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Part II

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Department of Transportation

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

ENVIRONMENTAL PROTECTION AGENCY

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DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

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

[EPA–HQ–OAR–2010–0799; FRL–9706–5; 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

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

ACTION: Final rule.

SUMMARY: EPA and NHTSA, on behalf of the Department of Transportation, are issuing final rules to further reduce greenhouse gas emissions and improve fuel economy for light-duty vehicles for model years 2017 and beyond. 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 improve fuel economy and reduce greenhouse gas emissions of light-duty vehicles for model years 2017–2025, building on the success of the first phase of the National Program for these vehicles for model years 2012–2016. This final rule, 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 finalizing Corporate Average Fuel Economy standards for model years 2017–2021 and issuing augural standards for model years 2022–2025 under the Energy Policy and Conservation Act, as amended by the Energy Independence and Security Act. NHTSA will set final standards for model years 2022–2025 in a future rulemaking. EPA is finalizing greenhouse gas emissions standards for model years 2017–2025 under the Clean Air Act. These standards apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles, and represent the continuation of a harmonized and consistent National Program. Under the National Program automobile manufacturers will 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 that are available today. EPA is also finalizing minor changes to the regulations applicable to model years 2012–2016, with respect to air conditioner performance, nitrous oxides measurement, off-cycle technology credits, and police and emergency vehicles.

DATES: This final rule is effective on December 14, 2012, *sixty days after date of publication in the* **Federal Register**. The incorporation by reference of certain publications listed in this regulation is approved by the Director of the **Federal Register** as of December 14, 2012.

ADDRESSES: EPA and NHTSA have established dockets for this action under Docket ID No. EPA–HQ–OAR–2010–0799 and NHTSA 2010–0131, respectively. All documents in the docket are listed in the *http://www.regulations.gov* index. Although listed in the index, some information is not publicly available, *e.g.,* confidential business information (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 can be found either electronically in *www.regulations.gov* by searching for the dockets using the Docket ID numbers above, 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 (DOT), West Building, Ground Floor, Rm. W12–140, 1200 New Jersey Avenue SE., Washington, DC 20590. The DOT 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	Alternative Fuel Vehicle Converters.

[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.

Category	NAICS Codes A	Examples of potentially regulated entities
	336399 811198	

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**.

Table of Contents

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

A. Executive Summary

1. Purpose of the Regulatory Action

a. The Need for the Action and How the Action Addresses the Need

NHTSA, on behalf of the Department of Transportation, and EPA are issuing final rules to further reduce greenhouse gas emissions and improve fuel economy for light-duty vehicles for model years 2017 and beyond. On May 21, 2010, President Obama issued a Presidential Memorandum requesting that EPA and NHTSA develop through notice and comment rulemaking a coordinated National Program to improve fuel economy and reduce greenhouse gas emissions of light-duty vehicles for model years 2017–2025, building on the success of the first phase of the National Program for these vehicles for model years 2012–2016. These final rules are consistent with the President's request and respond to the country's critical need to address global climate change and to reduce oil consumption.

These standards apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles (i.e. sport utility vehicles, cross-over utility vehicles, and light trucks), and represent the continuation of a harmonized and consistent National Program for these vehicles. Under the National Program automobile manufacturers will be able to continue building a single light-duty national fleet that satisfies all requirements under both programs.

The National Program is estimated to save approximately 4 billion barrels of oil and to reduce GHG emissions by the equivalent of approximately 2 billion metric tons over the lifetimes of those light duty vehicles produced in MYs 2017–2025. The agencies project 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 $326 billion to $451 billion (7 and 3 percent discount rates, respectively) over the lifetimes of those light duty vehicles sold in MYs 2017–2025.

The National Program is projected to provide significant savings for consumers due to reduced fuel use. Although the agencies estimate that technologies used to meet the standards will add, on average, about $1,800 to the cost of a new light duty vehicle in MY 2025, consumers who drive their MY 2025 vehicle for its entire lifetime will save, on average, $5,700 to $7,400 (7 and 3 percent discount rates, respectively) in fuel, for a net lifetime savings of $3,400 to $5,000. This estimate assumes gasoline prices of $3.87 per gallon in 2025 with small increases most years throughout the vehicle's lifetime.

b. Legal Authority

EPA and NHTSA are finalizing separate sets of standards for passenger cars and for light trucks, under their respective statutory authority. EPA is setting national CO_2 emissions standards for passenger cars and light-trucks under section 202 (a) of the Clean Air Act (CAA) ((42 U.S.C. 7521 (a)), and under its authority to measure passenger car and passenger car fleet fuel economy pursuant to the Energy Policy and Conservation Act (EPCA) 49 U.S.C. 32904 (c). NHTSA is setting national corporate average fuel economy (CAFE) standards under the Energy Policy and Conservation Act (EPCA), as amended by the Energy Independence and Security Act (EISA) of 2007 (49 U.S.C. 32902).

Section 202 (a) of the Clean Air Act requires EPA to establish 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. *See Coalition for Responsible Regulation* v. *EPA,* No. 09–1322 (D.C. Cir. June 26, 2012) slip op. p. 41 ("'[i]f EPA makes a finding of endangerment, the Clean Air Act requires the [a]gency to regulate emissions of the deleterious pollutant from new motor vehicles. '* * * Given the non-discretionary duty in Section 202 (a)(1) and the limited flexibility available under Section 202 (a)(2), which this court has held relates only to the motor-vehicle industry,* * * EPA had no statutory basis on which it could 'ground [any] reasons for further inaction'' (quoting *State of Massachusetts* v. *EPA,* 549 U.S. 497, 533, 535 (2007). In establishing such standards, EPA must consider issues of technical feasibility, cost, and available lead time. Standards under section 202 (a) thus 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'' (CAA section 202 (a)(2) (42 U.S.C. 7512 (a)(2)).

EPCA, as amended by EISA, contains a number of provisions regarding how NHTSA must set CAFE standards. EPCA requires that NHTSA establish separate passenger car and light truck standards (49 U.S.C. 32902(b)(1)) at ''the maximum feasible average fuel economy level that it decides the manufacturers can achieve in that model year (49 U.S.C. 32902(a)),'' 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 (49 U.S.C. 32902(f)). 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. 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 (49 U.S.C. 32902(b)(2)(A))]. For model years 2021–2030, standards need simply be set at the maximum feasible level (49 U.S.C.32903(b)(2)(B).

Section I.E of the preamble contains a detailed discussion of both agencies' statutory authority.

2. Summary of the Major Provisions of the Final Rule

NHTSA and EPA are finalizing rules for light-duty vehicles that the agencies believe represent the appropriate levels of fuel economy and GHG emissions standards for model years 2017 and beyond pursuant to their respective statutory authorities.

a. Standards

EPA is establishing 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.[3] Consistent with its statutory authority, NHTSA has developed two phases of passenger car and light truck standards in this rulemaking action. The first phase, from MYs 2017–2021, includes final standards that are projected to require, on an average industry fleet wide basis, a range from 40.3–41.0 mpg in MY 2021. The second phase of the CAFE program, from MYs 2022–2025, includes standards that are not final, due to the statutory requirement that NHTSA set average fuel economy standards not more than 5 model years at a time. Rather, those standards are augural, meaning that they represent NHTSA's current best estimate, based on the information available to the agency today, of what levels of stringency might be maximum feasible in those model years. NHTSA projects that those standards could require, on an average industry fleet wide basis, a range from 48.7–49.7 mpg in model year 2025.

Both the CO_2 and CAFE standards are footprint-based, as are the standards currently in effect for these vehicles through model year 2016. The standards will become more stringent on average in each model year from 2017 through 2025. Generally, the larger the vehicle footprint, the less numerically stringent the corresponding vehicle CO_2 emissions and MPG targets. As a result of the footprint-based standards, the burden of compliance is distributed

[3] 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. 163g/mi would be equivalent to 54.5 mpg, if the entire fleet were to meet this CO_2 level through tailpipe CO_2 and fuel economy improvements. The agencies expect, however, that a portion of these improvements will be made through improvements in air conditioning leakage and through use of alternative refrigerants, which would not contribute to fuel economy.

across all vehicle footprints and across all manufacturers. Manufacturers are not compelled to build vehicles of any particular size or type (nor do the rules create an incentive to do so), and each manufacturer will have its own fleet-wide standard that reflects the light duty vehicles it chooses to produce.

b. Mid-Term Evaluation

The agencies will conduct a comprehensive mid-term evaluation and agency decision-making process for the MYs 2022–2025 standards as described in the proposal. The mid-term evaluation reflects the rules' long time frame and, for NHTSA, the agency's statutory obligation to conduct a *de novo* rulemaking in order to establish final standards for MYs 2022–2025. In order to align the agencies' proceedings for MYs 2022–2025 and to maintain a joint national program, EPA and NHTSA will finalize their actions related to MYs 2022–2025 standards concurrently. If the EPA determination is that standards may change, the agencies will issue a joint NPRM and joint final rules. NHTSA and EPA fully expect to conduct this mid-term evaluation in coordination with the California Air Resources Board, given our interest in maintaining a National Program to address GHG emissions and fuel economy. Further discussion of the mid-term evaluation is found in Sections III.B.3 and IV.A.3.b.

c. Compliance Flexibilities

As proposed, the agencies are finalizing several provisions which provide compliance flexibility to manufacturers to meet the standards without compromising the program's overall environmental and energy security objectives. Further discussion of compliance flexibilities is in Section C.4, II.F, III.B, III.C, IV.I.

Credit Averaging, Banking and Trading

The agencies are continuing to allow manufacturers to generate credits for over-compliance with the CO_2 and CAFE standards.[4] A manufacturer will generate credits if its car and/or truck fleet achieves a fleet average CO_2/CAFE level better than its car and/or truck standards. Conversely, a manufacturer will incur a debit/shortfall if its fleet average CO_2/CAFE level does not meet the standard when all credits are taken into account. As in the prior CAFE and GHG programs, 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.

Air Conditioning Improvement Credits

As proposed, EPA is establishing that the maximum total A/C credits available for cars will be 18.8 grams/mile CO_2-equivalent and 24.4 grams/mile for trucks CO_2-equivalent.[5] The approaches used to calculate these credits for direct and indirect A/C improvement (i.e., improvements to A/C leakage (including substitution of low GHG refrigerant) and A/C efficiency) are generally consistent with those of the MYs 2012–2016 program, although there are several revisions. Most notably, a new test for A/C efficiency, optional under the GHG program starting in MY 2014, will be used exclusively in MY 2017 and beyond. Under its EPCA authority, EPA proposed and is finalizing provisions to allow manufacturers to generate fuel consumption improvement values for purposes of CAFE compliance based on these same improvements in air conditioner efficiency.

Off-Cycle Credits

EPA proposed and is finalizing provisions allowing manufacturers to continue to generate and use off-cycle credits to demonstrate compliance with the GHG standards. These credits are for measureable GHG emissions and fuel economy improvements attributable to use of technologies whose benefits are not measured by the two-cycle test mandated by EPCA. Under its EPCA authority, EPA proposed and is finalizing provisions to allow manufacturers to generate fuel consumption improvement values for purposes of CAFE compliance based on the use of off-cycle technologies.

Incentives for Electric Vehicles, Plug-in Hybrid Electric Vehicles, Fuel Cell Vehicles and Compressed Natural Gas Vehicles

In order to provide temporary regulatory incentives to promote the penetration of certain ''game changing'' advanced vehicle technologies into the light duty vehicle fleet, EPA is finalizing, as proposed, an incentive multiplier for CO_2 emissions compliance purposes for all electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs) sold in MYs 2017 through 2021. The incentives are expected to promote increased application of these advanced technologies in the program's early model years, which could achieve economies of scale that will support the wider application of these technologies to help achieve the more stringent standards in MYs 2022–2025. In addition, in response to public comments persuasively explaining how infrastructure for compressed natural gas (CNG) vehicles could serve as a bridge to use of advanced technologies such as hydrogen fuel cells, EPA is finalizing an incentive multiplier for CNG vehicles sold in MYs 2017 through 2021.

NHTSA currently interprets EPCA and EISA as precluding it from offering incentives for the alternative fuel operation of EVs, PHEVs, FCVs, and NGVs, except as specified by statute, and thus did not propose and is not including incentive multipliers comparable to the EPA incentive multipliers described above.

Incentives for Use of Advanced Technologies Including Hybridization for full-Size Pick-up Trucks

The agencies recognize that the standards presented in this final rule for MYs 2017–2025 will be challenging for large vehicles, including full-size pickup trucks. To help address this challenge, the program will, as proposed, contain incentives for the use of hybrid electric and other advanced technologies in full-size pickup trucks.

3. Costs and Benefits of National Program

It is important to note that NHTSA's CAFE standards and EPA's GHG standards will both be in effect, and both will lead to increases in average fuel economy and reductions in GHGs. The two agencies' standards together comprise the National Program, and the following discussions of the respective costs and benefits of NHTSA's CAFE standards and EPA's GHG standards does not change the fact that both the CAFE and GHG standards, jointly, are the source of the benefits and costs of the National Program.

