecutive model years.

(B) Vehicle models and projections of production volumes for each model year.

(C) Detailed description of each model, including the vehicle type, vehicle mass, power, footprint, and expected pricing.

(D) The expected production cycle for each model, including new model introductions and redesign or refresh cycles.

(ii) *Technology evaluation information.* (A) The CO_2 reduction technologies employed by the manufacturer on each vehicle model, including information regarding the cost and CO_2-reducing effectiveness. Include technologies that improve air conditioning efficiency and reduce air conditioning system leakage, and any ''off-cycle'' technologies that potentially provide benefits outside the operation represented by the Federal Test Procedure and the Highway Fuel Economy Test.

(B) An evaluation of comparable models from other manufacturers, including CO_2 results and air conditioning credits generated by the models. Comparable vehicles should be similar, but not necessarily identical, in the following respects: vehicle type, horsepower, mass, power-to-weight ratio, footprint, retail price, and any other relevant factors. For manufacturers requesting alternative standards starting with the 2017 model year, the analysis of comparable vehicles should include vehicles from the 2012 and 2013 model years, otherwise the analysis should at a minimum include vehicles from the most recent two model years.

(C) A discussion of the CO_2-reducing technologies employed on vehicles offered outside of the U.S. market but not available in the U.S., including a discussion as to why those vehicles and/or technologies are not being used to achieve CO_2 reductions for vehicles in the U.S. market.

(D) An evaluation, at a minimum, of the technologies projected by the Environmental Protection Agency in a final rulemaking as those technologies likely to be used to meet greenhouse gas emission standards and the extent to which those technologies are employed or projected to be employed by the manufacturer. For any technology that is not projected to be fully employed, explain why this is the case.

(iii) *Alternative fleet average CO_2 standards.* (A) The most stringent CO_2 level estimated to be feasible for each model, in each model year, and the technological basis for this estimate.

(B) For each model year, a projection of the lowest feasible sales-weighted fleet average CO_2 value, separately for passenger automobiles and light trucks, and an explanation demonstrating that these projections are reasonable.

(C) A copy of any application, data, and related information submitted to NHTSA in support of a request for alternative Corporate Average Fuel Economy standards filed under 49 CFR Part 525.

(iv) *Information supporting eligibility.* (A) U.S. sales for the three previous model years and projected sales for the model years for which the manufacturer is seeking alternative standards.

(B) Information regarding ownership relationships with other manufacturers, including details regarding the application of the provisions of § 86.1838–01(b)(3) regarding the aggregation of sales of related companies,

(5) *Alternative standards.* Upon receiving a complete application, the Administrator will review the application and determine whether an alternative standard is warranted. If the Administrator judges that an alternative standard is warranted, the Administrator will publish a proposed determination in the **Federal Register** to establish alternative standards for the manufacturer that the Administrator judges are appropriate. Following a 30 day public comment period, the Administrator will issue a final determination establishing alternative standards for the manufacturer. If the Administrator does not establish alternative standards for an eligible manufacturer prior to 12 months before the first model year to which the alternative standards would apply, the manufacturer may request an extension of the exemption under 86.1801–12(k) or an extension of previously approved alternative standards, whichever may apply.

(6) *Restrictions on credit trading.* Manufacturers subject to alternative standards approved by the Administrator under this paragraph (g) may not trade credits to another manufacturer. Transfers between car and truck fleets within the manufacturer are allowed.

(h) *Mid-term evaluation of standards.* No later than April 1, 2018, the Administrator shall determine whether the standards established in paragraph (c) of this section for the 2022 through 2025 model years are appropriate under section 202(a) of the Clean Air Act, in light of the record then before the Administrator. An opportunity for public comment shall be provided before making such determination. If the Administrator determines they are not appropriate, the Administrator shall initiate a rulemaking to revise the standards, to be either more or less stringent as appropriate.

(1) In making the determination required by this paragragh (h), the Administrator shall consider the information available on the factors relevant to setting greenhouse gas emission standards under section 202(a) of the Clean Air Act for model years 2022 through 2025, including but not limited to:

(i) The availability and effectiveness of technology, and the appropriate lead time for introduction of technology;

(ii) The cost on the producers or purchasers of new motor vehicles or new motor vehicle engines;

(iii) The feasibility and practicability of the standards;

(iv) The impact of the standards on reduction of emissions, oil conservation, energy security, and fuel savings by consumers;

(v) The impact of the standards on the automobile industry;

(vi) The impacts of the standards on automobile safety;

(vii) The impact of the greenhouse gas emission standards on the Corporate Average Fuel Economy standards and a national harmonized program; and

(viii) The impact of the standards on other relevant factors.

(2) The Administrator shall make the determination required by this paragraph (h) based upon a record that includes the following:

(i) A draft Technical Assessment Report addressing issues relevant to the standard for the 2022 through 2025 model years;

(ii) Public comment on the draft Technical Assessment Report;

(iii) Public comment on whether the standards established for the 2022 through 2025 model years are appropriate under section 202(a) of the Clean Air Act; and

(iv) Such other materials the Administrator deems appropriate.

(3) No later than November 15, 2017, the Administrator shall issue a draft Technical Assessment Report addressing issues relevant to the standards for the 2022 through 2025 model years.

(4) The Administrator will set forth in detail the bases for the determination

required by this paragraph (h), including the Administrator's assessment of each of the factors listed in paragraph (h)(1) of this section.

13. Section 86.1823–08 is amended by revising paragraph (m)(2)(iii) to read as follows:

§ 86.1823–08 Durability demonstration procedures for exhaust emissions.

* * * * *

(m) * * *

(2) * * *

(iii) For the 2012 through 2016 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 (or derived from, using good engineering judgment) 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 (or derived from, using good engineering judgment) NMOG or NMHC emissions according to the provisions of this section.

* * * * *

14. Section 86.1829–01 is amended by revising paragraph (b)(1)(iii) to read as follows:

§ 86.1829–01 Durability and emission testing requirements; waivers.

* * * * *

(b) * * *

(1) * * *

(iii) *Data submittal waivers.* (A) In lieu of testing a methanol-fueled diesel-cycle light truck for particulate emissions a manufacturer may provide a statement in its application for certification that such light trucks comply with the applicable standards. Such a statement shall be based on previous emission tests, development tests, or other appropriate information and good engineering judgment.

(B) In lieu of testing an Otto-cycle light-duty vehicle, light-duty truck, or heavy-duty vehicle for particulate emissions for certification, 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.

(C) A manufacturer may petition the Administrator for a waiver of the requirement to submit total hydrocarbon emission data. If the waiver is granted, then in lieu of testing a certification light-duty vehicle or light-duty truck for total hydrocarbon emissions the manufacturer may provide a statement in its application for certification that such vehicles comply with the applicable standards. Such a statement shall be based on previous emission tests, development tests, or other appropriate information and good engineering judgment.

(D) A manufacturer may petition the Administrator to waive the requirement to measure particulate emissions when conducting Selective Enforcement Audit testing of Otto-cycle vehicles.

(E) In lieu of testing a gasoline, diesel, natural gas, liquefied petroleum gas, or hydrogen fueled Tier 2 or interim non-Tier 2 vehicle for formaldehyde emissions when such vehicles are certified based upon NMHC 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.

(F) In lieu of testing a petroleum-, natural gas-, liquefied petroleum gas-, or hydrogen-fueled heavy-duty vehicle for formaldehyde emissions for certification, 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.

(G) For the 2012 through 2016 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.

* * * * *

15. Section 86.1865–12 is amended as follows:

a. By revising paragraph (k)(5) introductory text.

b. By redesignating paragraph (k)(5)(iv) as paragraph (k)(5)(v).

c. By adding new paragraph (k)(5)(iv).

d. By revising paragraph (k)(6).

e. By revising paragraph (k)(7)(i).

f. By revising paragraph (k)(8)(iv)(A).

g. By revising paragraph (l)(1)(ii) introductory text.

h. By revising paragraph (l)(1)(ii)(F).

The revisions read as follows:

§ 86.1865–12 How to comply with the fleet average CO_2 standards.

* * * * *

(k) * * *

(5) Total credits or debits generated in a model year, maintained and reported separately for passenger automobiles and light trucks, shall be the sum of the credits or debits calculated in paragraph (k)(4) of this section and any of the following credits, if applicable, minus any N_2O and/or CH_4 CO_2-equivalent debits calculated according to the provisions of § 86.1818–12(f)(4):

* * * * *

(iv) Full size pickup truck credits earned according to the provisions of § 86.1866–12(e).

(6) The expiration date of unused CO_2 credits is based on the model year in which the credits are earned, as follows:

(i) Unused CO_2 credits from the 2009 model year shall retain their full value through the 2014 model year. Credits remaining at the end of the 2014 model year shall expire.

(ii) Unused CO_2 credits from the 2010 through 2015 model years shall retain their full value through the 2021 model year. Credits remaining at the end of the 2021 model year shall expire.

(iii) Unused CO_2 credits from the 2016 and later model years shall retain their full value through the five subsequent model years after the model year in which they were generated. Credits remaining at the end of the fifth model year after the model year in which they were generated shall expire.

(7) * * *

(i) Credits generated and calculated according to the method in paragraphs (k)(4) and (5) of this section may not be used to offset deficits other than those deficits accrued with respect to the standard in § 86.1818. 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 transferred 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.

* * * * *

(8) * * *

(iv) * * *

(A) If a manufacturer ceases production of passenger automobiles 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)(8)(i) of this section and may subject the manufacturer to an enforcement action for sale of vehicles not covered by a certificate, pursuant to paragraphs (k)(8)(ii) and (iii) of this section.

* * * * *

(l) * * *

(1) * * *

(ii) Manufacturers producing any passenger automobiles 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 automobile or light truck subject to this subpart:

* * * * *

(F) Carbon-related exhaust emission standard, N_2O emission standard, and CH_4 emission standard to which the passenger automobile or light truck is certified.

* * * * *

16. Section 86.1866–12 is amended as follows:

a. By revising the heading,

b. By revising paragraphs (a) and (b).

c. By revising paragraph (c) introductory text.

d. By revising paragraphs (c)(1) through (3).

e. By revising paragraph (c)(5) introductory text.

f. By revising paragraph (c)(5)(i).

g. By revising paragraph (c)(5)(iii) introductory text.

h. By redesignating paragraph (c)(5)(iv) and paragraph (c)(5)(v).

i. By adding new paragraph (c)(5)(iv).

j. By redesignating paragraph (c)(6) as (c)(8).

k. By adding paragraphs (c)(6) and (7).

l. By revising paragraph (d).

m. By adding paragraph (e).

The revisions and additions read as follows:

§ 86.1866–12 CO_2 fleet average credit and incentive programs.

(a) *Advanced technology vehicles.* (1) 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 and delivered for sale in the United States in the 2012 through 2025 model years 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.

(i) Model years 2012 through 2016: 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.

(ii) Model years 2017 through 2021: For electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles produced and delivered for sale in the 2017 through 2021 model years, such use of zero (0) grams/mile CO_2 is unrestricted.

(iii) Model years 2022 through 2025: 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 2022 through 2025 model years, except that a manufacturer that produces and delivers for sale 300,000 or more such vehicles in the 2019 through 2021 model years shall be subject to a limitation on the use of zero (0) grams/mile CO_2 to the first 600,000 combined electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles produced and delivered for sale by a manufacturer in the 2022 through 2025 model years.

(2) For 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 and delivered for sale in the United States in the 2017 through 2021 model years and that meet the additional specifications in this section, the manufacturer may use the production multipliers in this paragraph (a)(2) when determining the manufacturer's fleet average carbon-related exhaust emissions under § 600.512 of this chapter. Full size pickup trucks eligible for and using a production multiplier are not eligible for the performance-based credits described in paragraph (e)(3) of this section.

(i) The production multipliers, by model year, for electric vehicles and fuel cell vehicles, are as follows:

Model year	Production multiplier
2017	2.0
2018	2.0
2019	2.0
2020	1.75
2021	1.5

(ii) (A) The production multipliers, by model year, for plug-in hybrid electric vehicles, are as follows:

Model year	Production multiplier
2017	1.6
2018	1.6
2019	1.6
2020	1.45
2021	1.3

(B) The minimum all-electric driving range that a plug-in hybrid electric vehicle must have in order to qualify for use of a production multiplier is 10.2 miles on its nominal storage capacity of electricity when operated on the highway fuel economy test cycle. Alternatively, a plug-in hybrid electric vehicle may qualify for use of a production multiplier by having an equivalent all-electric driving range greater than or equal to 10.2 miles during its actual charge-depleting range as measured on the highway fuel economy test cycle and tested according to the requirements of SAE J1711, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles (incorporated by reference, see § 86.1). The equivalent all-electric range of a PHEV is determined from the following formula:

$$EAER = R_{CDA} \times \frac{(CO2_{CS} - CO2_{CD})}{CO2_{CS}}$$

Where:

EAER = the equivalent all-electric range attributed to charge-depleting operation of a plug-in hybrid electric vehicle on the highway fuel economy test cycle.

R_{CDA} = The actual charge-depleting range determined according to SAE J1711, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles (incorporated by reference, see § 86.1).

$CO2_{CS}$ = The charge-sustaining CO_2 emissions in grams per mile on the highway fuel economy test determined according to SAE J1711, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles (incorporated by reference, see § 86.1).

$CO2_{CD}$ = The charge-depleting CO_2 emissions in grams per mile on the highway fuel economy test determined according to SAE J1711, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles (incorporated by reference, see § 86.1).

(iii) The actual production of qualifying vehicles may be multiplied by the applicable value according to the model year, and the result, rounded to the nearest whole number, may be used to represent the production of qualifying vehicles when calculating average carbon-related exhaust emissions under § 600.512 of this chapter.

(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 automobiles 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 leakage 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:

$$Leakage\ Credit = MaxCredit \times \left[1 - \left(\frac{LeakScore}{16.6}\right)\right] \times \left(\frac{GWP_{REF}}{GWP_{HFC134a}}\right) - HiLeakDis$$

Where:

HiLeakDis means the high leak disincentive, which is zero for model years 2012 through 2016, and for 2017 and later model years is determined using the following equation, except that if GWP_{REF} is greater than 150 or if the result is less than zero HiLeakDis shall be set equal to zero and if the result is greater than 1.8 g/mi HiLeakDis shall be set to 1.8 g/mi:

$$HiLeakDis = 1.8 \times [((LeakScore - MinScore)/((16.6 - MinScore))]$$

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.

LeakScore 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 only electric compressors), the rate for the purpose of this formula shall be 8.3 grams/year (4.1 grams/year for systems using only electric compressors).

The constant 16.6 is the average passenger automobile 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.

MinScore is 8.3 grams/year, except that for systems using only electric compressors it is 4.1 grams/year.

(ii) Light trucks:

$$Leakage\ Credit = MaxCredit \times \left[1 - \left(\frac{LeakScore}{20.7}\right)\right] \times \left(\frac{GWP_{REF}}{GWP_{HFC134a}}\right) - HiLeakDis$$

Where:

HiLeakDis means the high leak disincentive, which is zero for model years 2012 through 2016, and for 2017 and later model years is determined using the following equation, except that if GWP_{REF} is greater than 150 or if the result is less than zero HiLeakDis shall be set equal to zero and if the result is greater than 2.1 g/mi HiLeakDis shall be set to 2.1g/mi:

$$HiLeakDis = 2.1 \times [((LeakScore - MinScore)/((20.7 - MinScore))]$$

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 only electric compressors), the rate for the purpose of this formula shall be 10.4 grams/year (5.2 grams/year for systems using only electric compressors).

The constant 20.7 is the average light truck 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.