The costs and benefits projected by NHTSA to result from the CAFE standards are presented first, followed by those projected by EPA to result from the GHG emissions standards. For several reasons, the estimates for costs and benefits presented by NHTSA and EPA for their respective rules, while consistent, are not directly comparable, and thus should not be expected to be identical. See Section I.D of the preamble for further details and discussion.

NHTSA has analyzed in detail the projected costs and benefits for the 2017–2025 CAFE standards for light-

[4] This credit flexibility is required by EPCA/EISA, *see* 49 U.S.C. 32903, and is well within EPA's discretion under section 202 (a) of the CAA.

[5] This is further broken down by 5.0 and 7.2 g/mi respectively for car and truck A/C efficiency credits, and 13.8 and 17.2 g/mi respectively for car and truck alternative refrigerant credits.

duty vehicles. NHTSA estimates that the fuel economy increases would lead to fuel savings totaling about 170 billion gallons throughout the lives of light duty vehicles sold in MYs 2017–2025. At a 3 percent discount rate, the present value of the economic benefits resulting from those fuel savings is between $481 billion and $488 billion; at a 7 percent private discount rate, the present value of the economic benefits resulting from those fuel savings is between $375 billion and $380 billion. The agency further estimates that these new CAFE standards will lead to corresponding reductions in CO_2 emissions totaling 1.8 billion metric tons during the lives of light duty vehicles sold in MYs 2017–2025. The present value of the economic benefits from avoiding those emissions is approximately $49 billion, based on a global social cost of carbon value of about $26 per metric ton (in 2017, and growing thereafter).

The Table below shows NHTSA's estimated overall lifetime discounted costs and benefits, and net benefits for the model years 2017–2025 CAFE standards.

NHTSA'S ESTIMATED MYS 2017–2021 AND MYS 2017–2025 COSTS, BENEFITS, AND NET BENEFITS (BILLIONS OF 2010 DOLLARS)) UNDER THE CAFE STANDARDS [6]

	Baseline fleet	Totals		Annualized	
		3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
Cumulative for MYs 2017–2021 Final Standards					
Costs	2010	($61)–	($58)–	($2.4)–	($3.6)–
	2008	($57)	($54)	($2.2)	($3.3)
Benefits	2010	$243–	$195–	$9.2–	$11.3–
	2008	$240	$194	$9.0	$11.0
Net Benefits	2010	$183–	$137–	$6.8–	$7.7–
	2008	$184	$141	$6.8	$7.8
Cumulative for MYs 2017—2025 (Includes MYs 2022–2025 Augural Standards)					
Costs	2010	($154)–	($147)–	($5.4)–	($7.6)–
	2008	($156)	($148)	($5.4)	($7.5)
Benefits	2010	$629–	$502–	$21.0–	$24.2–
	2008	$639	$510	$21.3	$24.4
Net Benefits	2010	$476–	$356–	$15.7–	$16.7–
	2008	$483	$362	$15.9	$16.9

EPA has analyzed in detail the projected costs and benefits of the 2017–2025 GHG standards for light-duty vehicles. The Table below shows EPA's estimated lifetime discounted cost, fuel savings, and benefits for all such 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 particulate matter-related health benefits (including premature mortality), the value of additional driving attributed to the VMT rebound effect, the value of reduced refueling time needed to fill up a more fuel efficient vehicle. The analysis also includes estimates of economic impacts stemming from additional vehicle use, such as the economic damages caused by accidents, congestion and noise (from increased VMT rebound driving).

[6] "The "Estimated Achieved" analysis includes accounting for compliance flexibilities and advanced technologies that manufacturers may voluntarily use for compliance, but that NHTSA is prohibited from considering when determining the maximum feasible level of new CAFE standards.

EPA'S ESTIMATED 2017–2025 MODEL YEAR LIFETIME DISCOUNTED COSTS, BENEFITS, AND NET BENEFITS ASSUMING THE 3% DISCOUNT RATE SCC VALUE [7] (BILLIONS OF 2010 DOLLARS)

Lifetime Present Value [d]—3% Discount Rate	
Program Costs	$150
Fuel Savings	475
Benefits	126
Net Benefits [d]	451
Annualized Value [f]—3% Discount Rate	
Annualized costs	6.49
Annualized fuel savings	20.5
Annualized benefits	5.46
Net benefits	19.5
Lifetime Present Value [d]—7% Discount Rate	
.	
Program Costs	144
Fuel Savings	364
Benefits	106
Net Benefits [e]	326
Annualized Value [f]—7% Discount Rate	
Annualized costs	10.8
Annualized fuel savings	27.3
Annualized benefits	7.96
Net benefits	24.4

B. Introduction

EPA is announcing final greenhouse gas emissions standards for model years 2017–2025 and NHTSA is announcing final Corporate Average Fuel Economy standards for model years 2017–2021 and issuing augural [8] standards for

[7] Further notes and details concerning these SCC. Value are found in Section I.D.2. Table I–17.

[8] For the NPRM/PRIA/Draft EIS, NHTSA described the proposed standards for MYs 2022–2025 as "conditional." "Conditional" was understood and objected to by some readers as implying that the future proceeding would consist merely of a confirmation of the conclusions and analysis of the current rulemaking, which would be incorrect and inconsistent with the agency's obligations under both EPCA/EISA and the Administrative Procedure Act. The agency must conduct a de novo rulemaking for MYs 2022–2025. To avoid creating an incorrect impression, the agency is changing the descriptor for the MY 2022–2025 standards that are presented and discussed in these documents. The descriptor must convey that

Continued

model years (MYs) 2022–2025. These rules establish 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. These final rules extend the MYs 2012–2016 National Program by establishing more stringent Federal light-duty vehicle GHG emissions and corporate average fuel economy (CAFE) standards in MYs 2017 and beyond. This coordinated program will 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. NHTSA's final rule also constitutes the agency's Record of Decision for purposes of its NEPA analysis.

This joint rulemaking 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 MYs 2012–2016. As with the MY 2012–2016 final rules, a key element in developing this rulemaking was the agencies' discussions with automobile manufacturers, the California Air Resources Board (CARB) and many other stakeholders. During the extended public comment period, the agencies received nearly 300,000 written comments (and nearly 400 oral comments through testimony at three public hearings held in Detroit, Philadelphia and San Francisco) on this rule and received strong support from most auto manufacturers, the United Auto Workers (UAW), nongovernmental organizations (NGOs), consumer groups, national security experts and veterans, State/local government and auto suppliers.

Continuing the National Program in coordination with California will help to ensure that all manufacturers can build a single fleet of vehicles that satisfy all requirements under both federal programs as well as under California's program,[9] which will in turn help to reduce costs and regulatory complexity while providing significant energy security, consumer savings, and environmental benefits.[10]

Combined with the standards already in effect for MYs 2012–2016, as well as the MY 2011 CAFE standards, the final standards will 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 actions ever taken to reduce GHG emissions and improve fuel economy in the U.S.

EPA is establishing 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.[11] Consistent with its statutory authority,[12] NHTSA has developed two phases of passenger car and light truck standards in this rulemaking action. The first phase, from MYs 2017–2021, includes final standards that are projected to require, on an average industry fleet wide basis, a range from 40.3–41.0 mpg in MY 2021.[13] The second phase of the CAFE program, from MYs 2022–2025, includes standards that are not final due to the statutory provision that NHTSA shall issue regulations prescribing average fuel economy standards for at least 1 but not more than 5 model years at a time.[14] The MYs 2022–2025 CAFE standards, then, are not final based on this rulemaking, but rather augural, meaning that they represent the agency's current judgment, based on the information available to the agency today, of what levels of stringency would be maximum feasible in those model years. NHTSA projects that those standards could require, on an average industry fleet wide basis, a range from 48.7–49.7 mpg in model year 2025. The agencies note that these estimated combined fleet average mpg levels are projections and, in fact the agencies are establishing separate standards for passenger cars and trucks, based on a vehicle's size or ''footprint,'' and the actual average achieved fuel economy and GHG emissions levels will be determined by the actual footprints and production volumes of the vehicle models that are produced. NHTSA will undertake a *de novo* rulemaking at a later date to set legally binding CAFE standards for MYs 2022–2025. *See*

the standards we are now presenting for MYs 2022–2025 reflect the agency's current best judgment of what we would have set at this time had we the authority to do so, but also avoid suggesting that the future process for establishing final standards for MYs 2022–2025 would be anything other than a new and separate rulemaking based on the freshly gathered and solicited information before the agency at that future time and on a fresh assessing and balancing of all statutorily relevant factors, in light of the considerations existing at the time of that rulemaking. The agency deliberated extensively, considering many alternative descriptors, and concluded that the best descriptor was ''augural,'' from the verb ''to augur,'' meaning to foretell future events based on current information (as in, ''these standards may augur well for what the agency might establish in the future''). This is precisely what the MYs 2022–2025 standards presented in these documents are—our effort to help interested parties anticipate the future by providing our current best judgment as to what standards we would now set, based on the information before us today, recognizing that our future decision as to what standards we will actually set will be based on the information then before us.

[9] Section I.B.4 provides a explanation of California's authority to set air pollution standards for vehicles.

[10] The California Air Resources Board (CARB) adopted California MYs 2017–2025 GHG emissions standards on January 26, 2012. At its March 22, 2012 meeting the Board gave final approval to the California standards. The Board directed CARB's Executive Officer to ''continue collaborating with EPA and NHTSA as their standards are finalized and in the mid-term review * * *'' and the Board also reconfirmed its commitment to propose to revise its GHG emissions standards for MYs 2017 to 2025 ''to accept compliance with the 2017 through 2025 MY National Program as compliance with California's greenhouse gas emission standards in the 2017 through 2025 model years if the Executive Officer determines that U.S. EPA has adopted a final rule that at a minimum preserve greenhouse reductions benefits set forth'' in the NPRM issued by EPA on December 1, 2011. State of California Air Resources Board, Resolution 12–11, January 26, 2012, at 20. *Available at http://www.arb.ca.gov/regact/2012/cfo2012/res12–11.pdf* (last accessed July 9, 2012).

[11] 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. 163g/mi would be equivalent to 54.5 mpg, if the entire fleet were to meet this CO_2 level through tailpipe CO_2 and fuel economy improvements. The agencies expect, however, that a portion of these improvements will be made through improvements in air conditioning leakage and use of alternative refrigerants, which would not contribute to fuel economy.

[12] 49 U.S.C. 32902.

[13] The range of values here and through this rulemaking document reflect the results of co-analyses conducted by NHTSA using two different light-duty vehicle market forecasts through model year 2025. To evaluate the effects of the standards, the agencies must project what vehicles and technologies will exist in future model years and then evaluate what technologies can feasibly be applied to those vehicles to raise their fuel economy and reduce their greenhouse gas emissions. To project the future fleet, the agencies must develop a baseline vehicle fleet. For this final rule, the agencies have analyzed the impacts of the standards using two different forecasts of the light-duty vehicle fleet through MY 2025. The baseline fleets are discussed in detail in Section II.B of this preamble, and in Chapter 2 of the Technical Support Document. EPA's sensitivity analysis of the alternative fleet is included in Chapter 10 of its RIA.

[14] 49 U.S.C. 32902(b)(3)(B).

Section IV for more information. The agencies will conduct a comprehensive mid-term evaluation and agency decision-making process for the MYs 2022–2025 standards as described in the proposal. The mid-term evaluation reflects the rules' long time frame and, for NHTSA, the agency's statutory obligation to conduct *de novo* rulemaking in order to establish final standards for vehicles for those model years. In order to align the agencies' proceedings for MYs 2022–2025 and to maintain a joint national program, EPA and NHTSA will finalize their actions related to MYs 2022–2025 standards concurrently.

The agencies project that manufacturers will comply with the final rules by using a range of technologies, including improvements in air conditioning efficiency, which reduce both GHG emissions and fuel consumption. Compliance with EPA's GHG standards is also likely to be achieved through improvements in air conditioning system leakage and through the use of alternative air conditioning refrigerants with a lower global warming potential (GWP), which reduce GHGs (i.e., hydrofluorocarbons) but which do not generally improve fuel economy. The agencies believe there is a wide range of technologies already available to reduce GHG emissions and improve fuel economy from both passenger cars and trucks. The final rules facilitate long-term planning by manufacturers and suppliers for the continued development and deployment across their fleets of fuel saving and GHG 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 and lower leakage air conditioning systems. Many of these technologies are already available today, some on a limited number of vehicles while others are more widespread in the fleet, and manufacturers will be able to meet the standards through significant efficiency improvements in these technologies, as well as through 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 result in possible alternative, more cost-effective paths to compliance.

From a societal standpoint, this second phase of the National Program is estimated to save approximately 4 billion barrels of oil and to reduce GHG emissions by the equivalent of approximately 2 billion metric tons over the lifetimes of those light duty vehicles produced in MYs 2017–2025. These savings and reductions come on top of those that are being achieved through the MYs 2012–2016 standards.[15] The agencies project 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 $326 billion to $451 billion (7 and 3 percent discount rates, respectively) over the lifetimes of those light duty vehicles sold in MY 2017–2025.

These final standards are projected to provide significant savings for consumers due to reduced fuel use. Although the agencies estimate that technologies used to meet the standards will add, on average, about $1,800 to the cost of a new light duty vehicle in MY 2025, consumers who drive their MY 2025 vehicle for its entire lifetime will save, on average, $5,700 to $7,400 (7 and 3 percent discount rates, respectively) in fuel, for a net lifetime savings of $3,400 to $5,000. This estimate assumes gasoline prices of $3.87 per gallon in 2025 with small increases most years throughout the vehicle's lifetime.[16] For those consumers who purchase their new MY 2025 vehicle with cash, the discounted fuel savings will offset the higher vehicle cost in roughly 3.3 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 immediately benefit from an average monthly cash flow savings of about $12 during the loan period, or about $140 per year, on average. So this type of consumer would benefit immediately from the time of purchase: the increased monthly fuel savings would more than offset the higher monthly payment. Section I.D provides a detailed discussion of the projected costs and benefits of the MYs 2017–2025 for CAFE and GHG emissions standards for light-duty vehicles.

In addition to saving consumers money at the pump, the agencies have designed their final standards to preserve consumer choice—that is, the 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 (technically they are based on vehicle footprint, which is the area defined by the points where the tires contact the ground), and larger vehicles have numerically less stringent fuel economy/GHG emissions targets and smaller vehicles have numerically more stringent fuel economy/GHG emissions targets. Footprint based standards promote fuel economy and GHG emissions improvements in vehicles of all sizes, and are not expected to create incentives for manufacturers to change the size of their vehicles in order to comply with the standards. Moreover, since the standards are fleet average standards for each manufacturer, no specific vehicle *must* meet a target.[17] Thus, nothing in these rules prevents consumers in the 2017 to 2025 timeframe from choosing from the same mix of vehicles that are currently in the marketplace.

1. Continuation of the National Program

EPA is adopting final greenhouse gas emissions standards for model years 2017–2025 and NHTSA is adopting final Corporate Average Fuel Economy standards for model years 2017–2021 and presenting augural standards for model years 2022–2025. These rules will implement strong and coordinated Federal greenhouse gas and fuel economy standards for passenger cars, light-duty trucks, and medium-duty passenger vehicles. 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 final rules continue the National Program by setting more stringent standards for MY 2017 and beyond light duty vehicles. This coordinated program will achieve important reductions of

[15] The cost and benefit estimates provided in this final rule are only for the MYs 2017–2025 rulemaking. EPA and DOT's rulemaking establishing standards for MYs 2012–2016 are already part of the baseline for this analysis.

[16] See Chapter 4.2.2 of the Joint TSD for full discussion of fuel price projections over the vehicle's lifetime.

[17] A specific vehicle would only have to meet a fuel economy or GHG target value on the target curve standards being finalized today in the rare event that a manufacturer produces a single vehicle model.

greenhouse gas (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.

In working together to finalize these standards, 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 light duty vehicle standards for model years (MY) 2012–2016. As with the MY 2012–2016 final rules, a key element in developing the final rules was the agencies' collaboration with the California Air Resources Board (CARB) and discussions with automobile manufacturers and many other stakeholders. Continuing the National Program will help to ensure that all manufacturers can build a single fleet of U.S. light duty vehicles that satisfy all requirements under both federal programs as well as under California's program, helping to reduce costs and regulatory complexity while providing significant energy security, consumer savings and environmental benefits.

The agencies have been developing the basis for these final standards almost since the conclusion of the rulemaking establishing the first phase of the National Program. Consistent with Executive Order 13563, this rule 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. After much research and deliberation by the agencies, along with CARB and other stakeholders, on July 29, 2011 President Obama announced plans for extending the National Program to MY 2017–2025 light duty vehicles and NHTSA and EPA issued a Supplemental Notice of Intent (NOI) outlining the agencies' plans for proposing the MY 2017–2025 standards and program.[18] This July NOI built upon the extensive analysis conducted by the agencies during 2010 and 2011, including an initial technical assessment report and NOI issued in September 2010, and a supplemental NOI issued in December 2010. 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.[19] The United Auto Workers (UAW) also supported the announcement,[20] as did many consumer and environmental groups. As envisioned in the Presidential announcement, Supplemental NOI, and the December 2011 Notice of Proposed Rulemaking (NPRM), these final rules establish standards for MYs 2017– and beyond light duty vehicles. These standards take into consideration significant public input that was received in response to the NPRM from the regulated industry, consumer groups, labor unions, states, environmental organizations, national security experts and veterans, industry suppliers and dealers, as well as other organizations and by thousands of U.S. citizens. The agencies anticipate that these final standards will spur the development of a new generation of clean and more fuel efficient 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.

As described below, NHTSA and EPA are finalizing a continuation of the National Program for light-duty vehicles that the agencies believe represents the appropriate levels of fuel economy and GHG emissions standards for model years 2017 and beyond, given the technologies that the agencies project 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 establishing GHG emissions standards under the Clean Air Act (CAA), and NHTSA is establishing CAFE standards under EPCA, as amended by the Energy Independence and Security Act of 2007 (EISA). This joint final rulemaking reflects a carefully coordinated and harmonized approach to implementing these two statutes, in accordance with all substantive and procedural requirements imposed by law.[21]

These final rules 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. NHTSA's and EPA's technology assessment indicates there is a wide range of technologies available for manufacturers to consider utilizing to reduce GHG emissions and improve fuel economy. The agencies believe that advances in gasoline engines and transmissions will continue during these model years and that these technologies are likely to play a key role in compliance strategies for the MYs 2017–2025 standards, which is a view that is supported in the literature, among the vehicle manufacturers, suppliers, and by public comments.[22] The agencies also believe that there will be continued improvement in diesel engines, vehicle aerodynamics, and tires as well as the use of lighter weight materials and optimized designs that will reduce vehicle mass. 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.[23] Finally, the agencies expect that vehicle air conditioners will continue to become more efficient, thereby improving fuel efficiency. The agencies also expect that air conditioning leakage will be reduced and that manufacturers will use reduced global warming refrigerants. Both of these improvements will reduce GHG emissions.

Although a number of these technologies are available today, the agencies' assessments support that there will be continuing improvements in the efficiency of some of the technologies and that the cost of many of the technologies will be lower in the future.

[18] 76 FR 48758 (August 9, 2011).

[19] Letters of support are available at *http://www.epa.gov/otaq/climate/regulations.htm* and at *http://www.nhtsa.gov/fuel-economy* (last accessed June 12, 2012).

[20] 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 June 12, 2012).

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

[22] There are a number of competing gasoline engine technologies, with one in particular that the agencies project will increase beyond MY 2016. This is the downsized gasoline direct injection engine equipped with a turbocharger and cooled exhaust gas recirculation, which has better fuel efficiency than a larger engine and similar steady-state power performance. 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 contribute to providing fuel efficiency 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 MY 2016, we anticipate that by MY 2025 these will be common in new light duty vehicles.

[23] For example, while today less than three percent of annual vehicle sales are strong hybrids, plug-in hybrids and all electric vehicles, by MY 2025 we estimate in our analyses for this final rule that these technologies could represent 3–7%, while ''mild'' hybrids may be as high as 17– 27% of new sales and vehicles with stop/start systems only may be as high as 6–15% of new sales. Thus by MY 2025, 26–49% of the fleet may have some level of electrification.

We anticipate that the standards will require most manufacturers to considerably increase the application of these technologies across their light duty vehicle fleets in order to comply with the standards. Manufacturers may also develop and introduce other technologies that we have not considered for this rulemaking analysis, which could play important roles in compliance with the standards and potentially offer more cost effective alternatives. Due to the relatively long lead time for the later model years in this rule, it is quite possible that innovations may arise that the agencies (and the automobile manufacturers) are not considering today, which may even become commonplace by MY 2025.

As discussed further below, and as with the standards for MYs 2012–2016, the agencies believe that the final standards help to preserve consumer choice, that is, the standards should not affect consumers' opportunity to purchase the size and type of vehicle that meets their needs, and should not otherwise affect vehicles' performance attributes. NHTSA and EPA are finalizing standards based on vehicle footprint, which is the area defined by the points where the tires contact the ground, where smaller vehicles have relatively more stringent targets, and larger vehicles have less stringent targets. Footprint based standards promote fuel economy and GHG emissions improvements in vehicles of all sizes, and are not expected to create incentives for manufacturers to change the size of their vehicles in order to comply with the standards. Consequently, these rules should not have a significant effect on the relative availability of different size vehicles in the fleet. The agencies' analyses used a constraint of preserving all other aspects of vehicles' functionality and performance, and the technology cost and effectiveness estimates developed in the analyses reflect this constraint.[24] In addition, as with the standards for MYs 2012–2016, the agencies believe that the standards should not have a negative effect on vehicle safety, as it relates to vehicle size and mass as described in Section II.C and II.G below, respectively. Because the standards are fleet average standards for each manufacturer, no specific vehicle *must* meet a target.[25] Thus, nothing in these rules prevents consumers in the 2017 to 2025 timeframe from choosing from the same mix of vehicles that are currently in the marketplace.

Given the long time frame at issue in setting standards for MYs 2022–2025 light-duty vehicles, and given NHTSA's statutory obligation to conduct a *de novo* rulemaking in order to establish final standards for vehicles for the 2022–2025 model years, the agencies will conduct a comprehensive mid-term evaluation and agency decision-making process for the MYs 2022–2025 standards, as described in the proposal. As stated in the proposal, both NHTSA and EPA will develop and compile up-to-date information for the mid-term evaluation, through a collaborative, robust and transparent process, including public notice and comment. The mid-term evaluation will assess the appropriateness of the MYs 2022–2025 standards, based on information available at the time of the mid-term evaluation and 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 maintaining a National Program to address GHG emissions and fuel economy. NHTSA's rulemaking, which will incorporate findings from the mid-term evaluation, will be a totally fresh consideration of all relevant information and fresh balancing of statutory and other relevant factors in order to determine the maximum feasible CAFE standards for MYs 2022–2025. In order to align the agencies proceedings for MYs 2022–2025 and to maintain a joint national program, if the EPA determination is that its standards will not change, NHTSA will issue its final rule concurrently with the EPA determination. If the EPA determination is that standards may change, the agencies will issue a joint NPRM and joint final rule. Further discussion of the mid-term evaluation is found later in this section, as well as in Sections III.B.3 and IV.A.3.b.

The 2017–2025 National Program is estimated to reduce GHGs by approximately 2 billion metric tons and to save 4 billion barrels of oil over the lifetime of MYs 2017–2025 vehicles relative to the MY 2016 standard curves already in place.[26] The average cost for a MY 2025 vehicle to meet the standards is estimated to be about $1800 compared to a vehicle that meets the level of the MY 2016 standards in MY 2025. Fuel savings for consumers are expected to more than offset the higher vehicle costs. The typical driver will save a total of $5,700 to $7,400 (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 will save a net $3,400 to $5,000 (7 percent and 3 percent discount rate, respectively) over the vehicle's lifetime. This estimate assumes a gasoline price of $3.87 per gallon in 2025 with small increases most years over the vehicle's lifetime.[27] Further, the payback period for a consumer purchasing a 2025 light-duty vehicle with cash would be, on average, 3.4 years at a 7 percent discount rate or 3.2 years at a 3 percent discount rate, while consumers who buy with a 5-year loan would save more each month on fuel than the increased amount they will 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 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, perfluorocarbons, 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 Clean Air Act, anthropogenic emissions of GHGs are very likely (90 to 99 percent probability) the cause of most of the observed global warming over the last

24 One commenter asserted that the standards ''value purported consumer choice and the continued production of every vehicle in its current form over the need to conserve energy: as soon as increased fuel efficiency begins to affect any attribute of any existing vehicle, stringency increases cease.'' CBD Comments p. 4. This assertion is incorrect. As explained in the text above, the agencies' cost estimates include costs of preserving existing attributes, such as vehicle performance. These costs are reflected in the agencies' analyses of reasonableness of the costs of the rule, but do not by themselves dictate any particular level of standard stringency much less cause stringency to ''cease'' as the commenter would have it.

25 A specific vehicle would only have to meet a fuel economy or GHG target value on the target curve standards being finalized today in the rare event that a manufacturer produces a single vehicle model.

26 The cost and benefit estimates provided here are only for the MY 2017–2025 rulemaking. The CAFE and GHG emissions standards for MYs 2012–2016 and CAFE standards for MY 2011 are already part of the baseline for this analysis.