MinScore is 10.4 grams/year, except that for systems using only electric compressors it is 5.2 grams/year.

(3) The total leakage reduction credits generated by the air conditioning system shall be calculated separately for passenger automobiles 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 automobiles 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 automobiles 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 automobiles 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 either paragraph (c)(5) or (6) of this section must be met before an air conditioning system is allowed to generate credits.

(1)(i) 2012 through 2016 model year air conditioning efficiency credits are available for the following technologies in the gram per mile amounts indicated in the following table:

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Air Conditioning Technology	**Credit Value (g/mi)**
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
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
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: 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.	1.7
Default to recirculated air with open-loop control air supply (no sensor feedback) whenever the ambient temperature is 75 °F or higher. 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.	1.1

Blower motor controls which limit wasted electrical energy (e.g. pulse width modulated power controller).	0.9
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
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
Oil separator. 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.	0.6

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(i) 2017 and later model year air conditioning efficiency credits are available for the following technologies in the gram per mile amounts indicated for each vehicle category in the following table:

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Air Conditioning Technology	**Passenger Automobiles (g/mi)**	**Light Trucks (g/mi)**
Reduced reheat, with externally-controlled, variable-displacement compressor (<u>e.g.</u> a compressor that controls displacement based on temperature setpoint and/or cooling demand of the air conditioning system control settings inside the passenger compartment).	1.5	2.2
Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable displacement compressor (<u>e.g.</u> 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).	1.0	1.4
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: 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.	1.5	2.2

Default to recirculated air with open-loop control air supply (no sensor feedback) whenever the ambient temperature is 75 °F or higher. 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.	1.0	1.4
Blower motor controls which limit wasted electrical energy (e.g. pulse width modulated power controller).	0.8	1.1
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).	1.0	1.4
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).	1.0	1.4

Oil separator. 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.	0.5	0.7

BILLING CODE 4910–59–C

(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.

(i) In the 2012 through 2016 model years the total credit value for an air conditioning system may not be greater than 5.7 grams per mile.

(ii) In the 2017 and later model years the total credit value for an air conditioning system may not be greater than 5.0 grams per mile for any passenger automobile or 7.2 grams per mile for any light truck.

(3) The total efficiency credits generated by an air conditioning system shall be calculated separately for passenger automobiles and light trucks according to the following formula:

Total Credits (Megagrams) = (Credit × Production × VLM) ÷ 1,000,000

Where:

Credit = the 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 automobiles 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 automobiles shall be 195,264 and for light trucks shall be 225,865.

* * * * *

(5) For the 2014 through 2016 model years, manufacturers must validate air conditioning credits by using the Air Conditioning Idle Test Procedure according to the provisions of this paragraph (c)(5). In lieu of using the Air Conditioning Idle Test Procedure to determine eligibility to generate air conditioning efficiency credits in the 2014 through 2016 model years, the manufacturer may choose the AC17 reporting option specified in paragraph (c)(7) of this section.

(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 § 86.165–12 of this part.

* * * * *

(iii) For an air conditioning system to be eligible to generate credits in the 2014 through 2016 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. In lieu of using 21.3 grams per minute, manufacturers may optionally use the procedures in paragraph (c)(5)(iv) of this section to determine an alternative limit value.

* * * * *

(iv) Optional Air Conditioning Idle Test limit value for 2014 through 2016 model years. For an air conditioning system to be eligible to generate credits in the 2014 through 2016 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 § 86.165–12 must be less than the value calculated by the following equation and rounded to the nearest tenth of gram per minute:

$$Idle\ Test\ Threshold = 20.5 - (1.58 \times Displacment)$$

(A) If the increased CO_2 emissions determined from the Idle Test Procedure in § 86.165–12 is less than or equal to the Idle Test Threshold, 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 § 86.165–12 is greater than the Idle Test Threshold and less than the Idle Test Threshold plus 6.4, the total credit value for use in paragraph (c)(3) of this section shall be as determined according to the following formula:

$$TCV = TCV_1 \times \left[1 - \left(\frac{ITP - ITT}{6.4}\right)\right]$$

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.
ITT = the Idle Test Threshold from paragraph (c)(5)(iii) or (c)(5)(iv) of this section, whichever is applicable.

(6) For the 2017 and later model years, manufacturers must validate air conditioning credits by using the AC17 Test Procedure according to the provisions of this paragraph (c)(6).

(i) For each air conditioning system selected by the manufacturer to generate air conditioning efficiency credits, the manufacturer shall perform the AC17 Air Conditioning Efficiency Test Procedure specified in § 86.167–14 of this part, according to the requirements of this paragraph (c)(6).

(ii) Each air conditioning system shall be tested as follows:

(A) Perform the AC17 test on a vehicle that incorporates the air conditioning system with the credit-generating technologies.

(B) Perform the AC17 test on a vehicle which does not incorporate the credit-generating technologies. The tested vehicle must be similar to the vehicle tested under paragraph (c)(6)(ii)(A) of this section.

(C) Subtract the CO_2 emissions determined from testing under paragraph (c)(6)(ii)(A) of this section from the CO_2 emissions determined from testing under paragraph (c)(6)(ii)(B) of this section and round to the nearest 0.1 grams/mile. If the result is less than or equal to zero, the air conditioning system is not eligible to generate credits. If the result is greater than or equal to the total of the gram per mile credits determined in paragraph (c)(2) of this section, then the air conditioning system is eligible to generate the maximum allowable value determined in paragraph (c)(2) of this section. If the result is greater than zero but less than the total of the gram per mile credits determined in paragraph (c)(2) of this section, then the air conditioning system is eligible to generate credits in the amount determined by subtracting the CO_2 emissions determined from testing under paragraph (c)(6)(ii)(A) of this section from the CO_2 emissions determined from testing under paragraph (c)(6)(ii)(B) of this section and rounding to the nearest 0.1 grams/mile.

(iii) For the first model year for which an air conditioning system is expected to generate credits, the manufacturer must select for testing the highest-selling subconfiguration within each vehicle platform that uses the air conditioning system. Credits may continue to be generated by the air conditioning system installed in a vehicle platform provided that:

(A) The air conditioning system components and/or control strategies do not change in any way that could be expected to cause a change in its efficiency;

(B) The vehicle platform does not change in design such that the changes could be expected to cause a change in the efficiency of the air conditioning system; and

(C) The manufacturer continues to test at least one sub-configuration within each platform using the air conditioning system, in each model year, until all sub-configurations within each platform have been tested.

(iv) Each air conditioning system must be tested and must meet the testing criteria in order to be allowed to generate credits. Using good engineering judgment, in the first model year for which an air conditioning system is expected to generate credits, the manufacturer must select for testing the highest-selling subconfiguration within each vehicle platform using the air conditioning system. Credits may continue to be generated by an air conditioning system in subsequent model years if the manufacturer continues to test at least one sub-configuration within each platform on an annual basis, as long as the air conditioning system and vehicle platform do not change substantially.

(7) AC17 reporting requirements for model years 2014 through 2016. As an alternative to the use of the Air Conditioning Idle Test to demonstrate eligibility to generate air conditioning efficiency credits, manufacturers may use the provisions of this paragraph (c)(7).

(i) The manufacturer shall perform the AC17 test specified in § 86.167–14 of this part on each vehicle platform for which the manufacturer intends to accrue air conditioning efficiency credits and report the results separately for all four phases of the test to the Environmental Protection Agency.

(ii) The manufacturer shall also report the following information for each vehicle tested: The vehicle class, model type, curb weight, engine displacement, transmission class and configuration, interior volume, climate control system type and characteristics, refrigerant used, compressor type, and evaporator/condenser characteristics.

(d) *Off-cycle credits.* Manufacturers may generate credits for CO_2-reducing technologies where the CO_2 reduction benefit of the technology is not adequately captured on the Federal Test Procedure and/or the Highway Fuel Economy Test. These technologies must have a measurable, demonstrable, and verifiable real-world CO_2 reduction that occurs outside the conditions of the Federal Test Procedure and the Highway Fuel Economy Test. These optional credits are referred to as ''off-cycle'' credits. Off-cycle technologies used to generate emission credits are considered emission-related components subject to applicable requirements, and must 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. The manufacturer must use one of the three options specified in this paragraph (d) to determine the CO_2 gram per mile credit applicable to an off-cycle technology. Note that the option provided in paragraph (d)(1) of this section applies only to the 2017 and later model years. The manufacturer should notify EPA in their pre-model year report of their intention to generate any credits under this paragraph (d).

(1) *Credit available for certain off-cycle technologies.* The provisions of this paragraph (d)(1) are applicable only to 2017 and later model year vehicles.

(i) The manufacturer may generate a CO_2 gram/mile credit for certain technologies as specified in the following table, provided that each technology is applied to the minimum percentage of the manufacturer's total U.S. production of passenger automobiles and light trucks specified in the table in each model year for which credit is claimed. Technology definitions are in paragraph (d)(1)(iv) of this section.

Off-Cycle Technology	**Passenger Automobiles (g/mi)**	**Light Trucks (g/mi)**	**Minimum percent of U.S. production**
Active aerodynamics	0.6	1.0	10
High efficiency exterior lighting	1.1	1.1	10
Engine heat recovery	0.7 per 100W of capacity	0.7 per 100W of capacity	n/a
Engine start-stop (idle-off)	2.9	4.5	10
Active transmission warm-up	1.8	1.8	10
Active engine warm-up	1.8	1.8	10
Electric heater circulation pump	1.0	1.5	n/a
Solar roof panels	3.0	3.0	n/a
Thermal control	3.0	4.3	n/a

(A) Credits may also be accrued for thermal control technologies as defined in paragraph (d)(1)(iv) of this section in the amounts shown in the following table:

Thermal Control Technology	Credit value: Passenger Automobiles (g/mi)	Credit Value: Light Trucks (g/mi)
Glass or glazing	≤2.9	≤3.9
Active seat ventilation	1.0	1.3
Solar reflective paint	0.4	0.5
Passive cabin ventilation	1.7	2.3
Active cabin ventilation	2.1	2.8

(B) The maximum credit allowed for thermal control technologies is limited to 3.0 g/mi for passenger automobiles and to 4.3 g/mi for light trucks. The maximum credit allowed for glass or glazing is limited to 3.0 g/mi for passenger automobiles and to 4.3 g/mi for light trucks.

(C) Glass or glazing credits are calculated using the following equation:

$$\text{Credit} = \left[Z \times \sum_{i=1}^{n} \frac{T_i \times G_i}{G} \right]$$

Where:

Credit = the total glass or glazing credits, in grams per mile, for a vehicle, which may not exceed 3.0 g/mi for passenger automobiles or 4.3 g/mi for light trucks;

Z = 0.3 for passenger automobiles and 0.4 for light trucks;

G_i = the measured glass area of window i, in square meters and rounded to the nearest tenth;

G = the total glass area of the vehicle, in square meters and rounded to the nearest tenth;

T_i = the estimated temperature reduction for the glass area of window i, determined using the following formula:

$$T_i = 0.3987 \times (Tts_{base} - Tts_{new})$$

Where:

Tts_{new} = the total solar transmittance of the glass, measured according to ISO 13837, "Safety glazing materials—Method for determination of solar transmittance" (incorporated by reference; see § 86.1).

Tts_{base} = 62 for the windshield, side-front, side-rear, rear-quarter, and backlite locations, and 40 for rooflite locations.

(ii) The maximum allowable decrease in the manufacturer's combined passenger automobile and light truck fleet average CO_2 emissions attributable to use of the default credit values in paragraph (d)(1)(i) of this section is 10 grams per mile. If the total of the CO_2 g/mi credit values from the table in paragraph (d)(1)(i) of this section does not exceed 10 g/mi for any passenger automobile or light truck in a manufacturer's fleet, then the total off-cycle credits may be calculated according to paragraph (d)(5) of this section. If the total of the CO_2 g/mi credit values from the table in paragraph (d)(1)(i) of this section exceeds 10 g/mi for any passenger automobile or light truck in a manufacturer's fleet, then the gram per mile decrease for the combined passenger automobile and light truck fleet must be determined according to paragraph (d)(1)(ii)(A) of this section to determine whether the 10 g/mi limitation has been exceeded.

(A) Determine the gram per mile decrease for the combined passenger automobile and light truck fleet using the following formula:

$$\text{Decrease} = \frac{Credits \times 1{,}000{,}000}{[(\text{Prod}_\text{C} \times 195{,}264) + (\text{Prod}_\text{T} \times 225{,}865)]}$$

Where:

Credits = The total of passenger automobile and light truck credits, in Megagrams, determined according to paragraph (d)(5) of this section and limited to those credits accrued by using the default gram per mile values in paragraph (d)(1)(i) of this section.

Prod_C = The number of passenger automobiles produced by the manufacturer and delivered for sale in the U.S.

Prod_T = The number of light trucks produced by the manufacturer and delivered for sale in the U.S.

(B) If the value determined in paragraph (d)(1)(ii)(A) of this section is greater than 10 grams per mile, the total credits, in Megagrams, that may be accrued by a manufacturer using the default gram per mile values in paragraph (d)(1)(i) of this section shall be determined using the following formula:

$$\text{Credit (Megagrams)} = \frac{[10 \times ((\text{Prod}_C \times 195{,}264) + (\text{Prod}_T \times 225{,}865))]}{1}{,}000{,}000$$

Where:

Prod_C = The number of passenger automobiles produced by the manufacturer and delivered for sale in the U.S.

Prod_T = The number of light trucks produced by the manufacturer and delivered for sale in the U.S.

(C) If the value determined in paragraph (d)(1)(ii)(A) of this section is not greater than 10 grams per mile, then the credits that may be accrued by a manufacturer using the default gram per mile values in paragraph (d)(1)(i) of this section do not exceed the allowable limit, and total credits may be determined for each category of vehicles according to paragraph (d)(5) of this section.

(D) If the value determined in paragraph (d)(1)(ii)(A) of this section is greater than 10 grams per mile, then the combined passenger automobile and light truck credits, in Megagrams, that may be accrued using the calculations in paragraph (d)(5) of this section must not exceed the value determined in paragraph (d)(1)(ii)(B) of this section. This limitation should generally be done by reducing the amount of credits attributable to the vehicle category that caused the limit to be exceeded such that the total value does not exceed the value determined in paragraph (d)(1)(ii)(B) of this section.

(iii) In lieu of using the default gram per mile values specified in paragraph (d)(1)(i) of this section for specific technologies, a manufacturer may determine an alternative value for any of the specified technologies. An alternative value must be determined using one of the methods specified in paragraph (d)(2) or (3) of this section.

(iv) Definitions for the purposes of this paragraph (d)(1) are as follows:

(A) *Active aerodynamic improvements* means technologies that are activated only at certain speeds to improve aerodynamic efficiency by a minimum of three percent, while preserving other vehicle attributes or functions.

(B) *Electric heater circulation pump* means a pump system installed in a stop-start equipped vehicle or in a hybrid electric vehicle or plug-in hybrid electric vehicle that continues to circulate hot coolant through the heater core when the engine is stopped during a stop-start event. This system must be calibrated to keep the engine off for 1 minute or more when the external ambient temperature is 30 deg F.

(C) *High efficiency exterior lighting* means a lighting technology that, when installed on the vehicle, is expected to reduce the total electrical demand of the exterior lighting system by a minimum of 60 watts when compared to conventional lighting systems. To be eligible for this credit the high efficiency lighting must be installed in the following components: Parking/position, front and rear turn signals, front and rear side markers, stop/brake lights (including the center-mounted location), taillights, backup/reverse lights, and license plate lighting.