27 See Chapter 4.2.2 of the Joint TSD for full discussion of fuel price projections of the vehicle lifetimes.

50 years.[28] Mobile sources emitted 30 percent of all U.S. GHGs in 2010 (transportation sources, which do not include certain off-highway sources, account for 27 percent) and have been the source of the largest absolute increases in U.S. GHGs since 1990.[29] 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 emissions in 2010.[30] Light-duty vehicles emit CO_2, methane, nitrous oxide, and hydrofluorocarbons and were responsible for nearly 60 percent of all mobile source GHGs and over 70 percent of Section 202(a) mobile source GHGs in 2010.[31] For light-duty vehicles in 2010, CO_2 emissions represented about 94 percent of all greenhouse emissions (including HFCs), and similarly, 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.[32,33]

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. Although our dependence on foreign petroleum has declined since peaking in 2005, net petroleum imports accounted for approximately 45 percent of U.S. petroleum consumption in 2011.[34] 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 over $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 72 percent of U.S. petroleum consumption in 2010.[35] 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.[36]

2. Additional Background on the National Program and Stakeholder Engagement Prior to the NPRM

Following the successful adoption of a National Program for model years (MY) 2012–2016 light duty vehicles, President Obama issued a Memorandum on May 21, 2010 requesting that the NHTSA, on behalf of the Department of Transportation, and the U.S. EPA 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 for model years 2017–2025.*'' [37] 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. 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 announcement.[38]

The President's memorandum requested that the agencies, ''work with the State of California to develop by September 1, 2010, a technical assessment to inform the rulemaking process * * *''. Together, NHTSA, EPA, and CARB issued the joint Technical Assessment Report (TAR) consistent with Section 2(a) of the Presidential Memorandum.[39] In developing this assessment, the agencies 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. Concurrent with issuing the TAR, NHTSA and EPA also issued a joint Notice of Intent to Issue a Proposed Rulemaking (NOI) [40] which highlighted the results of the TAR analyses, 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 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

[28] 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/index.html* (last accessed August 9. 2012)

[29] Memorandum: Mobile Source Contribution to U.S. GHGs in 2010 (Docket EPA–HQ–OAR–2010–0799). See generally, U.S. Environmental Protection Agency. 2012. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010. EPA 430–R–12–001. Available at *http://epa.gov/climatechange/emissions/downloads12/US-GHG-Inventory-2012-Main-Text.pdf* (last accessed June 12, 2012).

[30] Section 202(a) sources include passenger cars, light-duty trucks, motorcycles, buses, and medium- and heavy-duty trucks. EPA's GHG Inventory groups these modes into on-road totals. However, the on-road totals in the Inventory include refrigerated transport for medium- and heavy-duty trucks, which is not considered a source for Section 202(a). In order to determine the Section 202(a) total, we took the on-road GHG total of 1556.8 Tg and subtracted the 11.6 Tg of refrigerated transport to yield a value of 1545.2 Tg.

[31] Memorandum: Mobile Source Contribution to U.S. GHGs in 2010 (Docket EPA–HQ–OAR–2010–0799). See generally, U.S. Environmental Protection Agency. 2012. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010. EPA 430–R–12–001. Available at *http://epa.gov/climatechange/emissions/downloads12/US-GHG-Inventory-2012-Main-Text.pdf* (last accessed June 12, 2012)

[32] Memorandum: Mobile Source Contribution to U.S. GHGs in 2010 (Docket EPA–HQ–OAR–2010–0799). See generally, 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*.

[33] Memorandum: Mobile Source Contribution to U.S. GHGs in 2010 (Docket EPA–HQ–OAR–2010–0799). See generally, U.S. Environmental Protection Agency. 2012. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010. EPA 430–R–12–001. Available at *http://epa.gov/climatechange/emissions/downloads12/US-GHG-Inventory-2012-Main-Text.pdf*

[34] 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 June12, 2012).

[35] Energy Information Administration, Annual Energy Outlook 2011, ''Oil/Liquids.'' *Available at http://www.eia.gov/forecasts/aeo/MT_liquidfuels.cfm* (last accessed June 12, 2012).

[36] Energy Information Administration, Annual Energy Outlook 2012 Early Release Overview. *Available at http://www.eia.gov/forecasts/aeo/er/early_fuel.cfm* (last accessed Jun. 14, 2012).

[37] 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).

[38] These letters of support in response to the May 21, 2010 Presidential Memorandum are available at *http://www.epa.gov/otaq/climate/letters.htm* (last accessed August 9, 2012).

[39] This Interim Joint Technical Assessment Report (TAR) is available at *http://www.epa.gov/otaq/climate/regulations/ldv-ghg-tar.pdf* (last accessed August 9, 2012) 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.''

[40] 75 FR 62739, October 13, 2010.

year 2016 fleet-wide average of 250 gram/mile (g/mi), which 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.[41,42] For each of these scenarios, the TAR also evaluated four illustrative ''technological pathways'' by which these levels could be attained, each pathway offering a different mix of advanced technologies and assuming various degrees of penetration of advanced gasoline technologies, mass reduction, hybrid electric vehicles (HEVs), plug-in hybrids (PHEVs), and electric vehicles (EVs). 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.

Manufacturers and others commented extensively on a variety of topics in the TAR, 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. EPA and NHTSA issued a follow-on Supplemental NOI in November 2010,[43] highlighting many of the key comments the agencies received in response to the September NOI and TAR, and summarized some of the key themes from the comments and the additional stakeholder meetings.

The agencies' stakeholder engagement between December 2010 and July 29, 2011 focused on ensuring that the agencies possessed the most complete and comprehensive set of information to inform the proposed rulemaking. Information that the agencies presented to stakeholders is posted in the NPRM docket and referenced in multiple places in the NPRM. Throughout this period, the stakeholders repeated many of the broad concerns and suggestions described in the TAR, NOI, and November 2010 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 final rule 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 November 2010 Supplemental NOI and that were summarized in that document. Manufacturers provided the agencies more detailed information related to their product plans for vehicle models and fuel efficiency improving technologies and associated cost estimates, as well as more detailed feedback regarding the potential program design elements to be included in the program. The second stage of meetings occurred between June 21, 2011 and July 14, 2011, during which EPA, NHTSA, CARB and several components of the Executive Office of the President kicked-off an intensive series of meetings, primarily with manufacturers, to share tentative regulatory concepts including concept stringency curves and program flexibilities based on the analyses completed by the agencies as of June 21, 2011[44] and requested manufacturer feedback; specifically[45] detailed and reliable information on how they might comply with the concepts, potential changes to the concept stringency levels and program flexibilities available under EPA's and NHTSA's respective authority that might facilitate compliance, and if they projected they could not comply, information supporting that belief. In these second stage meetings, the agencies received considerable input from the manufacturers related to the questions asked by the agencies and also related to consumer acceptance and adoption of some advanced technologies and program costs based on their independent assessment or information previously submitted to the agencies. The third stage of meetings occurred between July 15, 2011 and July 28, 2011 during which the agencies continued to refine concept stringencies and compliance flexibilities based on further consideration of the information available to them as well as meeting with manufacturers who expressed ongoing interest in engaging with the agencies.[46]

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. Environmental organizations consistently stated that stringent standards are technically achievable and critical to important national interests. Labor interests stressed the need to

[41] 75 FR 62744–45.

[42] 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/letters.htm* (last accessed August 9, 2012).

[43] 75 FR 76337, December 8, 2010.

[44] The agencies consider a range of standards that may satisfy applicable legal criteria, taking into account the complete record before them. The initial concepts shared with stakeholders were within the range the agencies were considering, based on the information then available to the agencies.

[45] ''Agency Materials Provided to Manufacturers'' Memo to docket NHTSA–2010–0131.

[46] ''Agency Materials Provided to Manufacturers'' Memo to docket NHTSA–2010–0131.

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.

On July 29, 2011, President Obama with the support of thirteen major automakers, announced plans 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.[47] 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 environmental and consumer groups, also announced their support.

On the same day as the President's announcement, EPA and NHTSA released a second SNOI (published in the **Federal Register** on August 9, 2011) describing the joint proposal that the agencies expected to issue to establish the National Program for model years 2017–2025. The agencies 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. The input of stakeholders, which is encouraged by Executive Order 13563, was invaluable to the agencies in developing the NPRM. A more detailed summary of the process leading to the proposed rulemaking is found at 76 FR 74862–865.

3. Public Participation and Stakeholder Engagement Since the NPRM Was Issued

The agencies signed their respective proposed rules on November 16, 2011 (76 FR 74854 (December 1, 2011)), and subsequently received a large number of comments representing many perspectives. Between January 17 and 24, 2012 the EPA and NHTSA held three public hearings in Detroit, Philadelphia and San Francisco. Nearly 400 people testified and many more attended the hearings. In response to requests, the written comment period was extended by two weeks for a total of 74 days from **Federal Register** publication, closing on February 13, 2012. The agencies received extensive written comments from more than 140 organizations, including auto manufacturers and suppliers, State and local governments and their associations, consumer groups, labor unions, fuels and energy providers, auto dealers, academics, national security experts and veterans, environmental and other non-governmental organizations (NGOs), and nearly 300,000 comments from private individuals. In addition to comments received on the proposal, the agencies met with many different stakeholder groups between issuance of the NPRM and this final rule. Generally, the agencies met with nearly all automakers individually to discuss flexibilities such as the A/C, off-cycle, and pickup truck incentives, as well as different ways to meet the standards; with suppliers to discuss the same flexibilities; with environmental groups to discuss flexibilities and that the agencies maintain strong standards for the final rule; and with the natural gas interests to discuss incentives for natural gas in the final rule. Memoranda summarizing these meetings can be found in the EPA and NHTSA dockets for this rulemaking. EPA–HQ–OAR–2010–0799 and NHTSA–2010–0131.[48]

An overwhelming majority of commenters supported the proposed 2017–2025 CAFE and GHG standards with most organizations and nearly all of the private individuals expressing broad support for the program and for the continuation of the National Program to model years (MY) 2017–2025 light-duty vehicles, and the Program's projected achievement of an emissions level of 163 gram/mile fleet average CO_2, which would be equivalent to 54.5 miles per gallon if the automakers were to meet this CO_2 level solely through fuel economy improvements.[49]

In general, more than a dozen automobile manufacturers supported the proposed standards as well as the credit opportunities and other provisions that provide compliance flexibility, while also recommending some changes to the credit and flexibility provisions—in fact, a significant majority of comments from industry focused on the credit and flexibility provisions. Nearly all automakers stressed the importance of the mid-term evaluation to assess the progress of technology development and cost, and the accuracy of the agencies' assumptions due to the long time-frame of the rule. Many industry commenters expressly predicated their support of the 2017–2025 National Program on the existence of this evaluation. Environmental and public interest non-governmental organizations (NGOs), as well as States that commented were also very supportive of extending the National Program to MYs 2017–2025 passenger vehicles and light trucks. Many of these organizations expressed concern that the mid-term evaluation might be used as an opportunity to weaken standards or to delay the environmental benefits of the National Program.

The agencies also received comments that either opposed the issuance of the standards, or that argued that they should be modified in various ways. The Center for Biological Diversity (CBD) commented that the proposed standards were not sufficiently stringent, recommending that the agencies increase the standards to 60–70 mpg in 2025. CBD, as well as several other organizations,[50] also argued that minimum standards (''backstops'') were necessary for all fleets in order to ensure anticipated fuel economy gains. Several environmental groups expressed concern that flexibilities, such as off-cycle credits, could result in significantly lower gains through double-counting and allowing manufacturers to avoid making fuel economy improvements.

Some car-focused manufacturers objected to the truck curves, which they considered lenient while some small truck manufacturers objected to the large truck targets, which they considered lenient; and some intermediate and small volume manufacturers with limited product lines requested additional lead time, as well as less stringent standards for their vehicles. Manufacturers in general argued that backstops were not

[47] The President's remarks are available at *http://www.whitehouse.gov/the-press-office/2011/07/29/remarks-president-fuel-efficiency-standards* (last accessed August 9, 2012); see also *http://www.nhtsa.gov/fuel-economy* for more information from the agency about the announcement.

[48] NHTSA is required to provide information on these meetings per DOT Order 2100.2, *available at http://www.reg-group.com/library/DOT2100-2.PDF* (last accessed Jun. 12, 2012). The agencies have placed memos summarizing these meetings in their respective dockets.

[49] 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. 163 g/mi would be equivalent to 54.5 mpg, if the entire fleet were to meet this CO_2 level through tailpipe CO_2 and fuel economy improvements, and assumes gasoline fueled vehicles (significant diesel fuel penetration would have a different mpg equivalent). The agencies expect, however, that a portion of these improvements will be made through improvements in air conditioning leakage and alternative refrigerants, which would not contribute to fuel economy.

[50] The Natural Resources Defense Council, the Union of Concerned Scientists, the Sierra Club, and the Consumer's Union.

necessary for fuel economy gains and would be outside NHTSA's authority. Manufacturers also commented extensively on the programs' flexibilities, such as off-cycle credits, generally requesting more permissive applications and requirements.

The National Automobile Dealers Association (NADA) opposed the MYs 2017–2025 proposed standards, arguing that the agencies should delay rulemaking since they believe there was no need to set standards so far in advance, that the costs of the proposed program are higher than agencies have projected, and that some (mostly low income) consumers will not be able to acquire financing for new cars meeting these more stringent standards.

Many environmental and consumer groups commented that the benefits of the rule were understated and the costs overstated, arguing that several potential benefits had not been included and the technology effectiveness estimates were overly conservative. Some environmental groups also expressed concern that the benefits of the rule could be eroded if the agencies' assumptions about the market do not come to pass or if manufacturers build larger vehicles. Other groups, such as NADA, Competitive Enterprise Institute, and the Institute for Energy Research, argued that the benefits of the rule were overstated and the costs understated, asserting that manufacturers would have already made improvements if the agencies' calculations were correct.

Many commenters discussed potential environmental and health aspects of the rule. Producers of specific materials, such as aluminum, steel, or plastic, commented that standards should ultimately reflect a life cycle analysis that accounts for the greenhouse gas emissions attributable to the materials from which vehicles are manufactured. Some environmental groups requested that standards for electrified vehicles reflect emissions attributable to upstream electricity generation. Many commenters expressed support for the rule and its health benefits, while other commenters were concerned about possible negative health impacts due to assumptions about future fuel properties.

Many commenters also addressed issues relating to safety, with most generally supporting the agencies' efforts to continue to improve their understanding of the relationship between mass reduction and safety. Consistent with their comments in prior rulemakings, several environmental and consumer organizations commented that data exist that mass reduction does not have adverse safety impacts, and stated that the use of better designs and materials can improve both fuel economy and safety. Dynamic Research Institute (DRI) submitted a study, and other commenters pointed to DRI's work and additional studies for the agencies' consideration, as discussed in more detail in Section II.G below. Materials producers (aluminum, steel, composite, etc.) commented that their respective materials can be used to improve safety. The Alliance commented that while some recent mass reduction vehicle design concept studies have created designs that perform well in simulation modeling of safety standard and voluntary safety guideline tests, the design concepts yield aggressively stiffer crash pulses may be detrimental to rear seat occupants, vulnerable occupants and potential crash partners. The Alliance also commented that there are simulation model uncertainties with respect to advanced materials, and the real-world crash behavior of these concepts may not match that predicted in those studies. The Alliance and Volvo commented that it is important to monitor safety trends, and the Alliance urged that the agencies revisit this topic during the mid-term evaluation.

Additional comments touched on the use of ''miles per gallon'' to describe the standards, the agencies' baseline market forecast, consumer welfare and trends in consumer preferences for fuel economy, and a wide range of other topics.

Throughout this notice, the agencies discuss key issues arising from the public comments and the agencies' responses to those comments. The agencies also respond to comments in the Joint TSD and in their respective RIAs. In addition, EPA has addressed all of the public comments specific to the GHG program in a Response to Comments document.[51]

4. 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.[52] On June 30, 2009, EPA granted California's request for a waiver of preemption under the CAA with respect to these standards.[53] Thirteen states and the District of Columbia, comprising approximately 40 percent of the light-duty vehicle market, adopted California's standards.[54] The granting of the waiver permits California and the other states to proceed with implementing the California emission standards for MYs 2009 and later. 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.[55] 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 worked closely with CARB throughout the development of the proposed rules. CARB staff released its proposal for MYs 2017–2025 GHG emissions standards consistent with the standards proposed by EPA on December 9, 2011 and the California Air Resources Board adopted these standards at its January 26, 2012 Board meeting, with final approval at its March 22, 2012 Board meeting.[56] In adopting their GHG standards the California Air Resources Board directed the Executive Officer to ''continue collaborating with EPA and NHTSA as their standards are finalized and in the mid-term review to minimize potential lost benefits from federal treatment of upstream emissions of electricity and hydrogen fueled vehicles,'' and also, ''to participate in U.S. EPA's review of the 2022 through 2025 model year

[51] EPA Response to Comments document. (EPA–420–F–12–017) Available in the docket and at: *http://www.epa.gov/otaq/climate/regs-light-duty.htm* (last accessed August 8, 2012).

[52] Through operation of section 209(b) of the Clean Air Act, California is able to seek and receive a waiver of section 209(a)'s preemptions to enforce such standards. Section 209(b)(1) requires a waiver to be granted for any State that had adopted standards (other than crankcase emission standards) for the control of emissions from new motor vehicles or new motor vehicles' engines prior to March 30, 1966. California is the only state to have adopted standards prior to 1966 and is therefore the only state qualified to seek and receive a waiver. EPA evaluates California's request under the three waiver criteria set forth in section 209(b)(1)(A)–(C) and must grant a waiver under section 209(e)(2) if these criteria are met.

[53] 74 FR 32744 (July 8, 2009). See also *Chamber of Commerce* v. *EPA,* 642 F.3d 192 (D.C. Cir. 2011) (dismissing petitions for review challenging EPA's grant of the waiver).

[54] The Clean Air Act allows other states to adopt California's motor vehicle emissions standards under section 177 if such standards are identical to the California standards for which a waiver has been granted. States are not required to seek EPA approval under the terms of section 177.

[55] *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 at 7. *Available at http://www.arb.ca.gov/regact/2010/ghgpv10/oaltp.pdf* (last accessed June 12, 2012).

[56] See California Low-Emission Vehicles (LEV) & GHG 2012 regulations adopted by State of California Air Resources Board, March 22, 2012, Resolution 12–21 incorporating by reference Resolution 12–11 (see especially Resolution 12–11 at 20) which was adopted January 26, 2012. Available at *http://www.arb.ca.gov/regact/2012/leviiighg2012/leviiighg2012.htm* (last accessed July 9, 2012).

passenger vehicle greenhouse gas standards being proposed under the 2017 through 2025 MY National Program.'' [57] CARB also reconfirmed its commitment, previously made in July 2011 in conjunction with release of the Supplemental NOI,[58] to propose to revise its GHG emissions standards for MYs 2017–2025 such that compliance with EPA GHG emissions standards shall be deemed compliance with the California GHG emissions standards. The Board directed CARB's Executive Officer that, ''it is appropriate to accept compliance with the 2017 through 2025 model year National Program as compliance with California's greenhouse gas emission standards in the 2017 through 2025 model years, once United States Environmental Protection Agency (U.S. EPA) issues their final rule on or after its current July 2012 planned release, provided that the greenhouse gas reductions set forth in U.S. EPA's December 1, 2011 Notice of Proposed Rulemaking for 2017 through 2025 model year passenger vehicles are maintained, except that California shall maintain its own reporting requirements.'' [59]

C. Summary of the Final 2017–2025 National Program

1. Joint Analytical Approach

These final rules continue the collaborative analytical effort between NHTSA and EPA, which began with the MYs 2012–2016 rulemaking for light-duty vehicles. NHTSA and EPA have worked together on nearly every aspect of the technical analysis supporting these joint rules. The results of this collaboration are reflected in key elements of the respective NHTSA and EPA rules, as well as in the analytical work contained in the Joint Technical Support Document (Joint TSD). The agencies have continued to develop and refine the supporting analyses since issuing the proposed rule last December. The Joint TSD, in particular, describes important details of the analytical work that are common to both agencies' rules, and also explains any key differences in approach. The joint analyses addressed in the TSD 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 final rules, a description of air conditioner and other off-cycle technologies, and the agencies' assessment of the impacts of hybrid technology incentive provisions for full-size pick-up trucks. This comprehensive joint analytical approach has provided a sound and consistent technical basis for both agencies in developing their final standards, which are summarized in the sections below.

2. Level of the Standards

EPA and NHTSA are finalizing separate sets of standards for passenger cars and for light trucks, each under its respective statutory authority. EPA is setting national CO_2 emissions standards for passenger cars and light-trucks under section 202(a) of the Clean Air Act (CAA), while NHTSA is setting national corporate average fuel economy (CAFE) standards under the Energy Policy and Conservation Act (EPCA), as amended by the Energy Independence and Security Act (EISA) of 2007 (49 U.S.C. 32902). Both the CO_2 and CAFE standards for passenger cars and standards for light trucks are footprint-based, similar to the standards currently in effect for these vehicles through model year 2016, and will become more stringent on average in each model year from 2017 through 2025. The basis for measuring performance relative to standards continues to be based predominantly on the EPA city and highway test cycles (2-cycle test). However, EPA is finalizing optional air conditioning and off-cycle credits for the GHG program and adjustments to calculated fuel economy for the CAFE program that are based on test procedures other than the 2-cycle tests.

As proposed, EPA is finalizing 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 and improvements in non-CO_2 GHG emissions from reduced air conditioning (A/C) system leakage and use of lower global warming potential (GWP) refrigerants. The level of 163 grams/mile CO_2 is equivalent on a mpg basis to 54.5 mpg, if this level was achieved solely through improvements in fuel efficiency.[60]

Consistent with the proposal, for passenger cars, the CO_2 compliance values associated with the footprint curves will 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 the fleet transitions 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 finalizing standards reflecting an annual rate of improvement for light-duty trucks which is lower than that for passenger cars in the early years of the program. For light-duty trucks, the average annual rate of CO_2 emissions reduction in model years 2017 through 2021 is 3.5 percent per year. As proposed, EPA is also changing 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 will be higher than 3.5 percent, and the annual rate of improvement for larger light-duty trucks over the same time period will be lower than 3.5 percent. For model years 2022 through 2025, EPA is finalizing an average annual rate of CO_2 emissions reduction for light-duty trucks of 5 percent per year.

Consistent with its statutory authority,[61] NHTSA has developed two phases of passenger car and light truck standards in this rulemaking action. The first phase, from MYs 2017–2021, includes final standards that are projected to require, on an average industry fleet wide basis, a range from 40.3 to 41 mpg in MY 2021.[62] For passenger cars, the annual increase in

[57] Id.

[58] See State of California July 28, 2011 letter available at: *http://www.epa.gov/otaq/climate/letters.htm* (last accessed August 9, 2012).

[59] Id., CARB Resolution 12–21 (March 22, 2012) (last accessed June 6, 2012).

[60] 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 included some degree of reductions in greenhouse gases other than CO_2, as one part of the A/C-related reductions. In addition, greater penetration of diesel fuel (as opposed to gasoline) will change the fuel economy equivalent.

[61] 49 U.S.C. 32902.

[62] The range of values here and through this rulemaking document reflect the results of co-analyses conducted by NHTSA using two different light-duty vehicle market forecasts through model year 2025. To evaluate the effects of the standards, the agencies must project what vehicles and technologies will exist in future model years and then evaluate what technologies can feasibly be applied to those vehicles to raise their fuel economy and reduce their greenhouse gas emissions. To project the future fleet, the agencies must develop a baseline vehicle fleet. For this final rule, the agencies have analyzed the impacts of the standards using two different forecasts of the light-duty vehicle fleet through MY 2025. The baseline fleets are discussed in detail in Section II.B of this preamble, and in Chapter 1 of the Technical Support Document. EPA's sensitivity analysis of the alternative fleet is included in Chapter 10 of its RIA.

the stringency of the target curves between model years 2017 to 2021 is expected to average 3.8 to 3.9 percent. In recognition of manufacturers' unique challenges in improving the fuel economy and GHG emissions of full-size pickup trucks as the fleet transitions 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 finalizing a lower annual rate of improvement for light trucks in the first phase of the program. For light trucks, the annual increase in the stringency of the target curves in model years 2017 through 2021 is 2.5 to 2.7 percent per year on average. NHTSA is changing the slopes of the fuel economy footprint curves for light trucks from those in the MYs 2012–2016 final rule, which effectively make the annual rate of improvement for smaller light trucks in MYs 2017–2021 higher than 2.5 or 2.7 percent per year, and the annual rate of improvement for larger light trucks over that time period lower than 2.5 or 2.7 percent per year.

The second phase of the CAFE program, from MYs 2022–2025, includes standards that are not final due to the statutory provision that NHTSA shall issue regulations prescribing average fuel economy standards for at least 1 but not more than 5 model years at a time.[63] The MYs 2022–2025 standards, then, are not final as part of this rulemaking, but rather augural, meaning that they represent the agency's current judgment, based on the information available to the agency today, of what levels of stringency would be maximum feasible in those model years. NHTSA projects that those standards would require, on an average industry fleet wide basis, a range from 48.7 to 49.7 mpg in model year 2025. NHTSA will undertake a *de novo* rulemaking at a later date to set legally binding standards for MYs 2022–2025. *See* Section IV for more information. For passenger cars, the annual increase in the stringency of the target curves between model years 2022 and 2025 is expected to average 4.7 [64] percent, and for light trucks, the annual increase during those model years is expected to average 4.8 to 4.9 percent.

NHTSA notes that for the first time in this rulemaking, EPA is finalizing, under its EPCA authority, rules allowing the impact of air conditioning system efficiency improvements to be included in the calculation of fuel economy for CAFE compliance. Given that these real-world improvements will be available to manufacturers for compliance, NHTSA has accounted for this by determining the amount that industry is expected to improve air conditioning system efficiency in each model year from 2017–2025, and setting the CAFE standards to reflect these improvements, in a manner consistent with EPA's GHG standards. See Sections III.B.10 and IV.I.4.b of this final rule preamble for more information.

NHTSA also notes that the rates of increase in stringency for CAFE standards are lower than EPA's 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 standards, unlike EPA's, do not reflect the inclusion of air conditioning system refrigerant and leakage improvements, but EPA's standards allows consideration of such A/C refrigerant improvements which reduce GHGs but do not affect fuel economy. As another example, the Clean Air Act allows various compliance flexibilities (among them certain credit generating mechanisms) not present in EPCA.