(D) *Engine start-stop* means a technology which enables a vehicle to automatically turn off the engine when the vehicle comes to a rest and restart the engine when the driver applies pressure to the accelerator or releases the brake. Off-cycle engine start-stop credits will only be allowed if the Administrator has made a determination under the testing and calculation provisions in 40 CFR part 600 that engine start-stop is the predominant operating mode.

(E) *Solar roof panels* means the installation of solar panels on an electric vehicle or a plug-in hybrid electric vehicle such that the solar energy is used to provide energy to the electric drive system of the vehicle by charging the battery or directly providing power to the electric motor with the equivalent of at least 50 Watts of rated electricity output.

(F) *Active transmission warmup* means a system that uses waste heat from the exhaust system to warm the transmission fluid to an operating temperature range quickly using a heat exchanger in the exhaust system, increasing the overall transmission efficiency by reducing parasitic losses associated with the transmission fluid, such as losses related to friction and fluid viscosity.

(G) *Active engine warmup* means a system using waste heat from the exhaust system to warm up targeted parts of the engine so that it reduces engine friction losses and enables the closed-loop fuel control more quickly. It would allow a faster transition from cold operation to warm operation, decreasing CO_2 emissions, and increasing fuel economy.

(H) *Engine heat recovery* means a system that captures heat that would otherwise be lost through the exhaust system or through the radiator and converting that heat to electrical energy that is used to meet the electrical requirements of the vehicle. Such a system must have a capacity of at least 100W to achieve 0.7 g/mi of credit. Every additional 100W of capacity will result in an additional 0.7 g/mi of credit.

(I) *Active seat ventilation* means a device which draws air from the seating surface which is in contact with the occupant and exhausts it to a location away from the seat.

(J) *Solar reflective paint* means a vehicle paint or surface coating which reflects at least 65 percent of the impinging infrared solar energy, as determined using ASTM standards E903, E1918–06, or C1549–09. These ASTM standards are incorporated by reference; see § 86.1.

(K) *Passive cabin ventilation* means ducts or devices which utilize convective airflow to move heated air from the cabin interior to the exterior of the vehicle.

(L) *Active cabin ventilation* means devices which mechanically move heated air from the cabin interior to the exterior of the vehicle.

(2) *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 the off-cycle city/highway combined carbon-related exhaust emissions benefit by using the EPA 5-cycle methodology described in 40 CFR Part 600. Testing shall be performed on a representative vehicle, selected using good engineering judgment, for each model type for which the credit is being demonstrated. The emission benefit of a technology is determined by testing both with and without the off-cycle technology operating. Multiple off-cycle technologies may be demonstrated on a test vehicle. The manufacturer shall conduct the following steps and submit all test data to the EPA.

(i) Testing without the off-cycle technology installed and/or operating. 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. Run each of these tests a minimum of three times without the off-cycle technology installed and operating and average the per phase (bag) results for each test procedure. Calculate the 5-cycle weighted city/highway combined carbon-related exhaust emissions from the averaged per phase results, where the 5-cycle city value is weighted 55% and the 5-cycle highway value is weighted 45%. The resulting combined city/highway value is the baseline 5-cycle carbon-related exhaust emission value for the vehicle.

(ii) Testing with the off-cycle technology installed and/or operating. Determine carbon-related exhaust emissions over 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. Run each of these tests a minimum of three times with the off-cycle technology installed and operating and average the per phase (bag) results for each test procedure. Calculate the 5-cycle weighted city/highway combined carbon-related exhaust emissions from the averaged per phase results, where the 5-cycle city value is weighted 55% and the 5-cycle highway value is weighted 45%. Use the averaged per phase results for the FTP and HFET determined in paragraph (d)(2)(i) of this section for operation without the off-cycle technology in this calculation. The resulting combined city/highway value is the 5-cycle carbon-related exhaust emission value showing the off-cycle benefit of the technology but excluding any benefit of the technology on the FTP and HFET.

(iii) Subtract the combined city/highway value determined in paragraph (d)(2)(i) of this section from the value determined in paragraph (d)(2)(ii) of this section. The result is the off-cycle benefit of the technology or technologies being evaluated. If this benefit is greater than or equal to three percent of the value determined in paragraph (d)(2)(i) of this section then the manufacturer may use this value, rounded to the nearest tenth of a gram per mile, to determine credits under paragraph (d)(4) of this section.

(iv) If the value calculated in paragraph (d)(2)(iii) of this section is less than three percent of the value determined in paragraph (d)(2)(i) of this section, then the manufacturer must repeat the testing required under paragraphs (d)(2)(i) and (ii) of this section, except instead of running each test three times they shall run each test two additional times. The off-cycle benefit of the technology or technologies being evaluated shall be calculated as in paragraph (d)(2)(iii) of this section using all the tests conducted under paragraph (d) of this section. If the value calculated in paragraph (d)(2)(iii) of this section is less than three percent of the value determined in paragraph (d)(2)(i) of this section, then the manufacturer must verify the emission reduction potential of the off-cycle technology or technologies using the EPA Vehicle Simulation Tool (incorporated by reference; see § 86.1), and if the results support a credit value that is less than three percent of the value determined in paragraph (d)(2)(i) of this section then the manufacturer may use the off-cycle benefit of the technology or technologies calculated as in paragraph (d)(2)(iii) of this section using all the tests conducted under paragraph (d) of this section, rounded to the nearest tenth of a gram per mile, to determine credits under paragraph (d)(4) of this section.

(3) *Technology demonstration using alternative EPA-approved methodology.* (i) This option may be used only with EPA approval, and the manufacturer must be able to justify to the Administrator why the 5-cycle option described in paragraph (d)(2) of this section insufficiently characterizes the effectiveness of the off-cycle technology. In cases where the EPA 5-cycle methodology described in paragraph (d)(2) 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. The manufacturer may seek EPA input on the proposed methodology prior to conducting testing or analytical work, and EPA will provide input on the manufacturer's analytical plan. 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.

(ii) *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 first model year for which the Administrator has issued a final approval.

(4) *Review and approval process for off-cycle credits.* (i) *Initial steps required.* (A) A manufacturer requesting off-cycle credits under the provisions of paragraph (d)(2) of this section must conduct the testing and/or simulation described in that paragraph.

(B) A manufacturer requesting off-cycle credits under the provisions of paragraph (d)(3) of this section must develop a methodology for demonstrating and determining the benefit of the off-cycle technology, and carry out any necessary testing and analysis required to support that methodology.

(C) A manufacturer requesting off-cycle credits under paragraph (d) of this section must conduct testing and/or prepare engineering analyses that demonstrate the in-use durability of the technology for the full useful life of the vehicle.

(ii) *Data and information requirements.* The manufacturer seeking off-cycle credits must submit an application for off-cycle credits determined under paragraphs (d)(2) and (d)(3) of this section. The application must contain the following:

(A) A detailed description of the off-cycle technology and how it functions to reduce CO_2 emissions under conditions not represented on the FTP and HFET.

(B) A list of the vehicle model(s) which will be equipped with the technology.

(C) A detailed description of the test vehicles selected and an engineering analysis that supports the selection of those vehicles for testing.

(D) All testing and/or simulation data required under paragraph (d)(2) or (d)(3) of this section, as applicable, plus any other data the manufacturer has considered in the analysis.

(E) For credits under paragraph (d)(3) of this section, a complete description of the methodology used to estimate the off-cycle benefit of the technology and all supporting data, including vehicle testing and in-use activity data.

(F) An estimate of the off-cycle benefit by vehicle model and the fleetwide benefit based on projected sales of vehicle models equipped with the technology.

(G) An engineering analysis and/or component durability testing data or whole vehicle testing data demonstrating the in-use durability of the off-cycle technology components.

(iii) *EPA review of the off-cycle credit application.* Upon receipt of an application from a manufacturer, EPA will do the following:

(A) Review the application for completeness and notify the manufacturer within 30 days if additional information is required.

(B) Review the data and information provided in the application to determine if the application supports the level of credits estimated by the manufacturer.

(C) For credits under paragraph (d)(3) of this section, EPA will make the application available to the public for comment, as described in paragraph (d)(3)(ii) of this section, within 60 days of receiving a complete application. The public review period will be specified as 30 days, during which time the public may submit comments. Manufacturers may submit a written rebuttal of comments for EPA consideration or may revise their application in response to comments. A revised application should be submitted after the end of the public review period, and EPA will review the application as if it was a new application submitted under this paragraph (d)(4)(iii).

(iv) *EPA decision.* (A) For credits under paragraph (d)(2) of this section, EPA will notify the manufacturer of its decision within 60 days of receiving a complete application.

(B) For credits under paragraph (d)(3) of this section, EPA will notify the manufacturer of its decision after reviewing and evaluating the public comments. EPA will make the decision and rationale available to the public.

(C) EPA will notify the manufacturer in writing of its decision to approve or deny the application, and will provide the reasons for the decision. EPA will make the decision and rationale available to the public.

(5) *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 credit value in grams per mile determined in paragraph (d)(1), (d)(2) or (d)(3) of this section.

Production = The total number of passenger automobiles or light trucks, whichever is applicable, produced with the off-cycle technology to which to the credit value determined in paragraph (d)(1), (d)(2), or (d)(3) of this section applies.

VLM = vehicle lifetime miles, which for passenger automobiles shall be 195,264 and for light trucks shall be 225,865.

(e) *Credits for certain full-size pickup trucks.* Full-size pickup trucks may be eligible for additional credits based on the implementation of hybrid technologies or on exhaust emission performance, as described in this paragraph (e). Credits may be generated under either paragraph (e)(2) or (e)(3) of this section for a qualifying pickup truck, but not both.

(1) The following definitions apply for the purposes of this paragraph (e).

(i) *Full size pickup truck* means a light truck which has a passenger compartment and an open cargo box and which meets the following specifications:

(A) A minimum cargo bed width between the wheelhouses of 48 inches, measured as the minimum lateral distance between the limiting interferences (pass-through) of the wheelhouses. The measurement shall exclude the transitional arc, local protrusions, and depressions or pockets, if present. An open cargo box means a vehicle where the cargo box does not have a permanent roof. Vehicles sold with detachable covers are considered ''open'' for the purposes of these criteria.

(B) A minimum open cargo box length of 60 inches, where the length is defined by the lesser of the pickup bed length at the top of the body and the pickup bed length at the floor, where the length at the top of the body is defined as the longitudinal distance from the inside front of the pickup bed to the inside of the closed endgate as measured at the cargo floor surface along vehicle centerline, and the length at the floor is defined as the longitudinal distance from the inside front of the pickup bed to the inside of the closed endgate as measured at the cargo floor surface along vehicle centerline.

(C) A minimum towing capability of 5,000 pounds, where minimum towing capability is determined by subtracting the gross vehicle weight rating from the gross combined weight rating, or a minimum payload capability of 1,700 pounds, where minimum payload capability is determined by subtracting the curb weight from the gross vehicle weight rating.

(ii) *Mild hybrid gasoline-electric vehicle* means a vehicle that has start/stop capability and regenerative braking capability, where the recaptured braking energy over the Federal Test Procedure is at least 15 percent but less than 75 percent of the total braking energy, where the percent of recaptured braking energy is measured and calculated according to § 600.116–12(c).

(iii) *Strong hybrid gasoline-electric vehicle* means a vehicle that has start/stop capability and regenerative braking capability, where the recaptured braking energy over the Federal Test Procedure is at least 75 percent of the total braking energy, where the percent of recaptured braking energy is measured and calculated according to § 600.116–12(c).

(2) *Credits for implementation of gasoline-electric hybrid technology.* Full size pickup trucks that implement hybrid gasoline-electric technologies may be eligible for an additional credit under this paragraph (e)(2). Pickup trucks using the credits under this paragraph (e)(2) may not use the credits described in paragraph (e)(3) of this section.

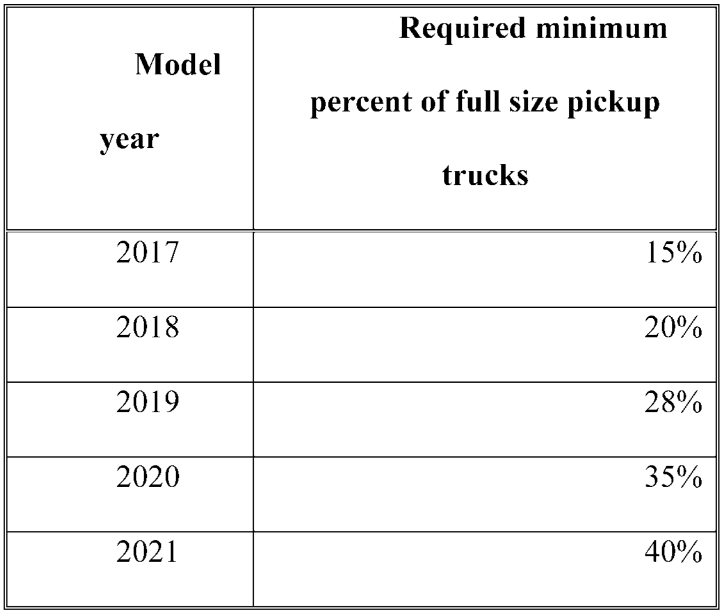
(i) Full size pickup trucks that are mild hybrid gasoline-electric vehicles and that are produced in the 2017 through 2021 model years are eligible for a credit of 10 grams/mile. To receive this credit, the manufacturer must produce a quantity of mild hybrid full size pickup trucks such that the proportion of production of such vehicles, when compared to the manufacturer's total production of full size pickup trucks, is not less than the amount specified in the table below for each model year.

Model year	**Required minimum percent of full size pickup trucks**
2017	30%
2018	40%
2019	55%
2020	70%
2021	80%

(ii) Full size pickup trucks that are strong hybrid gasoline-electric vehicles and that are produced in the 2017 through 2025 model years are eligible for a credit of 20 grams/mile. To receive this credit, the manufacturer must produce a quantity of strong hybrid full size pickup trucks such that the proportion of production of such vehicles, when compared to the manufacturer's total production of full size pickup trucks, is not less than 10 percent for each model year.

(3) *Credits for emission reduction performance.* Full size pickup trucks that achieve carbon-related exhaust emission values below the applicable target value determined in 86.1818–12(c)(3) may be eligible for an additional credit. For the purposes of this paragraph (e)(3), carbon-related exhaust emission values may include any applicable air conditioning leakage and/or efficiency credits as determined in paragraphs (b) and (c) of this section. Pickup trucks using the credits under this paragraph (e)(3) may not use the credits described in paragraph (e)(2) of this section or the production multipliers described in paragraph (a)(2) of this section.

(i) Full size pickup trucks that achieve carbon-related exhaust emissions less than or equal to the applicable target value determined in 86.1818–12(c)(3) multiplied by 0.85 (rounded to the nearest gram/mile) and greater than the applicable target value determined in 86.1818–12(c)(3) multiplied by 0.80 (rounded to the nearest gram/mile) in a model year are eligible for a credit of 10 grams/mile. A pickup truck that qualifies for this credit in a model year may claim this credit for subsequent model years through the 2021 model year if the carbon-related exhaust emissions of that pickup truck do not increase relative to the emissions in the model year in which the pickup truck qualified for the credit. To qualify for this credit in each model year, the manufacturer must produce a quantity of full size pickup trucks that meet the initial emission eligibility requirements of this paragraph (e)(3)(i) such that the proportion of production of such vehicles, when compared to the manufacturer's total production of full size pickup trucks, is not less than the amount specified in the table below for each model year.