As with the MYs 2012–2016 standards, NHTSA and EPA's final MYs 2017–2025 passenger car and light truck standards are expressed as mathematical functions depending on the vehicle footprint attribute.[65] 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 will 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.[66] 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 in any given model year. The values in the tables below reflect the agencies' projection of the range 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 these standards. EPA and NHTSA have each finalized the attribute-based curves, as proposed, for the model years covered by these final rules, as discussed in detail in Section II.B of this preamble and Chapter 2 of the Joint TSD. The agencies have updated their projections of the impacts of the final rule standards since the proposal, as discussed in Sections III and IV of this preamble and in the agencies' respective RIAs.

As shown in Table I–1 NHTSA's fleet-wide estimated required CAFE levels for passenger cars would increase from between 40.1 and 39.6 mpg in MY 2017 to between 55.3 and 56.2 mpg in MY 2025. Fleet-wide required CAFE levels for light trucks, in turn, are estimated to increase from between 29.1 and 29.4 mpg in MY 2017 and between 39.3 and 40.3 mpg in MY 2025. 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 a range from 48.7 to 49.7 mpg in MY 2025. Considering these combined car and truck increases, the standards together represent approximately a 4.0 percent annual rate of increase,[67] on average, relative to the MY 2016 required CAFE levels.

[63] 49 U.S.C. 32902(b)(3)(B).

[64] The rate of increase is rounded at 4.7 percent per year using 2010 and 2008 baseline.

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

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

[67] 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 Footprint-Based CAFE Standards

	MY Baseline	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger cars	2008 2010	40.1 – 39.6	41.6 – 41.1	43.1 – 42.5	44.8 – 44.2	46.8 – 46.1	49.0 – 48.2	51.2 – 50.5	53.6 – 52.9	56.2 – 55.3
Light trucks	2008 2010	29.4 – 29.1	30.0 – 29.6	30.6 – 30.0	31.2 – 30.6	33.3 – 32.6	34.9 – 34.2	36.6 – 35.8	38.5 – 37.5	40.3 – 39.3
Combined	2008 2010	35.4 – 35.1	36.5 – 36.1	37.7 – 37.1	38.9 – 38.3	41.0 – 40.3	43.0 – 42.3	45.1 – 44.3	47.4 – 46.5	49.7 – 48.7

The estimated average required mpg levels for passenger cars and trucks under the 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 flexibilities and credits that manufacturers may use for compliance that NHTSA cannot consider in establishing standards based on EPCA/EISA constraints. These flexibilities 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 Flexible Fuel Vehicle (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 CAFE standards will lead to the following average achieved fuel economy levels, based on the agencies' projections of what each manufacturer's fleet will comprise in each year of the program: [68]

[68] The 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 final levels. To receive these incentives, manufacturers must produce vehicles with these technologies or performance levels at volumes that meet or exceed final penetration levels (percentage of full size pick-up truck volume). This incentive is described in detail in Section IV.I.3.a.. The NHTSA estimates in Table I–2 do not account for the reduction in estimated average achieved fleet-wide CAFE fuel economy that will 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 RIA.

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

	MY	2017	2018	2019	2020	2021	2022	2023	2024	2025
	Baseline									
Passenger cars	2008	39.5 –	41.5 –	43.8 –	46.3 –	47.9 –	49.3 –	50.0 –	51.5 –	52.9 –
	2010	39.4	41.1	43.3	45.1	47.1	48.1	49.6	51.3	52.1
Light trucks	2008	29.3 –	30.3 –	31.9 –	33.3 –	35.2 –	36.1 –	36.8 –	37.9 –	39.0 –
	2010	28.8	29.3	31.3	32.8	34.9	35.5	36.5	37.4	37.6
Combined	2008	35.0 –	36.6 –	38.7 –	40.8 –	42.6 –	43.8 –	44.6 –	46.0 –	47.4 –
	2010	34.8	36.0	38.2	39.9	42.0	42.9	44.2	45.6	46.2

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 is finalizing minimum standards for domestic passenger cars for MYs 2017–2021 and providing augural standards for MYs 2022–2025 as presented below in Table I–3.

TABLE I–3—MINIMUM STANDARD FOR DOMESTICALLY MANUFACTURED PASSENGER CARS (MPG)

2017	2018	2019	2020	2021	2022	2023	2024	2025
36.7	38.0	39.4	40.9	42.7	44.7	46.8	49.0	51.3

EPA is finalizing 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 passenger car and truck footprint curves, but do not account for EPA's projection of how manufacturers will implement two of the incentive programs being finalized in today's rulemaking (advanced technology vehicle multipliers, and hybrid and performance-based incentives for full-size pickup trucks). Table I–4 also does not account for the intermediate volume manufacturer lead-time provisions that EPA is adopting. EPA's projection of fleet-wide emissions levels that do reflect these provisions is shown in Table I–5 below.

TABLE I–4—PROJECTED FLEET-WIDE CO_2 COMPLIANCE TARGETS UNDER THE FOOTPRINT-BASED CO_2 STANDARDS (G/MI) (PRIMARY ANALYSIS) [a]

	2016 base	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger Cars	225	212	202	191	182	172	164	157	150	143
Light Trucks	298	295	285	277	269	249	237	225	214	203
Combined Cars and Trucks	[69] 250	243	232	222	213	199	190	180	171	163

[a] Projected results using MY 2008 based fleet projection analysis. These values differ slightly from those shown in the proposal because of revisions to the MY 2008 based fleet.

As shown in Table I–4, projected fleet-wide CO_2 emission compliance targets for cars increase in stringency from 212 to 143 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 are made with fuel economy improvements.

EPA anticipates that manufacturers will take advantage of program flexibilities, credits and incentives, such as car/truck credit transfers, air conditioning credits, off-cycle credits, advanced technology vehicle multipliers, intermediate volume manufacturer lead-time provisions, and hybrid and performance-based incentives for full size pick-up trucks. Three of these flexibility provisions—advanced technology vehicle multipliers, intermediate volume manufacturer lead-time provisions, 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.[70] 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 EPA's projection of manufacturers' use of the advanced technology vehicle multipliers, and the full size pick-up hybrid/performance incentives, but does not reflect car-truck trading, air conditioning credits, or off-cycle credits, because, while the latter credit provisions 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.

TABLE I–5—PROJECTED FLEET-WIDE ACHIEVED CO_2-EQUIVALENT EMISSION LEVELS UNDER THE FOOTPRINT-BASED CO_2 STANDARDS (G/MI) [71] (PRIMARY ANALYSIS) [a]

	2016 base	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger Cars	225	213	203	193	183	173	164	157	150	143
Light Trucks	298	295	287	278	270	250	238	226	214	204
Combined Cars and Trucks	[72] 250	243	234	223	214	200	190	181	172	163

[a] Projected results using 2008 based fleet projection analysis. These values differ slightly from those shown in the proposal because of revisions to the MY 2008 based fleet and updates to the analysis.

A more detailed description of how the agency arrived at the year by year progression of both the projected compliance targets and the achieved CO_2 emission levels can be found in Sections III of this preamble.

As previously stated, there was broad support for the proposed standards by auto manufacturers including BMW, Chrysler, Ford, GM, Honda, Hyundai, Kia, Jaguar/Land Rover, Mazda, Mitsubishi, Nissan, Tesla, Toyota, Volvo, as well as the Global Automakers. Of the larger manufacturers, Volkswagen and Mercedes commented that the proposed passenger car standards were relatively too stringent while light truck standards were relatively too lenient and suggested several alternatives to the proposed standards. Toyota also commented that lower truck stringency puts more burdens on small cars. Honda was concerned that small light trucks face disproportionate stringency compared to larger footprint trucks under the proposed standards. The agencies' consideration of these and other comments and of the updated technical analyses did not lead to changes to the stringency of the standards nor in the shapes of the curves discussed above. These issues are discussed in more detail in Sections II, III and IV.

NHTSA and EPA reviewed the technology assessment employed in the proposal in developing this final rule, and concluded that there is a wide range of technologies available in the MY 2017–2025 timeframe for manufacturers to consider in upgrading light-duty vehicles to reduce GHG emissions and improve fuel economy. Commenters generally agreed with this assessment and conclusion.[73] The final technology assessment relied on our joint analyses for the proposed rule, as well as some new information and analyses, including information we received during the public comment period, as discussed in Section II.D below. The analyses performed for this final rule included an updated assessment of the cost, effectiveness and availability of several technologies.

As noted further in Section II.D, for this final rule, the agencies considered over 40 current and evolving vehicle and engine 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 we considered are available today, some on a limited number of vehicles and others more widespread throughout the fleet, and the agencies believe they could be incorporated into vehicles as manufacturers make their product development decisions. These ''near-term'' technologies are identical or very similar to those anticipated in the agencies' analyses of compliance strategies for the MYs 2012–2016 final rule, but we believe they can achieve wider penetration throughout the

[69] As noted at proposal, the projected fleet compliance levels for 2016 are different for trucks and the fleet than were projected in the 2012–2016 rule. See 76 FR 74868 n. 44. Our assessment for this final rule is based on a predicted 2016 car value of 224, a 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.

[70] There are extremely small (and unquantified) impacts on the achieved values from other flexibilities such as small volume manufacturer specific standards and emergency vehicle exemptions.

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

[72] The projected fleet achieved levels for 2016 are different for the fleet than were projected in the 2012–2016 rule. Our assessment is based on a predicted 2016 car value of 224, and a 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 achieved levels for any model year will not be known until the end of that model year based on actual vehicle sales.

[73] For more detail on comments regarding the agencies' technology assessment, see Section II.D.

vehicle fleet during the MYs 2017–2025 timeframe. For this rulemaking, given its timeframe, we also considered other technologies 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 emerging hybrid architecture combined with an 8-speed dual clutch transmission, a combination that is not available today. These are technologies that the agencies believe that manufacturers can, for the most part, apply both to cars and trucks, and that we expect will achieve significant improvements in fuel economy and reductions in CO_2 emissions at reasonable cost in the MYs 2017–2025 timeframe. Chapter 3 of the joint TSD provides the full assessment of these technologies. Due to the relatively long lead time before MY 2017, the agencies expect that manufacturers will be able to employ combinations of these and potentially other technologies and that manufacturers and the supply industry will be able to produce them in sufficient volumes to comply with the final standards.

A number of commenters suggested that the proposed standards were either too stringent or not stringent enough (either in some model years or in all model years, depending on the commenter), and nearly all auto manufacturers and their associations stressed the importance of the mid-term evaluation of the MYs 2022–2025 standards in their comments due to the long timeframe of the rule and uncertainty in assumptions given this timeframe. Our consideration of these comments as well as our revised analyses, leads us to conclude that the general rate of increase in the stringency of the standards as proposed remains appropriate. The comprehensive mid-term evaluation process being finalized and our evaluation of the stringency of the standards is discussed further in Sections III and IV.

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 final standards. EPA's and NHTSA's analyses of these regulatory alternatives (and explanation of why we are finalizing the standards) are contained in Sections III and IV of this preamble, respectively, as well as in the agencies' respective Regulatory Impact Analyses (RIAs).

3. Form of the Standards

NHTSA and EPA are finalizing attribute-based standards for passenger cars and light trucks, as required by EISA and as allowed by the CAA, and will continue to use vehicle footprint as the attribute.[74] Footprint is defined as a vehicle's wheelbase multiplied by its average 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.[75] The agencies continue to believe that footprint is the most appropriate attribute on which to base the proposed standards, as discussed in Section II.C and in Chapter 2 of the Joint TSD. The majority of commenters supported the continued use of footprint as the vehicle attribute; those comments and the agencies' response are discussed in Section II.C below.

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 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 the projected production volume of its vehicle fleet (and are estimated as part of the EPA certification process), the standards to which the manufacturer must comply will be determined by 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.[76]

The final footprint-based standards are identical to those proposed. The passenger car curves are also similar in shape to the car curves for MYs 2012–2016. However, as proposed, the final light truck curves for MYs 2017–2025 reflect more significant changes compared to the light truck curves for MYs 2012–2016; specifically, the agencies have increased the slope and extended the large-footprint cutpoint for the light truck curves over time to larger footprints. We continue to believe that these changes from the MYs 2012–2016 curves represent an appropriate balance of both technical and policy issues, as discussed in Section II.C below and Chapter 2 of the Joint TSD.

NHTSA is adopting the attribute curves below for model years 2017 through 2021 and presenting the augural attribute curves below for model years 2022–2025. As just explained, these targets, expressed as 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 curves for model years 2017 through 2025 while Figure I–2 below illustrates the light truck CAFE curves for model years 2017 through 2025.

EPA is finalizing the attribute curves shown in Figure I–3 and Figure I–4 below, for model years 2017 through 2025. 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–

[74] NHTSA and EPA 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. This approach of using common definitions allows the CO_2 standards and the CAFE standards to continue to be harmonized across all vehicles for the National Program.

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

[76] 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 production weighted average of the target levels for each model) with fleet average performance (based on the production weighted average of the performance for each model).

4 shows the CO_2 truck standard curves for model years 2017–2025.

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Figure I-1 CAFE Target Curves for Passenger Cars

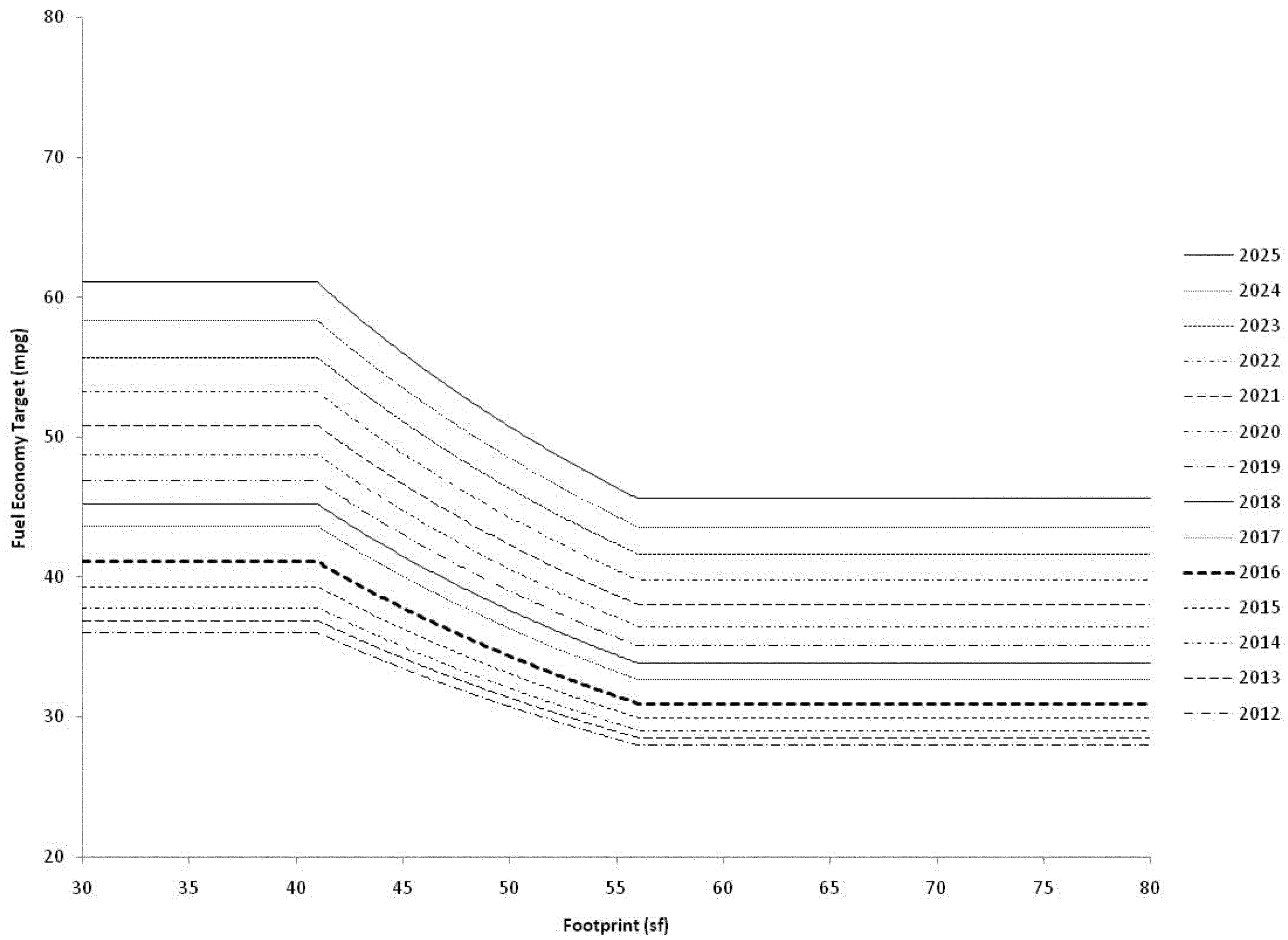


Figure I -2 CAFE Target Curves for Light Trucks

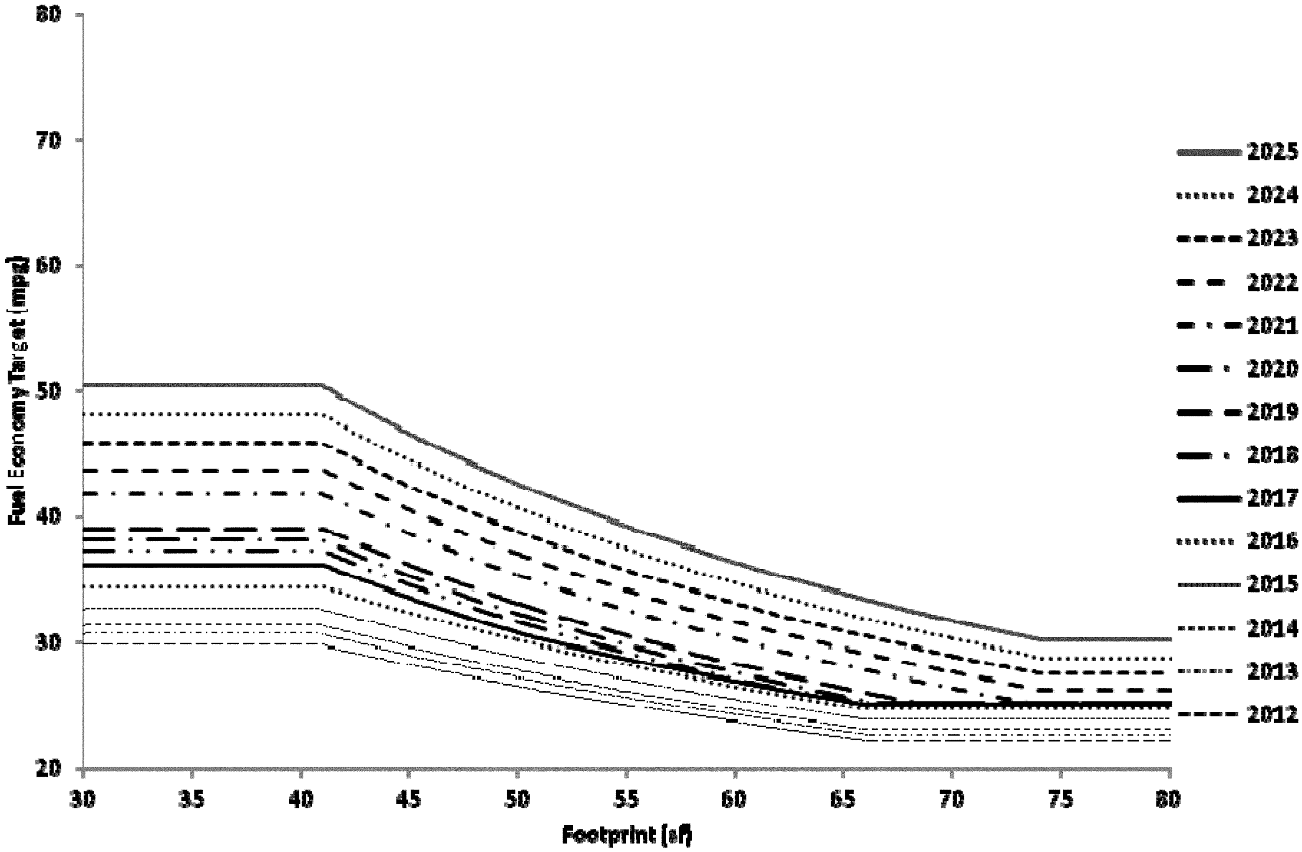


Figure I- 3 CO2 (g/mile) Passenger Car Standards Curves

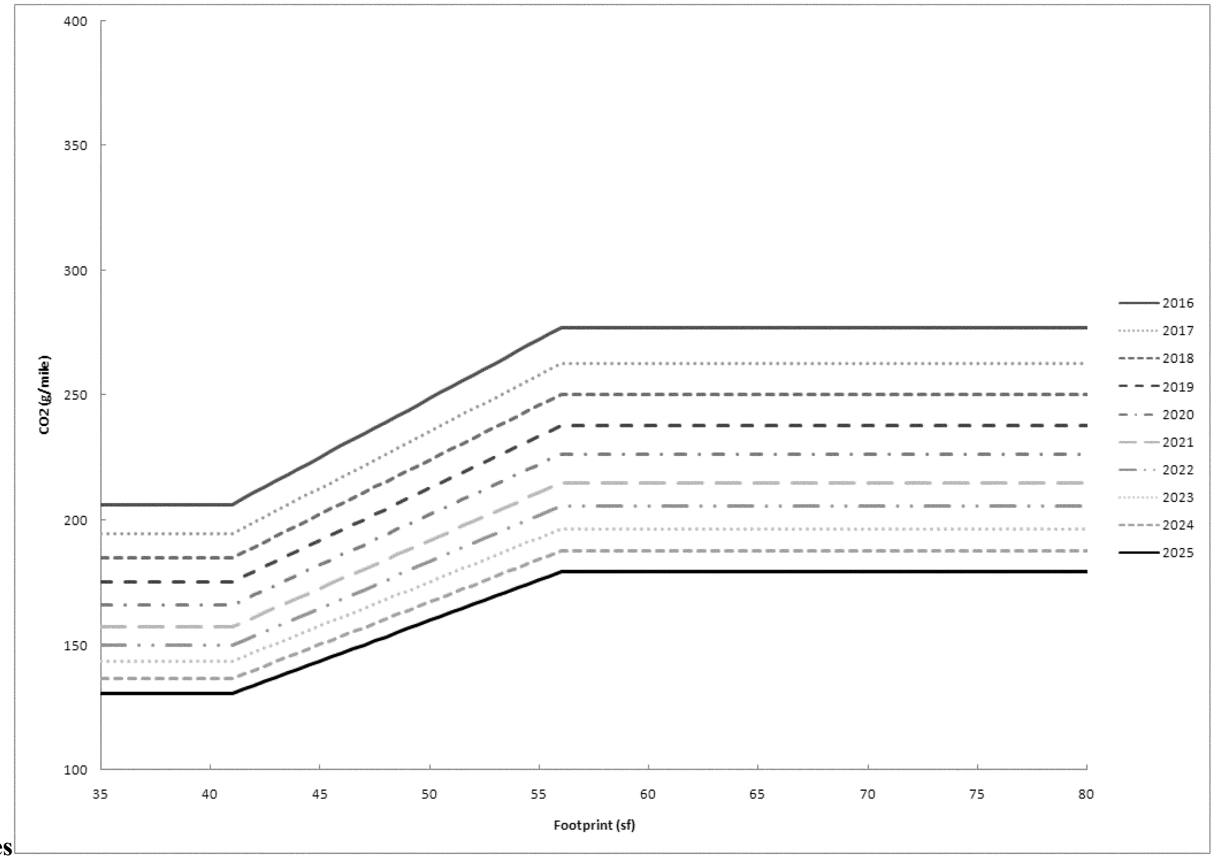
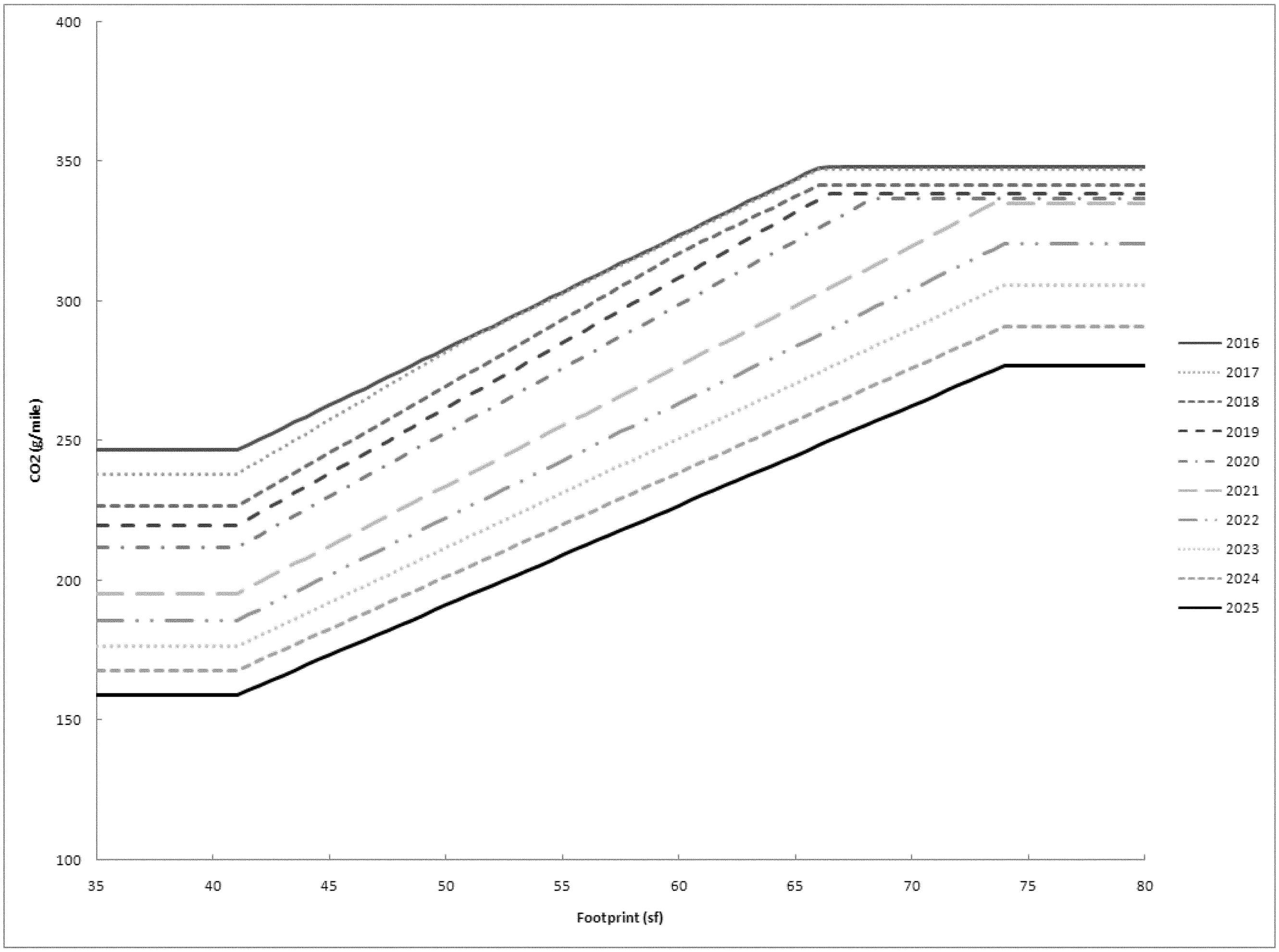