Model year	Required minimum percent of full size pickup trucks
2017	15%
2018	20%
2019	28%
2020	35%
2021	40%

(ii) Full size pickup trucks that achieve carbon-related exhaust emissions less than or equal to the applicable target value determined in 86.1818–12(c)(3) multiplied by 0.80 (rounded to the nearest gram/mile) in a model year are eligible for a credit of 20 grams/mile. A pickup truck that qualifies for this credit in a model year may claim this credit for a maximum of five subsequent model years if the carbon-related exhaust emissions of that pickup truck do not increase relative to the emissions in the model year in which the pickup truck first qualified for the credit. This credit may not be claimed in any model year after 2025. To qualify for this credit, the manufacturer must produce a quantity of full size pickup trucks that meet the emission requirements of this paragraph (e)(3)(i) such that the proportion of production of such vehicles, when compared to the manufacturer's total production of full size pickup trucks, is not less than 10 percent in each model year. A pickup truck that qualifies for this credit in a model year and is subject to a major redesign in a subsequent model year such that it qualifies for the credit in the model year of the redesign may be allowed to qualify for an additional five years (not to go beyond the 2025 model year) with the approval of the Administrator.

(4) *Calculation of total full size pickup truck credits.* Total credits in Megagrams of CO_2 (rounded to the nearest whole number) shall be calculated for qualifying full size pickup trucks according to the following formula:

$$\text{Total Credits (Megagrams)} = ([(10 \times \text{Production}_{10}) + (20 \times \text{Production}_{20})] \times 225{,}865) \div 1{,}000{,}000$$

Where:

Production_{10} = The total number of full size pickup trucks produced with a credit value of 10 grams per mile from paragraphs (e)(2) and (e)(3).

Production_{20} = The total number of full size pickup trucks produced with a credit value of 20 grams per mile from paragraphs (e)(2) and (e)(3).

17. Section 86.1867–12 is amended by revising paragraph (a)(2)(i) to read as follows:

§ 86.1867–12 Optional early CO_2 credit programs.

* * * * *

(a) * * *

(2) * * *

(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 automobiles, 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.

* * * * *

PART 600—FUEL ECONOMY AND GREENHOUSE GAS EXHAUST EMISSIONS OF MOTOR VEHICLES

18. The authority citation for part 600 continues to read as follows:

Authority: 49 U.S.C. 32901—23919q, Pub. L. 109–58.

Subpart B—[Amended]

19. Section 600.002 is amended by revising the definitions of "combined fuel economy" and "fuel economy" to read as follows:

§ 600.002 Definitions.

* * * * *

Combined fuel economy means:

(1) The fuel economy value determined for a vehicle (or vehicles) by harmonically averaging the city and highway fuel economy values, weighted 0.55 and 0.45, respectively.

(2) For electric vehicles, for the purpose of calculating average fuel economy pursuant to the provisions of part 600, subpart F, the term means the equivalent petroleum-based fuel economy value as determined by the calculation procedure promulgated by the Secretary of Energy. For the purpose of labeling pursuant to the provisions of part 600, subpart D, the term means the fuel economy value as determined by the procedures specified in § 600.116–12.

* * * * *

Fuel economy means:

(1) The average number of miles traveled by an automobile or group of automobiles per volume of fuel consumed as calculated in this part; or

(2) For the purpose of calculating average fuel economy pursuant to the

provisions of part 600, subpart F, fuel economy for electrically powered automobiles means the equivalent petroleum-based fuel economy as determined by the Secretary of Energy in accordance with the provisions of 10 CFR part 474. For the purpose of labeling pursuant to the provisions of part 600, subpart D, the term means the fuel economy value as determined by the procedures specified in § 600.116–12.

* * * * *

20. Section 600.111–08 is amended by revising the introductory text to read as follows:

§ 600.111–08 Test procedures.

This section provides test procedures for the FTP, highway, US06, SC03, and the cold temperature FTP tests. Testing shall be performed according to test procedures and other requirements contained in this part 600 and in part 86 of this chapter, including the provisions of part 86, subparts B, C, and S. Test hybrid electric vehicles using the procedures of SAE J1711 (incorporated by reference in § 600.011). For FTP testing, this generally involves emission sampling over four phases (bags) of the UDDS (cold-start, transient, warm-start, transient); however, these four phases may be combined into two phases (phases 1 + 2 and phases 3 + 4). Test plug-in hybrid electric vehicles using the procedures of SAE J1711 (incorporated by reference in § 600.011) as described in § 600.116–12. Test electric vehicles using the procedures of SAE J1634 (incorporated by reference in § 600.011) as described in § 600.116–12.

* * * * *

21. Section 600.113–12 is amended by revising paragraphs (g)(2)(iv)(C) and (j) through (m) to read as follows:

§ 600.113–12 Fuel economy, CO_2 emissions, and carbon-related exhaust emission calculations for FTP, HFET, US06, SC03 and cold temperature FTP tests.

* * * * *

(g) * * *

(2) * * *

(iv) * * *

(C) For the 2012 through 2016 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.

* * * * *

(j)(1) For methanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and methanol, the fuel economy in miles per gallon of methanol 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 and rounded according to paragraph (g)(3) of this section.

SG = Specific gravity of the fuel as determined in paragraph (f)(2)(i) of this section and rounded according to paragraph (g)(3) of this section.

CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons = CWF as determined in paragraph (f)(2)(ii) of this section and rounded according to paragraph (g)(3) of this section (for M100 fuel, CWF_{exHC} = 0.866).

HC = Grams/mile HC as obtained in paragraph (g)(1) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(1) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(1) of this section.

CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (g)(1) of this section.

HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g)(1) 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 while operating on methanol 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.

CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons = CWF as determined in paragraph (f)(2)(ii) of this section and rounded according to paragraph (g)(3) of this section (for M100 fuel, CWF_{exHC} = 0.866).

HC = Grams/mile HC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (g)(2) of this section.

HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g)(2) of this section.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818 of this chapter, the carbon-related exhaust emissions in grams per mile for 2012 and later model year methanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and methanol while operating on 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.

CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons = CWF as determined in paragraph (f)(2)(ii) of this section and rounded according to paragraph (g)(3) of this section (for M100 fuel, CWF_{exHC} = 0.866).

NMHC = Grams/mile HC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (g)(2) of this section.

HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g)(2) of this section.

N_2O = Grams/mile N_2O as obtained in paragraph (g)(2) of this section.

CH_4 = Grams/mile CH_4 as obtained in paragraph (g)(2) of this section.

(k)(1) For automobiles fueled with natural gas and automobiles designed to operate on gasoline and 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 gasoline gallon equivalent of natural gas.

$CWF_{HC/NG}$ = carbon weight fraction based on the hydrocarbon constituents in the natural gas fuel as obtained in paragraph (f)(3) of this section and rounded according to paragraph (g)(3) of this section.

D_{NG} = density of the natural gas fuel [grams/ft³ at 68 °F (20 °C) and 760 mm Hg (101.3

kPa)] pressure as obtained in paragraph (g)(3) 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 obtained in paragraph (g)(2) 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 and rounded according to paragraph (g)(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)(3) 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 (incorporated by reference in § 600.011).

(2)(i) For automobiles fueled with natural gas and automobiles designed to operate on gasoline and natural gas, the carbon-related exhaust emissions in grams per mile while operating on natural gas is to be calculated for 2012 and later model year vehicles using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = 2.743 \times CH_4 + CWF_{NMHC}/0.273 \times NMHC + 1.571 \times CO + CO_2$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002.

CH_4 = Grams/mile CH_4 as obtained in paragraph (g)(2) of this section.

NMHC = Grams/mile NMHC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

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 and rounded according to 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 of this chapter, the carbon-related exhaust emissions in grams per mile for 2012 and later model year automobiles fueled with natural gas and automobiles designed to operate on gasoline and natural gas while operating on 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.

CH_4 = Grams/mile CH_4as obtained in paragraph (g)(2) of this section.

NMHC = Grams/mile NMHC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

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 and rounded according to paragraph (f)(3) of this section.

N_2O = Grams/mile N_2O as obtained in paragraph (g)(2) 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 of ethanol 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 and rounded according to paragraph (f)(3) of this section.

SG = Specific gravity of the fuel as determined in paragraph (f)(4) of this section and rounded according to paragraph (f)(3) of this section.

CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons = CWF as determined in paragraph (f)(4) of this section and rounded according to paragraph (f)(3) of this section.

HC = Grams/mile HC as obtained in paragraph (g)(1) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(1) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(1) of this section.

CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (g)(1) of this section.

HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g)(1) of this section.

C_2H_5OH = Grams/mile C_2H_5OH (ethanol) as obtained in paragraph (g)(1) of this section.

C_2H_4O = Grams/mile C_2H_4O (acetaldehyde) as obtained in paragraph (g)(1) 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 while operating on ethanol 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.

CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons = CWF as determined in paragraph (f)(4) of this section and rounded according to paragraph (f)(3) of this section.

HC = Grams/mile HC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (g)(2) of this section.

HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g)(2) of this section.

C_2H_5OH = Grams/mile C_2H_5OH (ethanol) as obtained in paragraph (g)(2) of this section.

C_2H_4O = Grams/mile C_2H_4O (acetaldehyde) as obtained in paragraph (g)(2) of this section.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818 of this chapter, the carbon-related exhaust emissions in grams per mile for 2012 and later model year ethanol-fueled automobiles and automobiles designed to operate on mixtures of gasoline and ethanol while operating on 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.

CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons = CWF as determined in paragraph (f)(4) of this section and rounded according to paragraph (f)(3) of this section.

NMHC = Grams/mile HC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

CH_3OH = Grams/mile CH_3OH (methanol) as obtained in paragraph (g)(2) of this section.

HCHO = Grams/mile HCHO (formaldehyde) as obtained in paragraph (g)(2) of this section.

C_2H_5OH = Grams/mile C_2H_5OH (ethanol) as obtained in paragraph (g)(2) of this section.

C_2H_4O = Grams/mile C_2H_4O (acetaldehyde) as obtained in paragraph (g)(2) of this section.

N_2O = Grams/mile N_2O as obtained in paragraph (g)(2) of this section.

CH_4 = Grams/mile CH_4 as obtained in paragraph (g)(2) of this section.

(m) Manufacturers shall determine CO_2 emissions and carbon-related exhaust emissions for electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles according to the provisions of this paragraph (m). Subject to the limitations on the number of vehicles produced and delivered for sale as described in § 86.1866 of this chapter, the manufacturer may be allowed to use a value of 0 grams/mile to represent the emissions of fuel cell vehicles and the proportion of electric operation of a electric vehicles and plug-in hybrid electric vehicles that is derived from electricity that is generated from sources that are not onboard the vehicle, as described in paragraphs (m)(1) through (3) of this section. For purposes of labeling under this part, the CO_2 emissions for electric vehicles shall be 0 grams per mile. Similarly, for purposes of labeling under this part, the CO_2 emissions for plug-in hybrid electric vehicles shall be 0 grams per mile for the proportion of electric operation that is derived from electricity that is generated from sources that are not onboard the vehicle. For manufacturers no longer eligible to use 0 grams per mile to represent electric operation, the provisions of this paragraph (m) shall be used to determine the non-zero value for CREE for purposes of meeting the greenhouse gas emission standards described in § 86.1818 of this chapter.

(1) For 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, which may be set equal to zero for eligible 2012 through 2025 model year electric vehicles for a certain number of vehicles produced and delivered for sale as described in § 86.1866–12(a) of this chapter.

$$CREE_{UP} = \frac{EC}{GRIDLOSS} \times AVGUSUP, \text{ and}$$

$$CREE_{GAS} = 0.2485 \times TargetCO_2,$$

Where:

EC = The vehicle energy consumption in watt-hours per mile, determined according to procedures established by the Administrator under § 600.116–12.

GRIDLOSS = 0.93 (to account for grid transmission losses).

AVGUSUP = 0.642 for the 2012 through 2016 model years, and 0.574 for 2017 and later model years (the nationwide average electricity greenhouse gas emission rate at the powerplant, in grams per watt-hour).

$TargetCO_2$ = The CO_2Target Value determined according to § 86.1818 of this chapter for passenger automobiles and light trucks, respectively.

(2) For plug-in hybrid electric vehicles the carbon-related exhaust emissions in grams per mile is to be calculated according to the provisions of § 600.116, except that the CREE for charge-depleting operation shall be the sum of the CREE associated with gasoline consumption and the net upstream CREE determined according to paragraph (m)(1)(i) of this section, rounded to the nearest one gram per mile.

(3) For 2012 and later model year fuel cell vehicles, the carbon-related exhaust emissions in grams per mile shall be calculated using the method specified in paragraph (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 of this chapter the value of CREE may be set equal to zero for a certain number of 2012 through 2025 model year fuel cell vehicles.

* * * * *

22. Section 600.116–12 is amended as follows:

a. By revising the heading.

b. By revising paragraph (a) introductory text.

c. By adding paragraph (c).

The revisions and additions read as follows:

§ 600.116–12 Special procedures related to electric vehicles, hybrid electric vehicles, and plug-in hybrid electric vehicles.

(a) Determine fuel economy values for electric vehicles as specified in §§ 600.210 and 600.311 using the procedures of SAE J1634 (incorporated by reference in § 600.011), with the follo wing clarifications and modifications:

* * * * *

(c) *Determining the proportion of recovered braking energy for hybrid electric vehicles.* Hybrid electric vehicles tested under this part may determine the proportion of braking energy recovered over the FTP relative to the total available braking energy required over the FTP. This determination is required for pickup trucks accruing credits for implementation of hybrid technology under § 86. 1866–12(e)(2), and requires the measurement of electrical current (in amps) flowing into the hybrid system battery for the duration of the test.

(1) Calculate the theoretical maximum amount of energy that could be recovered by a hybrid electric vehicle over the FTP test cycle, where the test cycle time and velocity points are expressed at 10 Hz, and the velocity (miles/hour) is expressed to the nearest 0.01 miles/hour, as follows:

(i) For each time point in the 10 Hz test cycle (*i.e.,* at each 0.1 seconds):

(A) Determine the road load power in kilowatts using the following equation:

$$P_{roadload} = \frac{V_{mph} \times 0.44704(\times 4.448 \times \left(A + \left(B \times V_{mph}\right) + \left(C \times V_{mph}^{2}\right)\right)}{1000}$$

Where:

A, B, and C are the vehicle-specific dynamometer road load coefficients in lb-force, lb-force/mph, and lb-force/mph², respectively; and

V_{mph} = velocity in miles/hour, expressed to the nearest 0.01 miles/hour.

(B) Determine the applied deceleration power in kilowatts using the following equation. Positive values indicate acceleration and negative values indicate deceleration.

$$P_{accel} = \frac{ETW \times (V \times 0.44704) \times \left(0.44704 \times (V_{t+1} - V)\right)}{220.5}$$

Where:

ETW = the vehicle Emission Test Weight (lbs);

V = velocity in miles/hour, rounded to the nearest 0.01 miles/hour;

V_{t+1} = the velocity in miles/hour at the next time point in the 10 Hz speed vs. time table, rounded to the nearest 0.01 miles/hour.

(C) Determine braking power in kilowatts using the following equation.

$$P_{brake} = P_{accel} - P_{roadload}$$

Where:

P_{accel} = the value determined in paragraph (c)(1)(i)(B) of this section;

$P_{roadload}$ = the value determined in paragraph (c)(1)(i)(A) of this section; and

P_{brake} = 0 if P_{accel} is greater than or equal to $P_{roadload}$.

(ii) [Reserved]

(2) The total maximum braking energy (E_{brake}) that could theoretically be recovered is equal to the absolute value of the sum of all the values of P_{brake} determined in paragraph c)(1)(i)(C) of this section, divided by 36,000 and rounded to the nearest 0.01 kilowatt hours.

(3) Calculate the actual amount of energy recovered by a hybrid electric vehicle when tested on the FTP according to the provisions of this part.

(i) Measure the state of charge, in Amp-hours, of the hybrid battery system at each second of the FTP.

(ii) Calculate the change in the state of charge (current in Watt hours) at each second of the test using the following equation:

$$dSOC = (AH_t - AH_{t-1}) \times V$$

Where:

dSOC = the change in the state of charge of the hybrid battery system, in Watt hours;

AH_t = the state of charge of the battery system, in Amp hours, at time t in the test;

AH_{t-1} = the state of charge of the battery system, in Amp hours, at time t-1 in the test; and

V = the nominal voltage of the hybrid battery system.

(iii) Depending on the equipment and methodology used by a manufacturer, batter charging during the test may be represented by either a negative current or by a positive current. Determine the total energy recovered by the hybrid battery system as follows:

(A) If battery charging is represented by positive current, then the total energy recovered by the hybrid battery system, in kilowatt hours, is the sum of the positive current values for each second of the test determined in paragraph (c)(3)(ii) of this section, divided by 1,000 and rounded to the nearest 0.01 kilowatt hours.

(B) If battery charging is represented by negative current, then the total energy recovered by the hybrid battery system, in kilowatt hours, is the absolute value of the sum of the negative current values for each second of the test determined in paragraph (c)(3)(ii) of this section, divided by 1,000 and rounded to the nearest 0.01 kilowatt hours.

(4) The percent of braking energy recovered by a hybrid system relative to the total available energy is determined by the following equation, rounded to the nearest one percent:

$$Energy\ Recovered\ \% = \frac{E_{rec}}{E_{max}} \times 100$$

Where:

E_{rec} = The actual total energy recovered, in kilowatt hours, as determined in paragraph (c)(2)(iii) of this section; and

E_{max} = The theoretical maximum amount of energy, in kilowatt hours, that could be recovered by a hybrid electric vehicle over the FTP test cycle, as determined in paragraph (c)(2) of this section.

23. Section 600.303–12 is amended as follows:

a. By revising the introductory text.

b. By revising paragraph (b) introductory text.

c. By revising paragraph (b)(6).

d. By revising paragraph (c).

The revisions read as follows:

§ 600.303–12 Fuel economy label—special requirements for flexible-fuel vehicles.

Fuel economy labels for flexible-fuel vehicles must meet the specifications described in § 600.302, with the modifications described in this section. This section describes how to label flexible-fuel vehicles equipped with gasoline engines. If the vehicle has a diesel engine, all the references to ''gas'' or ''gasoline'' in this section are understood to refer to ''diesel'' or ''diesel fuel'', respectively. All values described in this section are based on gasoline operation, unless otherwise specifically noted.

* * * * *

(b) Include the following elements instead of the information identified in § 600.302–12(c)(1):

* * * * *

(6) Add the following statement after the statements described in § 600.302–12(c)(2): ''Values are based on gasoline and do not reflect performance and ratings based on E85.'' Adjust this statement as appropriate for vehicles designed to operate on different fuels.

(c) You may include the sub-heading ''Driving Range'' below the combined fuel economy value, with range bars below this sub-heading as follows:

(1) Insert a horizontal range bar nominally 80 mm long to show how far the vehicle can drive from a full tank of gasoline. Include a vehicle logo at the right end of the range bar. Include the following left-justified expression inside the range bar: ''Gasoline: × miles''. Complete the expression by identifying the appropriate value for total driving range from § 600.311.

(2) Insert a second horizontal range bar as described in paragraph (*c*)(*1*) of this section that shows how far the vehicle can drive from a full tank with the second fuel. Establish the length of the line based on the proportion of driving ranges for the different fuels. Identify the appropriate fuel in the range bar.

24. Section 600.311–12 is amended as follows:

a. By revising paragraph (c)(1).

b. By revising paragraph (e)(3)(vii).

c. By adding paragraph (e)(4).

The revisions and addition read as follows:

§ 600.311–12 Determination of values for fuel economy labels.

* * * * *

(c) * * *

(1) For vehicles with engines that are not plug-in hybrid electric vehicles, calculate the fuel consumption rate in gallons per 100 miles (or gasoline gallon equivalent per 100 miles for fuels other than gasoline or diesel fuel) with the following formula, rounded to the first decimal place:

Fuel Consumption Rate = 100/MPG

Where:

MPG = The value for combined fuel economy from § 600.210–12(c), rounded to the nearest whole mpg.

* * * * *

(e) * * *

(3) * * *

(vii) Calculate the annual fuel cost based on the combined values for city and highway driving using the following equation:

Annual fuel cost = ($/milecity × 0.55 + $/milehwy × 0.45) × Average Annual Miles

(4) Round the annual fuel cost to the nearest $50 by dividing the unrounded annual fuel cost by 50, then rounding the result to the nearest whole number, then multiplying this rounded result by 50 to determine the annual fuel cost to be used for purposes of labeling.

* * * * *

25. Section 600.510–12 is amended as follows:

a. By removing and reserving paragraph (b)(3)(iii).

b. By adding paragraph (b)(4).

c. By revising paragraph (c).

d. By revising paragraph (g)(1) introductory text.

e. By revising paragraph (g)(3).

f. By revising paragraph (h) introductory text.

g. By revising paragraph (j)(2)(vii).

h. By revising paragraph (k).

The addition and revisions read as follows:

§ 600.510–12 Calculation of average fuel economy and average carbon-related exhaust emissions.

* * * * *

(b) * * *

(4) Emergency vehicles may be excluded from the fleet average carbon-related exhaust emission calculations described in paragraph (j) of this section. The manufacturer should notify the Administrator that they are making such an election in the model year reports required under § 600.512 of this chapter. Such vehicles should be excluded from both the calculation of the fleet average standard for a manufacturer under 40 CFR 86.1818–12(c)(4) and from the calculation of the fleet average carbon-related exhaust emissions in paragraph (j) of this section.

(c)(1) Average fuel economy shall be calculated as follows:

(i) Except as allowed in paragraph (d) of this section, the average fuel economy for the model years before 2017 will be calculated individually for each category identified in paragraph (a)(1) of this according to the provisions of paragraph (c)(2) of this section.

(ii) Except as permitted in paragraph (d) of this section, the average fuel economy for the 2017 and later model years will be calculated individually for each category identified in paragraph (a)(1) of this section using the following equation:

$$\text{Average MPG} = \frac{1}{\left[\frac{1}{MPG} - (AC + OC + PU)\right]}$$

Where:

Average MPG = the fleet average fuel economy for a category of vehicles;

MPG = the average fuel economy for a category of vehicles determined according to paragraph (c)(2) of this section;

AC = Air conditioning fuel economy credits for a category of vehicles, in gallons per mile, determined according to paragraph (c)(3)(i) of this section;

OC = Off-cycle technology fuel economy credits for a category of vehicles, in gallons per mile, determined according to paragraph (c)(3)(ii) of this section; and

PU = Pickup truck fuel economy credits for the light truck category, in gallons per mile, determined according to paragraph (c)(3)(iii) of this section.

(2) Divide the total production volume of that category of automobiles by 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 paragraph (g) of this section are met; or

(v) For alcohol dual fuel model types, for model years after 2019, the combined model type fuel economy determined according to the following equation and rounded to the nearest 0.1 mpg:

$$MPG = \left(\frac{F}{MPG_A} + \frac{(1-F)}{MPG_G}\right)^{-1}$$

Where:

F = 0.00 unless otherwise approved by the Administrator according to the provisions of paragraph (k) of this section;

MPG_A = The combined model type fuel economy for operation on alcohol fuel as determined in § 600.208–12(b)(5)(ii) divided by 0.15 provided the requirements of paragraph (g) of this section are met; and

MPG_G = The combined model type fuel economy for operation on gasoline or diesel fuel as determined in § 600.208–12(b)(5)(i).

(vi) 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; or

(vii) For natural gas dual fuel model types, for model years after 2019, the combined model type fuel economy determined according to the following formula and rounded to the nearest 0.1 mpg:

$$MPG = \left(\frac{UF}{MPG_{CNG}} + \frac{(1-UF)}{MPG_G}\right)^{-1}$$

Where:

MPG_{CNG} = The combined model type fuel economy 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; and

MPG_G = The combined model type fuel economy for operation on gasoline or diesel fuel as determined in § 600.208–12(b)(5)(i).

UF = A Utility Factor (UF) value selected from the following table based on the driving range of the vehicle while operating on natural gas. Determine the vehicle's driving range in miles by multiplying the combined fuel economy as determined in § 600.208–12(b)(5)(ii) by the vehicle's usable fuel storage capacity (as defined at § 600.002 and expressed in gasoline gallon equivalents), and rounding to the nearest 10 miles.

Driving Range (miles)	**UF**
10	0.228
20	0.397
30	0.523
40	0.617
50	0.689
60	0.743
70	0.785
80	0.818
90	0.844
100	0.865
110	0.882
120	0.896
130	0.907
140	0.917
150	0.925
160	0.932
170	0.939
180	0.944
190	0.949
200	0.954

210	0.958
220	0.962
230	0.965
240	0.968
250	0.971
260	0.973
270	0.976
280	0.978
290	0.980
300	0.981

(3) *Fuel consumption improvement.* Calculate the separate air conditioning, off-cycle, and pickup truck fuel consumption improvement as follows:

(i) Air conditioning fuel consumption improvements are calculated separately for each category identified in paragraph (a)(1) of this section using the following equation:

$$\text{AC Credit (gal/mi)} = \frac{(\mathit{ACCredit} \times 1{,}000{,}000)}{(\mathit{VLM} \times \mathit{Production} \times 8887)}$$

Where:

FE Credit = the fleet production-weighted total value of air conditioning efficiency credits for all air conditioning systems in the applicable fleet, expressed in gallons per mile;

ACCredit = the total of all air conditioning efficiency credits for the vehicle category, in megagrams, from 40 CFR 86.1866–12(c)(3);

VLM = vehicle lifetime miles, which for passenger automobiles shall be 195,264 and for light trucks shall be 225,865; and

Production = the total production volume for the category of vehicles (either passenger automobiles or light trucks).

(ii) Off-cycle technology fuel consumption improvements are calculated separately for each category identified in paragraph (a)(1) of this section using the following equation:

$$\text{Off-Cycle Credit (gal/mi)} = \frac{(\mathit{OCCredit} \times 1{,}000{,}000)}{(\mathit{VLM} \times \mathit{Production} \times 8887)}$$

Where:

FE Credit = the fleet production-weighted total value of off-cycle technology credits for all off-cycle technologies in the applicable fleet, expressed in gallons per mile;

OCCredit = the total of all off-cycle technology credits for the vehicle category, in megagrams, from 40 CFR 86.1866–12(d)(5);

VLM = vehicle lifetime miles, which for passenger automobiles shall be 195,264 and for light trucks shall be 225,865; and

Production = the total production volume for the category of vehicles (either passenger automobiles or light trucks).

(iii) Full size pickup truck fuel consumption improvements are calculated for the light truck category identified in paragraph (a)(1) of this section using the following equation:

$$\text{Pickup Truck Credit (gal/mi)} = \frac{(\mathit{PUCredit} \times 1{,}000{,}000)}{(\mathit{VLM} \times \mathit{Production} \times 8887)}$$

Where:

FE Credit = the fleet production-weighted total value of full size pickup truck credits for the light truck fleet, expressed in gallons per mile;

PUCredit = the total of all full size pickup truck credits, in megagrams, from 40 CFR 86.1866–12(e)(4); and

Production = the total production volume for the light truck category.

* * * * *

(g)(1) Dual fuel automobiles must provide equal or greater energy efficiency while operating on the alternative fuel 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) of this section. The following equation must hold true:

$$E_{alt}/E_{pet} \geq 1$$

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 § 600.113–12(a) and (b).

FE_{pet} is the fuel economy [miles/gallon] while operated on petroleum fuel (gasoline or diesel) as determined in § 600.113–12(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.

* * * * *

(3) 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 dual fuel automobiles, except where the alternative fuel is electricity, 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

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* * * * *

(j) * * *

(2) * * *

(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:

$$CREE = [CREE_{CNG} \times UF] + [CREE_{GAS} \times (1 - UF)]$$

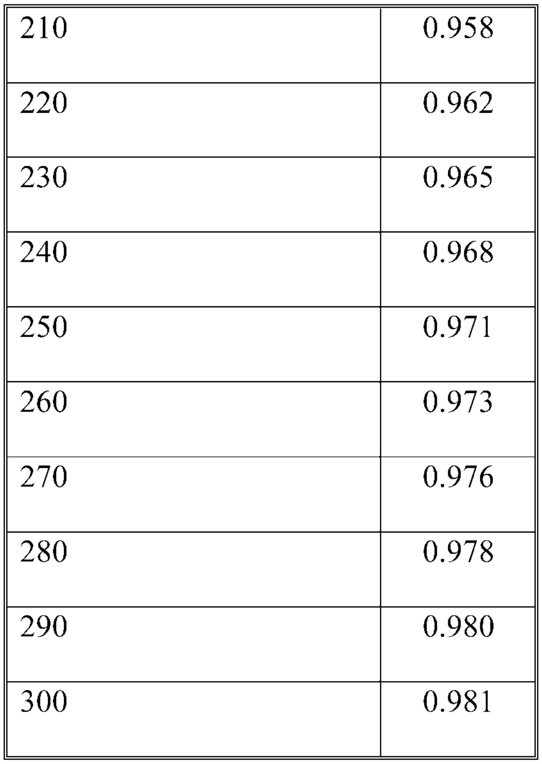
Where:

$CREE_{CNG}$ = 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).

UF = A Utility Factor (UF) value selected from the following table based on the driving range of the vehicle while operating on natural gas. Determine the vehicle's driving range in miles by multiplying the combined fuel economy as determined in § 600.208–12(b)(5)(ii) by the vehicle's usable fuel storage capacity (as defined at § 600.002 and expressed in gasoline gallon equivalents), and rounding to the nearest 10 miles.

Driving Range (miles)	**UF**
10	0.228
20	0.397
30	0.523
40	0.617
50	0.689
60	0.743
70	0.785
80	0.818
90	0.844
100	0.865
110	0.882
120	0.896
130	0.907
140	0.917
150	0.925
160	0.932
170	0.939
180	0.944
190	0.949
200	0.954



210	0.958
220	0.962
230	0.965
240	0.968
250	0.971
260	0.973
270	0.976
280	0.978
290	0.980
300	0.981

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(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 (c)(2)(v) and (j)(2)(vi) of this section. Unless otherwise approved by the Administrator, the manufacturer must use the value of F that is in effect in paragraphs (c)(2)(v) and (j)(2)(vi) 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 (c)(2)(v) and (j)(2)(vi) 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.

26. Section 600.514–12 is amended by revising paragraphs (b)(1)(v) and (vii) and adding paragraphs (b)(1)(viii) and (ix) to read as follows:

§ 600.514–12 Reports to the Environmental Protection Agency.

* * * * *

(b) * * *

(1) * * *

(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, advanced technology vehicles, hybrid or low emission full-size pickup trucks, and various early credit programs;

* * * * *

(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 credit and incentives program;

(viii) The methodology which will be used to comply with N_2O and CH_4 emission standards;

(ix) Notification of the manufacturer's intent to exclude emergency vehicles from the calculation of fleet average standards and the end-of-year fleet average, including a description of the excluded emergency vehicles and the quantity of such vehicles excluded.

* * * * *

Title 49

National Highway Traffic Safety Administration

In consideration of the foregoing, under the authority of 49 U.S.C. 32901, 32902, and 32903, and delegation of authority at 49 CFR 1.50, NHTSA proposes to amend 49 CFR Chapter V as follows:

PART 523—VEHICLE CLASSIFICATION

27. The authority citation for part 523 continues to read as follows:

Authority: 49 U.S.C. 32901, delegation of authority at 49 CFR 1.50.

28. Revise § 523.2 to read as follows:

§ 523.2 Definitions.

Approach angle means the smallest angle, in a plane side view of an automobile, formed by the level surface on which the automobile is standing and a line tangent to the front tire static loaded radius arc and touching the underside of the automobile forward of the front tire.

Axle clearance means the vertical distance from the level surface on which an automobile is standing to the lowest point on the axle differential of the automobile.

Base tire (for passenger automobiles, light trucks, and medium duty passenger vehicles) means the tire that has the highest production sales volume that is installed by the vehicle manufacturer on each vehicle configuration of a model type.

Basic vehicle frontal area is used as defined in 40 CFR 86.1803.

Breakover angle means the supplement of the largest angle, in a plan side view of an automobile, that can be formed by two lines tangent to the front and rear static loaded radii arcs and intersecting at a point on the underside of the automobile.

Cab-complete vehicle means a vehicle that is first sold as an incomplete vehicle that substantially includes the vehicle cab section as defined in 40 CFR 1037.801. For example, vehicles known commercially as chassis-cabs, cab-chassis, box-deletes, bed-deletes, and cut-away vans are considered cab-complete vehicles. A cab includes a steering column and a passenger compartment. Note that a vehicle lacking some components of the cab is a cab-complete vehicle if it substantially includes the cab.

Cargo-carrying volume means the luggage capacity or cargo volume index, as appropriate, and as those terms are defined in 40 CFR 600.315–08, in the case of automobiles to which either of these terms apply. With respect to automobiles to which neither of these terms apply, ‘‘cargo-carrying volume’’ means the total volume in cubic feet, rounded to the nearest 0.1 cubic feet, of either an automobile's enclosed non-seating space that is intended primarily for carrying cargo and is not accessible from the passenger compartment, or the space intended primarily for carrying cargo bounded in the front by a vertical plane that is perpendicular to the longitudinal centerline of the automobile and passes through the rearmost point on the rearmost seat and elsewhere by the automobile's interior surfaces.

Class 2b vehicles are vehicles with a gross vehicle weight rating (GVWR) ranging from 8,501 to 10,000 pounds (lbs).

Class 3 through Class 8 vehicles are vehicles with a GVWR of 10,001 lbs or more, as defined in 49 CFR 565.15.

Commercial medium- and heavy-duty on-highway vehicle means an on-highway vehicle with a GVWR of 10,000 lbs or more, as defined in 49 U.S.C. 32901(a)(7).

Complete vehicle means a vehicle that requires no further manufacturing operations to perform its intended function and is a functioning vehicle that has the primary load-carrying device or container (or equivalent equipment) attached or is designed to pull a trailer. Examples of equivalent equipment include fifth wheel trailer hitches, firefighting equipment, and utility booms.

Curb weight is defined the same as *vehicle curb weight* in 40 CFR 86.1803–01.

Departure angle means the smallest angle, in a plane side view of an automobile, formed by the level surface on which the automobile is standing and a line tangent to the rear tire static loaded radius arc and touching the underside of the automobile rearward of the rear tire.

Final stage manufacturer has the meaning given in 49 CFR 567.3.

Footprint is defined as the product of track width (measured in inches, calculated as the average of front and rear track widths, and rounded to the nearest tenth of an inch) times wheelbase (measured in inches and rounded to the nearest tenth of an inch), divided by 144 and then rounded to the nearest tenth of a square foot. For purposes of this definition, ‘‘track width’’ is the lateral distance between the centerlines of the base tires at ground, including the camber angle. For purposes of this definition, ‘‘wheelbase’’ is the longitudinal distance between front and rear wheel centerlines.

Full-size pickup truck means a light truck or medium duty passenger vehicle that meets the requirements specified in 40 CFR 86.1866–12(e).

Gross combination weight rating (GCWR) means the value specified by the manufacturer as the maximum allowable loaded weight of a combination vehicle (*e.g.,* tractor plus trailer).

Gross vehicle weight rating (GVWR) means the value specified by the manufacturer as the maximum design loaded weight of a single vehicle (*e.g.,* vocational vehicle).

Heavy-duty engine means any engine used for (or which the engine manufacturer could reasonably expect to be used for) motive power in a heavy-duty vehicle. For purposes of this definition in this part, the term ‘‘engine’’ includes internal combustion engines and other devices that convert chemical fuel into motive power. For example, a fuel cell and motor used in a heavy-duty vehicle is a heavy-duty engine.

Heavy-duty off-road vehicle means a heavy-duty vocational vehicle or vocational tractor that is intended for off-road use meeting either of the following criteria:

(1) Vehicles with tires installed having a maximum speed rating at or below 55 mph.

(2) Vehicles primarily designed to perform work off-road (such as in oil fields, forests, or construction sites), and meeting at least one of the criteria of paragraph (2)(i) of this definition and at least one of the criteria of paragraph (2)(ii) of this definition.

(i) Vehicles must have affixed components designed to work in an off-road environment (for example, hazardous material equipment or drilling equipment) or be designed to operate at low speeds making them unsuitable for normal highway operation.

(ii) Vehicles must:

(A) Have an axle that has a gross axle weight rating (GAWR), as defined in 49 CFR 571.3, of 29,000 pounds or more;

(B) Have a speed attainable in 2 miles of not more than 33 mph; or

(C) Have a speed attainable in 2 miles of not more than 45 mph, an unloaded vehicle weight that is not less than 95 percent of its GVWR, and no capacity to carry occupants other than the driver and operating crew.

Heavy-duty vehicle means a vehicle as defined in § 523.6.

Incomplete vehicle means a vehicle which does not have the primary load carrying device or container attached when it is first sold as a vehicle or any vehicle that does not meet the definition of a complete vehicle. This may include vehicles sold to secondary vehicle manufacturers. Incomplete vehicles include cab-complete vehicles.

Innovative technology means technology certified as such under 40 CFR 1037.610.

Light truck means a non-passenger automobile as defined in § 523.5.

Medium duty passenger vehicle means a vehicle which would satisfy the criteria in § 523.5 (relating to light trucks) but for its gross vehicle weight rating or its curb weight, which is rated at more than 8,500 lbs GVWR or has a vehicle curb weight of more than 6,000 lbs or has a basic vehicle frontal area in excess of 45 square feet, and which is designed primarily to transport passengers, but does not include a vehicle that:

(1) Is an ‘‘incomplete vehicle’’' as defined in this subpart; or

(2) Has a seating capacity of more than 12 persons; or

(3) Is designed for more than 9 persons in seating rearward of the driver's seat; or

(4) Is equipped with an open cargo area (for example, a pick-up truck box or bed) of 72.0 inches in interior length or more. A covered box not readily accessible from the passenger compartment will be considered an open cargo area for purposes of this definition.

Mild hybrid gasoline-electric vehicle means a vehicle as defined by EPA in 40 CFR 86.1866–12(e).

Motor home has the meaning given in 49 CFR 571.3.

Motor vehicle has the meaning given in 40 CFR 85.1703.

Passenger-carrying volume means the sum of the front seat volume and, if any, rear seat volume, as defined in 40 CFR 600.315–08, in the case of automobiles to which that term applies. With respect to automobiles to which that term does not apply, ''passenger-carrying volume'' means the sum in cubic feet, rounded to the nearest 0.1 cubic feet, of the volume of a vehicle's front seat and seats to the rear of the front seat, as applicable, calculated as follows with the head room, shoulder room, and leg room dimensions determined in accordance with the procedures outlined in Society of Automotive Engineers Recommended Practice J1100a, Motor Vehicle Dimensions (Report of Human Factors Engineering Committee, Society of Automotive Engineers, approved September 1973 and last revised September 1975).

(1) For front seat volume, divide 1,728 into the product of the following SAE dimensions, measured in inches to the nearest 0.1 inches, and round the quotient to the nearest 0.001 cubic feet.

(i) H61–Effective head room—front.

(ii) W3—Shoulder room—front.

(iii) L34—Maximum effective leg room-accelerator.

(2) For the volume of seats to the rear of the front seat, divide 1,728 into the product of the following SAE dimensions, measured in inches to the nearest 0.1 inches, and rounded the quotient to the nearest 0.001 cubic feet.

(i) H63—Effective head room—second.

(ii) W4—Shoulder room—second.

(iii) L51—Minimum effective leg room—second.

Pickup truck means a non-passenger automobile which has a passenger compartment and an open cargo area (bed).

Recreational vehicle or RV means a motor vehicle equipped with living space and amenities found in a motor home.

Running clearance means the distance from the surface on which an automobile is standing to the lowest point on the automobile, excluding unsprung weight.

Static loaded radius arc means a portion of a circle whose center is the center of a standard tire-rim combination of an automobile and whose radius is the distance from that center to the level surface on which the automobile is standing, measured with the automobile at curb weight, the wheel parallel to the vehicle's longitudinal centerline, and the tire inflated to the manufacturer's recommended pressure.

Strong hybrid gasoline-electric vehicle means a vehicle as defined by EPA in 40 CFR 86.1866–12(e).

Temporary living quarters means a space in the interior of an automobile in which people may temporarily live and which includes sleeping surfaces, such as beds, and household conveniences, such as a sink, stove, refrigerator, or toilet.

Van means a vehicle with a body that fully encloses the driver and a cargo carrying or work performing compartment. The distance from the leading edge of the windshield to the foremost body section of vans is typically shorter than that of pickup trucks and sport utility vehicles.

Vocational tractor means a tractor that is classified as a vocational vehicle according to 40 CFR 1037.630.

Vocational vehicle means a vehicle that is equipped for a particular industry, trade or occupation such as construction, heavy hauling, mining, logging, oil fields, refuse and includes vehicles such as school buses, motorcoaches and RVs.

Work truck means a vehicle that is rated at more than 8,500 pounds and less than or equal to 10,000 pounds gross vehicle weight, and is not a medium-duty passenger vehicle as defined in 40 CFR 86.1803 effective as of December 20, 2007.

PART 531—PASSENGER AUTOMOBILE AVERAGE FUEL ECONOMY STANDARDS

29. 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.

30. Amend § 531.5 by revising paragraph (a) Introductory text, revising paragraphs (b), (c), and (d), redesignating paragraph (e) as paragraph (f), and adding a new paragraph (e) to read as follows:

§ 531.5 Fuel economy standards.

(a) Except as provided in paragraph (e) of this section, each manufacturer of passenger automobiles shall comply with the fleet average fuel economy standards in Table I, expressed in miles per gallon, in the model year specified as applicable:

* * * * *

(b) For model year 2011, a manufacturer's passenger automobile fleet shall comply with the fleet average fuel economy level calculated for that model year according to Figure 1 and the appropriate values in Table II.

Figure 1:

$$Required\_Fuel\_Economy\_Level = \frac{N}{\sum_i \frac{N_i}{T_i}}$$

Where:

N is the total number (sum) of passenger automobiles produced by a manufacturer;

N_i is the number (sum) of the *ith* passenger automobile model produced by the manufacturer; and

T_i is the fuel economy target of the *ith* model passenger automobile, which is determined according to the following formula, rounded to the nearest hundredth:

$$T = \frac{1}{\frac{1}{a} + \left(\frac{1}{b} - \frac{1}{a}\right)\frac{e^{(x-c)d}}{1 + e^{(x-c)d}}}$$

Where:

Parameters *a, b, c,* and *d* are defined in Table II;

e = 2.718; and

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

Table II – Parameters for the Passenger Automobile Fuel Economy Targets

Model year	Parameters			
	a (mpg)	*b* (mpg)	*c* (gal/mi/ft^2)	*d* (gal/mi)
2011..............................	31.20	24.00	51.41	1.91

(c) For model years 2012–2025, a manufacturer's passenger automobile fleet shall comply with the fleet average fuel economy level calculated for that model year according to Figure 2 and the appropriate values in Table III.

Figure 2:

$$CAFE_{required} = \frac{\sum_i PRODUCTION_i}{\sum_i \frac{PRODUCTION_i}{TARGET_i}}$$

Where:

$CAFE_{required}$ is the fleet average fuel economy standard 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 share 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 share 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 III; and

The *MIN* and *MAX* functions take the minimum and maximum, respectively, of the included values.

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TABLE III – PARAMETERS FOR THE PASSENGER AUTOMOBILE FUEL ECONOMY TARGETS, MYS 2012-2025

Model year	**Parameters**			
	a (mpg)	*b* (mpg)	*c* (gal/mi/ft^2)	*d* (gal/mi)
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
2017..........................	43.61	32.65	0.0005131	0.001896
2018...........................	45.21	33.84	0.0004954	0.001811
2019...........................	46.87	35.07	0.0004783	0.001729
2020...........................	48.74	36.47	0.0004603	0.001643
2021...........................	50.83	38.02	0.0004419	0.001555
2022..........................	53.21	39.79	0.0004227	0.001463
2023..........................	55.71	41.64	0.0004043	0.001375
2024..........................	58.32	43.58	0.0003867	0.001290
2025..........................	61.07	45.61	0.0003699	0.001210

(d) In addition to the requirements of paragraphs (b) and (c) of this section, each manufacturer shall also meet the minimum fleet standard for domestically manufactured passenger automobiles expressed in Table IV:

TABLE IV – MINIMUM FUEL ECONOMY STANDARDS FOR DOMESTICALLY MANUFACTURED PASSENGER AUTOMOBILES, MYS 2011-2021

Model year	Minimum standard
2011	27.8
2012	30.7
2013	31.4
2014	32.1
2015	33.3
2016	34.7
2017	36.8
2018	38.1
2019	39.6
2020	41.1
2021	42.9
2022	44.9
2023	47.0
2024	49.2
2025	51.5

(e) For model years 2022–2025, each manufacturer shall comply with the standards set forth in paragraphs (c) and (d) in this section, if NHTSA determines in a rulemaking, initiated after January 1, 2017, and conducted in accordance with 49 U.S.C. 32902, that the standards in paragraphs (c) and (d) are the maximum feasible standards for model years 2022–2025. If, for any of those model years, NHTSA determines that the maximum feasible standard for passenger cars and the corresponding minimum standard for domestically manufactured passenger cars should be set at a different level, manufacturers shall comply with those different standards in lieu of the standards set forth for those model years in paragraphs (c) and (d), and NHTSA will revise this section to reflect the different standards.

* * * * *

31. Amend § 531.6 by revising paragraph (a) to read as follows:

§ 531.6 Measurement and calculation procedures.

(a) The fleet average fuel economy performance of all passenger automobiles that are manufactured by a manufacturer in a model year shall be determined in accordance with procedures established by the Administrator of the Environmental Protection Agency under 49 U.S.C. 32904 and set forth in 40 CFR part 600. For model years 2017 to 2025, a manufacturer is eligible to increase the fuel economy performance of passenger cars in accordance with procedures established by EPA set forth in 40 CFR part 600, including any adjustments to fuel economy EPA allows, such as for fuel consumption improvements related to air conditioning efficiency and off-cycle technologies.

* * * * *

32. Revise Appendix A to part 531 to read as follows:

Appendix 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 TABLE I

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 TABLE I: Manufacturer X's required fleet average fuel economy standard level 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 Table II:

APPENDIX TABLE II

Manufacturer X calculates a fuel economy target standard for each unique model type and footprint combination.

Model type				Description	Base tire size	Wheelbase (inches)	Track width F&R average (inches)	Foot print (ft^2)	Volume	Fuel economy target standard (mpg)
Group	Carline name	Basic engine (L)	Transmission class							
1	PC A	1.8	A5	2-door sedan	205/75R	99.8	61.2	42.4	1,500	35.01

	FWD				14					
2	PC A FWD	1.8	M6	2-door sedan	215/70R 15	99.8	60.9	42.2	2,000	35.14
3	PC A FWD	2.5	A6	4-door wagon	215/70R 15	100.0	60.9	42.3	2,000	35.08
4	PC A AWD	1.8	A6	4-door wagon	235/60R 15	100.0	61.2	42.5	1,000	35.95
5	PC A AWD	2.5	M6	2-door hatchback	225/65R 16	99.6	59.5	41.2	3,000	35.81
6	PC B RWD	2.5	A6	4-door wagon	265/55R 18	109.2	66.8	50.7	8,000	30.33
7	PC B RWD	2.5	A7	4-door sedan	235/65R 17	109.2	67.8	51.4	2,000	29.99
8	PC C AWD	3.2	A7	4-door sedan	265/55R 18	111.3	67.8	52.4	5,000	29.52
9	PC C FWD	3.2	M6	2-door coupe	225/65R 16	111.3	67.2	51.9	3,000	29.76
Total.........									27,500	

NOTE TO APPENDIX TABLE II: With the appropriate fuel economy targets determined for each unique model type and footprint combination, Manufacturer X's required fleet average fuel economy standard would be calculated as illustrated in Appendix Figure 1:

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Appendix Figure 1 – Calculation of Manufacturer X's fleet average fuel economy standard using Table II:

Fleet average fuel economy standard =

$$= \frac{(Manufacturer's\ Domestic\ Passenger\ Automobile\ Production\ for\ Applicable\ Model\ Year)}{\sum_i (\frac{Group_1\ Production}{Group_1 Target\ Standard} + \frac{Group_2\ Production}{Group_2 Target\ Standard} + \cdots \frac{Group_9\ Production}{Group_9 Target\ Standard})}$$

$$= \frac{(27{,}500)}{(\frac{1500}{35.01} + \frac{2000}{35.14} + \frac{2000}{35.08} + \frac{1000}{35.95} + \frac{3000}{35.81} + \frac{8000}{30.33} + \frac{2000}{29.99} + \frac{5000}{29.52} + \frac{3000}{29.79})}$$

= 31.6 mpg

Appendix Figure 2 – Calculation of Manufacturer X's actual fleet average fuel economy performance level using Table I:

Fleet average fuel economy performance =

$$= \frac{(Manufacturer's\ Domestic\ Passenger\ Automobile\ Production\ for\ Applicable\ Model\ Year)}{\sum_i \left(\frac{Group_1\ Production}{Group_1 Performance} + \frac{Group_2\ Production}{Group_2 Performance} + \cdots \frac{Group_9\ Production}{Group_9 Performance}\right)}$$

$$= \frac{(27{,}500)}{\left(\frac{1500}{34.0} + \frac{2000}{34.6} + \frac{2000}{33.8} + \frac{1000}{34.4} + \frac{3000}{32.9} + \frac{8000}{32.2} + \frac{2000}{33.1} + \frac{5000}{30.6} + \frac{3000}{28.5}\right)}$$

= 32.0 mpg

NOTE TO APPENDIX FIGURE 2: Since the actual fleet average fuel economy performance of Manufacturer X's fleet is 32.0 mpg, as compared to its required fleet fuel economy standard of 31.6 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

33. 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.

34. Amend § 533.5 by revising paragraphs (a), (f), (g), (h), (i) and adding paragraphs (j) and (k) to read as follows:

§ 533.5 Requirements.

(a) Each manufacturer of light trucks shall comply with the following fleet average fuel economy standards, expressed in miles per gallon, in the model year specified as applicable:

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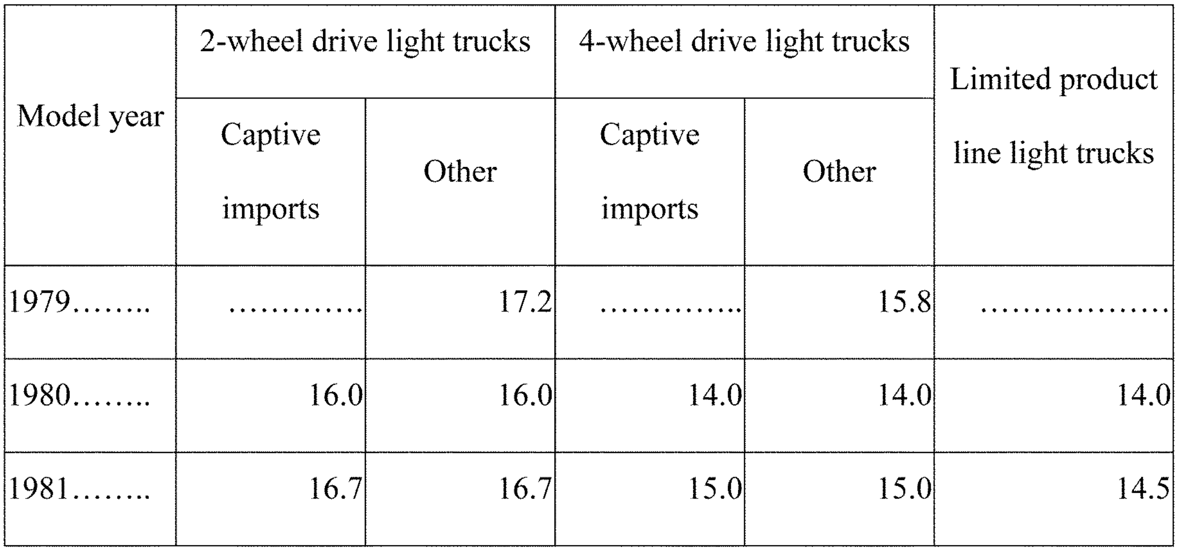
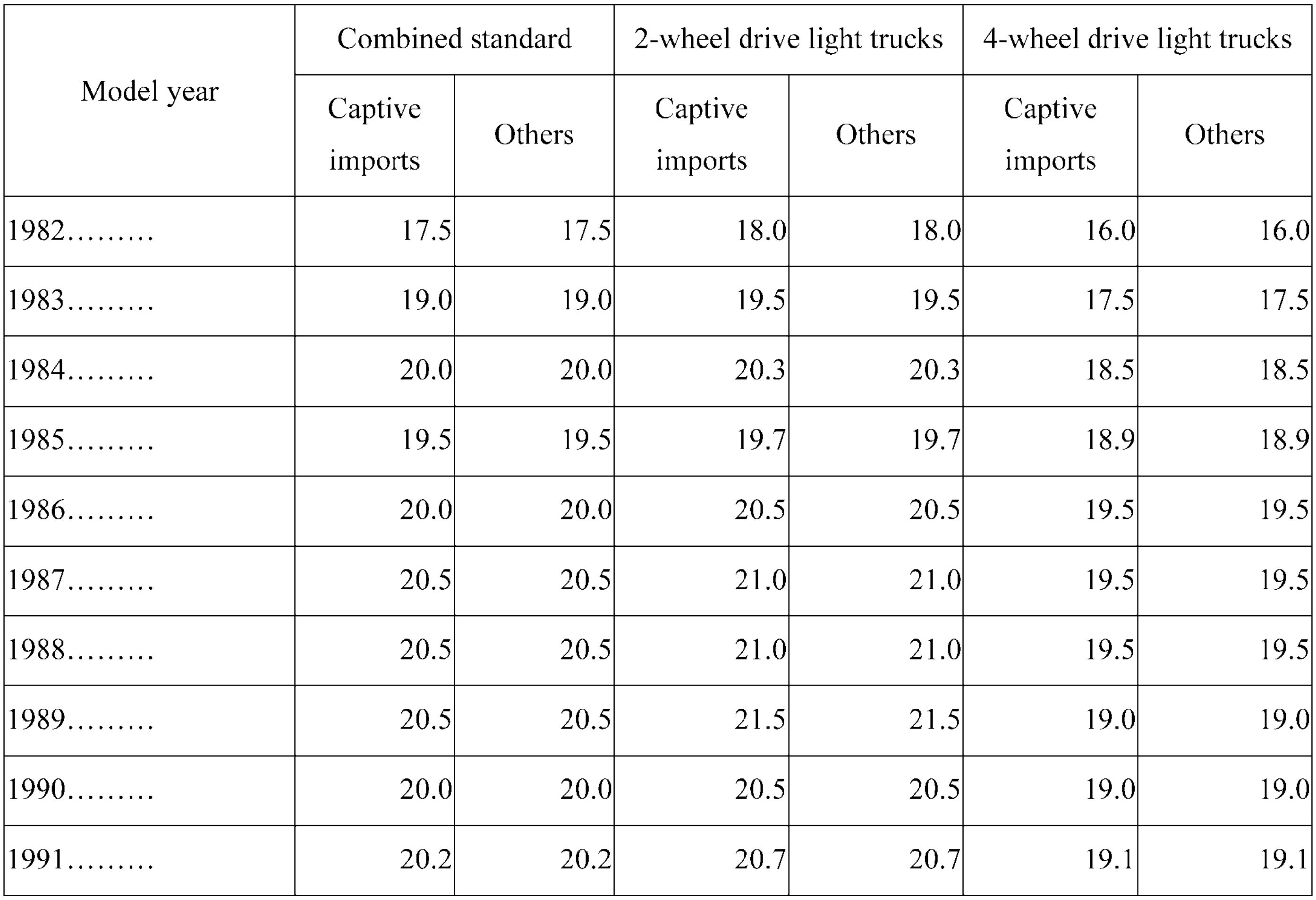
TABLE I



Model year	2-wheel drive light trucks		4-wheel drive light trucks		Limited product line light trucks
	Captive imports	Other	Captive imports	Other	
1979........	....	17.2	....	15.8	....
1980........	16.0	16.0	14.0	14.0	14.0
1981........	16.7	16.7	15.0	15.0	14.5

TABLE II



Model year	Combined standard		2-wheel drive light trucks		4-wheel drive light trucks	
	Captive imports	Others	Captive imports	Others	Captive imports	Others
1982.........	17.5	17.5	18.0	18.0	16.0	16.0
1983.........	19.0	19.0	19.5	19.5	17.5	17.5
1984.........	20.0	20.0	20.3	20.3	18.5	18.5
1985.........	19.5	19.5	19.7	19.7	18.9	18.9
1986.........	20.0	20.0	20.5	20.5	19.5	19.5
1987.........	20.5	20.5	21.0	21.0	19.5	19.5
1988.........	20.5	20.5	21.0	21.0	19.5	19.5
1989.........	20.5	20.5	21.5	21.5	19.0	19.0
1990.........	20.0	20.0	20.5	20.5	19.0	19.0
1991.........	20.2	20.2	20.7	20.7	19.1	19.1

TABLE III

Model Year	Combined standard	
	Captive imports	Other
1992	20.2	20.2
1993	20.4	20.4
1994	20.5	20.5
1995	20.6	20.6

TABLE IV

Model year	Standard
2001	20.7
2002	20.7
2003	20.7
2004	20.7
2005	21.0
2006	21.6
2007	22.2
2008	22.5
2009	23.1
2010	23.5

Figure 1:

$$Required\_Fuel\_Economy\_Level = \frac{N}{\sum_i \frac{N_i}{T_i}}$$

Where:

N is the total number (sum) of light trucks produced by a manufacturer;

N_i is the number (sum) of the *ith* light truck model type produced by a manufacturer; and

T_i is the fuel economy target of the *ith* light truck model type, which is determined according to the following formula, rounded to the nearest hundredth:

$$T = \frac{1}{\frac{1}{a} + \left(\frac{1}{b} - \frac{1}{a}\right)\frac{e^{(x-c)d}}{1 + e^{(x-c)d}}}$$

Where:

Parameters *a, b, c,* and *d* are defined in Table V;

e = 2.718; and

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

TABLE V – PARAMETERS FOR THE LIGHT TRUCK FUEL ECONOMY TARGETS FOR MYS 2008-2011

Model year	**Parameters**			
	a (mpg)	*b* (mpg)	*c* (gal/mi/ft^2)	*d* (gal/mi)
2008	28.56	19.99	49.30	5.58
2009	30.07	20.87	48.00	5.81
2010	29.96	21.20	48.49	5.50
2011	27.10	21.10	56.41	4.28

Figure 2:

$$CAFE_{required} = \frac{\sum_i PRODUCTION_i}{\sum_i \frac{PRODUCTION_i}{TARGET_i}}$$

Where:

$CAFE_{required}$ is the fleet average fuel economy standard for a given light truck 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 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 share the same model type and footprint, calculated according to either Figure 3 or Figure 4, as appropriate, 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 FOR MYS 2012-2016

Model year	Parameters			
	a (mpg)	*b* (mpg)	*c* (gal/mi/ft^2)	*d* (gal/mi)
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

Figure 4:

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

Table VII – Parameters for the Light Truck Fuel Economy Targets for MYs 2017-2025

Model year	Parameters							
	a (mpg)	*b* (mpg)	*c* (gal/mi/ft^2)	*d* (gal/mi)	*e* (mpg)	*f* (mpg)	*g* (gal/mi/ft^2)	*h* (gal/mi)
2017	36.26	25.09	0.0005484	0.005097	35.10	25.09	0.0004546	0.009851
2018	37.36	25.20	0.0005358	0.004797	35.31	25.20	0.0004546	0.009682
2019	38.16	25.25	0.0005265	0.004623	35.41	25.25	0.0004546	0.009603
2020	39.11	25.25	0.0005140	0.004494	35.41	25.25	0.0004546	0.009603
2021	41.80	25.25	0.0004820	0.004164	35.41	25.25	0.0004546	0.009603
2022	43.79	26.29	0.0004607	0.003944	35.41	25.25	0.0004546	0.009603
2023	45.89	27.53	0.0004404	0.003735	35.41	25.25	0.0004546	0.009603
2024	48.09	28.83	0.0004210	0.003534	35.41	25.25	0.0004546	0.009603
2025	50.39	30.19	0.0004025	0.003343	35.41	25.25	0.0004546	0.009603

* * * * *

(f) For each model year 1996 and thereafter, each manufacturer shall combine its captive imports with its other light trucks and comply with the fleet average fuel economy standard in paragraph (a) of this section.

(g) For model years 2008–2010, at a manufacturer's option, a manufacturer's light truck fleet may comply with the fuel economy standard calculated for each model year according to Figure 1 and the appropriate values in Table V, with said option being irrevocably chosen for that model year and reported as specified in § 537.8.

(h) For model year 2011, a manufacturer's light truck fleet shall comply with the fleet average fuel economy standard calculated for that model year according to Figure 1 and the appropriate values in Table V.

(i) For model years 2012–2016, a manufacturer's light truck fleet shall comply with the fleet average fuel economy standard calculated for that model year according to Figures 2 and 3 and the appropriate values in Table VI.

(j) For model years 2017–2025, a manufacturer's light truck fleet shall comply with the fleet average fuel economy standard calculated for that model year according to Figures 2 and 4 and the appropriate values in Table VII.

(k) For model years 2022–2025, each manufacturer shall comply with the standards set forth in paragraph (j) of this section, if NHTSA determines in a rulemaking, initiated after January 1, 2017, and conducted in accordance with 49 U.S.C. 32902, that the standards in paragraph (j) are the maximum feasible standards for model years 2022–2025. If, for any of those model years, NHTSA determines that the maximum feasible standard for light trucks should be set at a different level, manufacturers shall comply with those different standards in lieu of the standards set forth for those model years in paragraph (j), and NHTSA will revise this section to reflect the different standards.

* * * * *

35. Amend § 533.6 by revising paragraph (b) to read as follows:

§ 533.6 Measurement and calculation procedures.

* * * * *

(b) The fleet average fuel economy performance of all vehicles subject to part 533 that are manufactured by a manufacturer in a model year shall be determined in accordance with procedures established by the Administrator of the Environmental Protection Agency under 49 U.S.C. 32904 and set forth in 40 CFR part 600. For model years 2017 to 2025, a manufacturer is eligible to increase the fuel economy performance of light trucks in accordance with procedures established by EPA and set forth in 40 CFR part 600, including any adjustments to fuel economy EPA allows, such as for fuel consumption improvements related to air conditioning efficiency, off-cycle technologies, and hybridization and other over-compliance for full-size pickup trucks.

36. Redesignate Appendix A to part 533 as Appendix to part 533 and revise it to read as follows:

Appendix 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 TABLE I

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

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 Table I: Manufacturer X's required fleet average fuel economy standard level 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 as illustrated in Appendix Table II:

APPENDIX TABLE II

Manufacturer X calculates a fuel economy target standard for each unique model type and footprint combination.

Model type										
Group	**Carline name**	**Basic engine (L)**	**Transmission class**	**Description**	**Base tire size**	**Wheelbase (inches)**	**Track width F&R average (inches)**	**Footprint (ft^2)**	**Volume**	**Fuel economy target standard (mpg)**
1	Pickup A 2WD	4	A5	Reg cab, MB	235/75R 15	100.0	68.8	47.8	800	27.30
2	Pickup B 2WD	4	M5	Reg cab, MB	235/75R 15	100.0	68.2	47.4	200	27.44
3	Pickup C 2WD	4.5	A5	Reg cab, LB	255/70R 17	125.0	68.8	59.7	300	23.79
4	Pickup C 2WD	4	M5	Ext cab, MB	255/70R 17	125.0	68.8	59.7	400	23.79
5	Pickup C 4WD	4.5	A5	Crew cab, SB	275/70R 17	150.0	69.0	71.9	400	22.27
6	Pickup D 2WD	4.5	A6	Crew cab, SB	255/70R 17	125.0	68.8	59.7	400	23.79
7	Pickup E 2WD	5	A6	Ext cab, LB	255/70R 17	125.0	68.8	59.7	500	23.79
8	Pickup E	5	A6	Crew cab, MB	285/70R	125.0	69.2	60.1	500	23.68

	2WD			MB	17					
9	Pickup F 2WD	4.5	A5	Reg cab, LB	255/70R 17	125.0	68.9	59.8	1,600	23.76
10	Pickup F 4WD	4.5	A5	Ext cab, MB	275/70R 17	150.0	69.0	71.9	800	22.27
11	Pickup F 4WD	4.5	A5	Crew cab, SB	285/70R 17	150.0	69.2	72.1	800	22.27
Total...									6,700	

NOTE TO APPENDIX TABLE II: With the appropriate fuel economy targets determined for each unique model type and footprint combination, Manufacturer X's required fleet average fuel economy standard would be calculated as illustrated in Appendix Figure 1:

Appendix Figure 1 – Calculation of Manufacturer X's fleet average fuel economy standard using Table II:

Fleet average fuel economy standard =

$$= \frac{(\text{Manufacturer's Lig□t Truck Production for Applicable Model Year})}{\sum_i\left(\frac{Group_1\,Production}{Group_1 Target\ Standard} + \frac{Group_{2a}\,Production}{Group_2 Target\ Standard} + \cdots \frac{Group_{11}\,Production}{Group_{11} Target\ Standard}\right)}$$

$$= \frac{(6{,}700)}{\left(\frac{800}{27.30} + \frac{200}{27.44} + \frac{300}{23.79} + \frac{400}{23.79} + \frac{400}{22.27} + \frac{400}{23.79} + \frac{500}{23.79} + \frac{500}{23.68} + \frac{1600}{23.76} + \frac{800}{22.27} + \frac{800}{22.27}\right)}$$

= 23.7 mpg

Appendix Figure 2 – Calculation of Manufacturer X's actual fleet average fuel economy performance level using Table I:

Fleet average fuel economy performance =

$$= \frac{(Manufacturer's\ Light\ Truck\ Production\ for\ Applicable\ Model\ Year)}{\sum_i \left(\frac{Group_1\ Production}{Group_1 Performance} + \frac{Group_2\ Production}{Group_2 Performance} + \cdots \frac{Group_{11}\ Production}{Group_{11} Performance} \right)}$$

$$= \frac{(27{,}500)}{\left(\frac{1500}{34.0} + \frac{2000}{34.6} + \frac{2000}{33.8} + \frac{1000}{34.4} + \frac{3000}{32.9} + \frac{8000}{32.2} + \frac{2000}{33.1} + \frac{5000}{30.6} + \frac{3000}{28.5} \right)}$$

= 23.3 mpg

NOTE TO APPENDIX FIGURE 2: Since the actual fleet average fuel economy performance of Manufacturer X's fleet is 23.3 mpg, as compared to its required fleet fuel economy standard of 23.7 mpg, Manufacturer X did not comply with the CAFE standard for MY 2012 as set forth in § 533.5(i).

Where:

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

Parameters *a, b, c, d, e, f, g,* and *h* are defined in Table VII; and

The *MIN* and *MAX* functions take the minimum and maximum, respectively, of the included values.

PART 536—TRANSFER AND TRADING OF FUEL ECONOMY CREDITS

37. Revise the authority citation for part 536 to read as follows:

Authority: 49 U.S.C. 32903; delegation of authority at 49 CFR 1.50.

38. Amend § 536.4 by revising paragraph (c) to read as follows:

§ 536.4 Credits.

* * * * *

(c) *Adjustment factor.* When traded or transferred and used, fuel economy credits are adjusted to ensure fuel oil savings is preserved. For traded credits, the user (or buyer) must multiply the calculated adjustment factor by the number of its shortfall credits it plans to offset in order to determine the number of equivalent credits to acquire from the earner (or seller). For transferred credits, the user of credits must multiply the calculated adjustment factor by the number of its shortfall credits it plans to offset in order to determine the number of equivalent credits to transfer from the compliance category holding the available credits. The adjustment factor is calculated according to the following formula:

$$A = \frac{VMT_u * MPG_{ae} * MPG_{se}}{VMT_e * MPG_{au} * MPG_{su}}$$

Where:

A = Adjustment factor applied to traded and transferred credits;

VMT_e = Lifetime vehicle miles traveled as provided in the following table for the model year and compliance category in which the credit was earned;

VMT_u = 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)**						
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017-2025**
Passenger Cars	152,922	177,238	177,366	178,652	180,497	182,134	195,264
Light Trucks	172,552	208,471	208,537	209,974	212,040	213,954	225,865

MPG_{se} = Required fuel economy standard for the originating (earning) manufacturer, compliance category, and model year in which the credit was earned;

MPG_{ae} = Actual fuel economy for the originating manufacturer, compliance category, and model year in which the credit was earned;

MPG_{su} = Required fuel economy standard for the user (buying) manufacturer, compliance category, and model year in which the credit is used for compliance; and

MPG_{au} = Actual fuel economy for the user manufacturer, compliance category, and model year in which the credit is used for compliance.

39. Amend § 536.9 by revising paragraph (c) to read as follows:

§ 536.9 Use of credits with regard to the domestically manufactured passenger automobile minimum standard.

* * * * *

(c) Transferred or traded credits may not be used, pursuant to 49 U.S.C. 32903(g)(4) and (f)(2), to meet the domestically manufactured passenger automobile minimum standard specified in 49 U.S.C. 32902(b)(4) and in 49 CFR 531.5(d).

* * * * *

40. Amend § 536.10 by revising the section heading and paragraphs (b) and (c) and adding paragraph (d) to read as follows:

§ 536.10 Treatment of dual-fuel and alternative-fuel vehicles.

* * * * *

(b) If a manufacturer's calculated fuel economy for a particular compliance category, including any statutorily-required calculations for alternative fuel and dual fuel vehicles, is higher or lower than the applicable fuel economy standard, manufacturers will earn credits or must apply credits or pay civil penalties equal to the difference between the calculated fuel economy level in that compliance category and the applicable standard. Credits earned are the same as any other credits, and may be held, transferred, or traded by the manufacturer subject to the limitations of the statute and this regulation.

(c) For model years up to and including MY 2019, if a manufacturer builds enough dual fuel vehicles (except plug-in electric vehicles) to improve the calculated fuel economy in a particular compliance category by more than the limits set forth in 49 U.S.C. 32906(a), the improvement in fuel economy for compliance purposes is restricted to the statutory limit. Manufacturers may not earn credits nor reduce the application of credits or fines for calculated improvements in fuel economy based on dual fuel vehicles beyond the statutory limit.

(d) For model years 2020 and beyond, a manufacturer must calculate the fuel economy of dual fueled vehicles in accordance with 40 CFR 600.510–12(c)(2)(v) and (vii).

PART 537—AUTOMOTIVE FUEL ECONOMY REPORTS

41. 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.

42. Amend § 537.5 by revising paragraph (c)(4) to read as follows:

* * * * *

(c) * * *

(4) Be submitted on CD or by email with the contents in a pdf or MS Word format except the information required in 537.7 must be provided in a MS Excel format. Submit 2 copies of the CD to: Administrator, National Highway Traffic Administration, 1200 New Jersey Avenue SW., Washington, DC 20590, or submit reports electronically to the following secure email address: *cafe@dot.gov*;

* * * * *

43. Amend § 537.7 by revising paragraphs (b)(3), (c)(4), and (c)(5) to read as follows:

§ 537.7 Pre-model year and mid-model year reports.

* * * * *

(b) * * *

(3) State the projected required fuel economy for the manufacturer's passenger automobiles and light trucks

determined in accordance with 49 CFR 531.5(c) and 49 CFR 533.5 and based upon the projected sales figures provided under paragraph (c)(2) of this section. For each unique model type and footprint combination of the manufacturer's automobiles, provide the information specified in paragraph (b)(3)(i) and (ii) of this section in tabular form. List the model types in order of increasing average inertia weight from top to bottom down the left side of the table and list the information categories in the order specified in paragraphs (i) and (ii) of this section from left to right across the top of the table. Other formats, such as those accepted by EPA, which contain all of the information in a readily identifiable format are also acceptable.

(i) In the case of passenger automobiles:

(A) Beginning model year 2013, base tire as defined in 49 CFR 523.2,

(B) Beginning model year 2013, front axle, rear axle and average track width as defined in 49 CFR 523.2,

(C) Beginning model year 2013, wheelbase as defined in 49 CFR 523.2, and

(D) Beginning model year 2013, footprint as defined in 49 CFR 523.2.

(ii) In the case of light trucks:

(A) Beginning model year 2013, base tire as defined in 49 CFR 523.2,

(B) Beginning model year 2013, front axle, rear axle and average track width as defined in 49 CFR 523.2,

(C) Beginning model year 2013, wheelbase as defined in 49 CFR 523.2, and

(D) Beginning model year 2013, footprint as defined in 49 CFR 523.2.

* * * * *

(c) * * *

(4) (i) Loaded vehicle weight;

(ii) Equivalent test weight;

(iii) Engine displacement, liters;

(iv) SAE net rated power, kilowatts;

(v) SAE net horsepower;

(vi) Engine code;

(vii) Fuel system (number of carburetor barrels or, if fuel injection is used, so indicate);

(viii) Emission control system;

(ix) Transmission class;

(x) Number of forward speeds;

(xi) Existence of overdrive (indicate yes or no);

(xii) Total drive ratio (N/V);

(xiii) Axle ratio;

(xiv) Combined fuel economy;

(xv) Projected sales for the current model year;

(xvi) Air conditioning efficiency improvement technologies used to acquire the incentive in 40 CFR 86.1866 and the amount of the incentive;

(xvii) Full-size pickup truck technologies used to acquire the incentive in 40 CFR 86.1866 and the amount of the incentive;

(xviii) Off-cycle technologies used to acquire the incentive in 40 CFR 86.1866 and the amount of the incentive;

(xix) (A) In the case of passenger automobiles:

(*1*) Interior volume index, determined in accordance with subpart D of 40 CFR part 600;

(*2*) Body style;

(B) In the case of light trucks:

(*1*) Passenger-carrying volume;

(*2*) Cargo-carrying volume;

(xx) Frontal area;

(xxi) Road load power at 50 miles per hour, if determined by the manufacturer for purposes other than compliance with this part to differ from the road load setting prescribed in 40 CFR 86.177–11(d);

(xxii) Optional equipment that the manufacturer is required under 40 CFR parts 86 and 600 to have actually installed on the vehicle configuration, or the weight of which must be included in the curb weight computation for the vehicle configuration, for fuel economy testing purposes.

(5) For each model type of automobile which is classified as a non-passenger vehicle (light truck) under part 523 of this chapter, provide the following data:

(i) For an automobile designed to perform at least one of the following functions in accordance with 523.5 (a) indicate (by ''yes'' or ''no'') whether the vehicle can:

(A) Transport more than 10 persons (if yes, provide actual designated seating positions);

(B) Provide temporary living quarters (if yes, provide applicable conveniences as defined in 523.2);

(C) Transport property on an open bed (if yes, provide bed size width and length);

(D) Provide, as sold to the first retail purchaser, greater cargo-carrying than passenger-carrying volume, such as in a cargo van and quantify the value; if a vehicle is sold with a second-row seat, its cargo-carrying volume is determined with that seat installed, regardless of whether the manufacturer has described that seat as optional; or

(E) Permit expanded use of the automobile for cargo-carrying purposes or other non passenger-carrying purposes through:

(*1*) For non-passenger automobiles manufactured prior to model year 2012, the removal of seats by means installed for that purpose by the automobile's manufacturer or with simple tools, such as screwdrivers and wrenches, so as to create a flat, floor level, surface extending from the forward-most point of installation of those seats to the rear of the automobile's interior; or

(*2*) For non-passenger automobiles manufactured in model year 2008 and beyond, for vehicles equipped with at least 3 rows of designated seating positions as standard equipment, permit expanded use of the automobile for cargo-carrying purposes or other nonpassenger-carrying purposes through the removal or stowing of foldable or pivoting seats so as to create a flat, leveled cargo surface extending from the forward-most point of installation of those seats to the rear of the automobile's interior.

(ii) For an automobile capable of off-highway operation, identify which of the features below qualify the vehicle as off-road in accordance with 523.5 (b) and quantify the values of each feature:

(A) 4-wheel drive; or

(B) A rating of more than 6,000 pounds gross vehicle weight; and

(C) Has at least four of the following characteristics calculated when the automobile is at curb weight, on a level surface, with the front wheels parallel to the automobile's longitudinal centerline, and the tires inflated to the manufacturer's recommended pressure. The exact value of each feature should be quantified:

(*1*) Approach angle of not less than 28 degrees.

(*2*) Breakover angle of not less than 14 degrees.

(*3*) Departure angle of not less than 20 degrees.

(*4*) Running clearance of not less than 20 centimeters.

(*5*) Front and rear axle clearances of not less than 18 centimeters each.

* * * * *

44. Amend § 537.8 by revising paragraph (a)(3) to read as follows:

§ 537.8 Supplementary reports.

(a) * * *

(3) Each manufacturer whose pre-model year report omits any of the information specified in § 537.7 (b), (c)(1) and (2), or (c)(4) shall file a supplementary report containing the information specified in paragraph (b)(3) of this section.

* * * * *

Dated: November 16, 2011.

Ray LaHood,

Secretary, Department of Transportation.

Dated: November 16, 2011.

Lisa P. Jackson,

Administrator, Environmental Protection Agency.

[FR Doc. 2011–30358 Filed 11–30–11; 8:45 am]

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