Figure I-4 CO2 (g/mile) Light-Truck Standard Curves



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EPA and NHTSA received a number of comments about the shape of the car and truck curves. Some commenters, including Honda, Toyota and Volkswagen, stated that the light truck curve was too lenient for large trucks, while Nissan and Honda stated the light truck curve was too stringent for small trucks; Porsche and Volkswagen stated the car curve was too stringent generally, and Toyota stated it was too stringent for small cars. A number of NGOs (Center for Biological Diversity, International Council on Clean Transportation, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists) also commented on the truck curves as well as the relationship between the car and truck curves. We address all these comments further in Section II.C as well as in Sections III and IV.

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 a comparable level of fuel efficiency improvement technology. Since the finalized standards apply to a manufacturer's overall passenger car fleet and overall light truck fleet, not to an individual vehicle, if one of a manufacturer's fleets 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 final 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 these standards, which will help to maintain consumer choice during the MY 2017 to MY 2025 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 final standards that different vehicle sizes will have, although we emphasize again that these targets are not actual standards—the standards are manufacturer-specific, rather than vehicle-specific.

TABLE I–6—MODEL YEAR 2025 CO_2 AND FUEL ECONOMY TARGETS FOR VARIOUS MY 2012 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
Full size car	Chrysler 300	53	170	48.0
Example Light-duty Trucks				
Small SUV	4WD Ford Escape	43	170	47.5
Midsize crossover	Nissan Murano	49	188	43.4
Minivan	Toyota Sienna	56	209	39.2
Large pickup truck	Chevy Silverado (extended cab, 6.5 foot bed).	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

As proposed, the agencies are finalizing several provisions which provide compliance flexibility to manufacturers to meet the standards. Many of the provisions are also found in the MYs 2012–2016 rules. For example, the agencies are continuing to allow manufacturers to generate credits for over-compliance with the CO_2 and CAFE standards.[77] As noted above, under the footprint-based standards, a manufacturer's ultimate compliance obligations are determined at the end of each model year, when production of vehicles for that 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 its 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, as proposed, EPA is continuing this limitation in the MY 2017–2025 program. In its comments, Volkswagen requested that credits under the GHG rules be allowed to be carried back for five model years rather than three as proposed. A five year carry back could create a perverse incentive for shortfalls to accumulate past the point where they can be rectified by later model year performance. EPA is therefore adopting the three year carry back period in its rule. NHTSA is required to allow a three year carry-back period by statute.

However, to facilitate the transition to the increasingly more stringent standards, EPA proposed, and is finalizing under its CAA authority a one-time CO_2 carry-forward beyond 5 years, such that any credits generated from MYs 2010 through 2016 will be able to be used to comply with light duty vehicle GHG standards at any time through MY 2021. This provision does not apply to early credits generated in MY 2009. EPA received comments from the Alliance of Automobile Manufacturers and several individual manufacturers supporting the proposed additional credit carry-forward flexibility and also comments from the Center for Biological Diversity opposing the additional credit carry-forward provisions which are addressed in section III.B.4. 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. As part of the EISA amendments to EPCA, NHTSA was required to establish by regulation a CAFE credit 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 standards through transferred credits: 1 mpg for MYs 2011–2013; 1.5 mpg for MYs 2014–2017; and 2 mpg for MYs 2018 and beyond.[78] These statutory limits will continue to apply to the determination of compliance with the CAFE standards. EISA also prohibits the use of transferred credits to meet the minimum domestic passenger car fleet CAFE standard.[79]

Under section 202 (a) of the CAA there is no statutory limitation on car-truck credit transfers, and EPA's GHG program allows unlimited credit transfers across a manufacturer's car-light truck fleet to meet the GHG

[77] This credit flexibility is required by EPCA/EISA, *see* 49 U.S.C. 32903, and is well within EPA's discretion under section 202(a) of the CAA.

[78] 49 U.S.C. 32903(g)(3).

[79] 49 U.S.C. 32903(g)(4).

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 in the MY 2012–2016 rule,[80] as doing so would reduce the flexibility to achieve the standards in the lead time provided, and would increase costs with no corresponding environmental benefit. EPA did not propose and is not finalizing any constraints on credit transfers for MY 2017 and later, consistent with the MY 2012–2016 program. As discussed in Section III.B.4, EPA received one comment from Center for Biological Diversity that it should be consistent with EISA and establish limitations on credit transfers. EPA disagrees with the commenter and continues to believe that limiting transfers and trading would unnecessarily constrain program flexibility as discussed in section III.B.4 below.

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. EISA also prohibits manufacturers from using traded credits to meet the minimum domestic passenger car CAFE standard.[81]

b. Air Conditioning Improvement Credits/Fuel Economy Value Increases

Air conditioning (A/C) systems contribute to GHG emissions in two ways. The primary refrigerant used in automotive air conditioning systems today—a hydrofluorocarbon (HFC) refrigerant and potent GHG called HFC–134a—can leak directly from the A/C system (direct A/C emissions). In addition, operation of the A/C system places an additional load on the engine that increases fuel consumption and thus results in additional CO_2 tailpipe emissions (indirect A/C emissions). In the MY 2012–2016 program, EPA allows manufacturers to generate credits by reducing either or both types of GHG emissions related to A/C systems. For those model years, EPA anticipated that manufacturers would pursue these relatively inexpensive reductions in GHGs due to improvements in A/C systems and accounted for generation and use of both of these credits in setting the levels of the CO_2 standards.

For this rule, as with the MYs 2012–2016 program, EPA is finalizing its proposal to allow manufacturers to generate CO_2-equivalent[82] credits to use in complying with the CO_2 standards by reducing direct and/or indirect A/C emissions. These reductions can be achieved by improving A/C system efficiency (and thus reducing tailpipe CO_2 and improving fuel consumption), by reducing refrigerant leakage, and by using refrigerants with lower global warming potentials (GWPs) than HFC–134a. As proposed, EPA is establishing that the maximum total A/C credits available for cars will be 18.8 grams/mile CO_2-equivalent and for trucks will be 24.4 grams/mile CO_2-equivalent.[83] The approaches to be used to calculate these direct and indirect A/C credits are generally consistent with those of the MYs 2012–2016 program, although there are several revisions, including as proposed the introduction of a new A/C efficiency test procedure that will be applicable starting in MY 2014 for compliance with EPA's GHG standards.

In addition to the grams-per-mile CO_2-equivalent credits, for the first time the agencies are establishing provisions in the CAFE program that would account for improvements in air conditioner efficiency. Improving A/C efficiency leads to real-world fuel economy benefits, because as explained above, A/C operation represents an additional load on the engine. Thus, 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 to calculate CAFE compliance values.[84] Under this authority, EPA is establishing that manufacturers can generate fuel consumption improvement values for purposes of CAFE compliance based on air conditioning system efficiency improvements for cars and trucks. An increase in a vehicle's CAFE grams-per-mile value would be allowed up to a maximum based on 0.000563 gallon/mile for cars and on 0.000810 gallon/mile for trucks. This is equivalent to the A/C efficiency CO_2 credit allowed by EPA under the GHG program. For the CAFE program, EPA would use the same methods to calculate the values for air conditioning efficiency improvements for cars and trucks as are used in EPA's GHG program. Additionally, given that these real-world improvements will be available to manufacturers for compliance, NHTSA has accounted for this by determining the amount that industry is expected to improve air conditioning system efficiency in each model year from 2017–2025, and setting the CAFE standards to reflect these improvements, in a manner consistent with EPA's GHG standards. EPA is not allowing generation of fuel consumption improvement values for CAFE purposes, nor is NHTSA increasing stringency of the CAFE standard, for the use of A/C systems that reduce leakage or employ alternative, lower GWP refrigerant. This is because those changes do not generally affect fuel economy. Most industry commenters supported this proposal, while one NGO noted that the inclusion of air conditioning improvements for purposes of CAFE car compliance was a change from prior interpretations.

c. Off-cycle Credits/Fuel Economy Value Increases

For MYs 2012–2016, EPA provided an option for manufacturers to generate credits for utilizing 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 and active aerodynamics, among other technologies. See generally 75 FR 25438–39. EPA's current program allows off-cycle credits to be generated through MY 2016.

EPA proposed and is finalizing provisions allowing manufacturers to continue to generate and use off-cycle credits for MY 2017 and later to demonstrate compliance with the light-duty vehicle GHG standards. In addition, 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 proposed and is finalizing provisions to allow manufacturers to generate fuel consumption improvement

[80] EPA's GHG program will continue to adjust car and truck credits by vehicle miles traveled (VMT), as in the MY2012–2016 program.

[81] 49 U.S.C. 32903(f)(2).

[82] CO_2 equivalence (CO_2e) expresses the global warming potential of a greenhouse gas (for A/C, hydrofluorocarbons) by normalizing that potency to CO_2's. Thus, the maximum A/C credit for direct emissions is the equivalent of 18.8 grams/mile of CO_2 for cars.

[83] This is further broken down by 5.0 and 7.2 g/mi respectively for car and truck AC efficiency credits, and 13.8 and 17.2 g/mi respectively for car and truck alternative refrigerant credits.

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

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.D and IV.I of this final rule preamble, the ability to generate off-cycle credits and increases in fuel economy for use in compliance will not affect or change the stringency of the GHG or CAFE standards established by each agency.[85]

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. Other commenters, such as suppliers and some NGOs, also provided technical input on various aspects of the off-cycle credit program. Some environmental groups expressed concerns about the uncertainties in calculating off-cycle credits and that the ability for manufacturer's to earn credits from off-cycle technologies should not be a disincentive for implementing other (2-cycle) technologies. For MY 2017 and later, EPA is finalizing several proposed provisions to expand and streamline the MYs 2012–2016 off-cycle credit provisions, including an approach by which the agencies will provide default values, which will eliminate the need for case-by-case-testing, for a subset of off-cycle technologies whose benefits are reliably and conservatively quantified. EPA is finalizing a list of technologies and default credit values for these technologies, as well as capping the maximum amount of these credits which can be utilized unless a manufacturer demonstrates through testing that greater amounts are justified. The agencies believe that our assessment of off-cycle technologies and associated credit values on this list is conservative, and emphasize that automakers may apply for additional off-cycle credits beyond the minimum credit value and cap if they present sufficient supporting data. Manufacturers may also apply to receive credit for off-cycle technologies besides those listed, again, if they have sufficient data. EPA received several comments regarding the list of technologies and associated credit values and has modified the list somewhat in response to these comments, as discussed in Section II.F.2. EPA was also persuaded by the public comments that the default credit values should not be contingent upon a minimum penetration of the technology into a manufacturer's fleet, and so is not adopting this aspect of the proposal. Manufacturers often apply new technologies on a limited basis to gain experience, gauge consumer acceptance, allow refinement of the manufacturing and production processes for quality and cost, and other legitimate reasons. The proposed minimum penetration requirement might have discouraged introduction of off-cycle technologies in these legitimate circumstances.

In addition, as requested by commenters, EPA is providing additional detail on the process and timing for the credit/fuel consumption improvement values application and approval process for those instances where manufacturers seek off-cycle credits rather than using the default values from the list provided, or seek credits for technologies other than those provided through the list. EPA is finalizing a timeline for the approval process, including a 60-day EPA decision process from the time a manufacturer submits a complete application for credits based on 5-cycle testing. As proposed, EPA is also finalizing a detailed, step-by-step process, including a specification of the data that manufacturers must submit. EPA will also consult with NHTSA during the review process. 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 retaining the public comment process from the MYs 2012–2016 rule, and will consult with NHTSA during the review process.

Finally, in response to many OEM and supplier comments encouraging EPA to allow access to the pre-defined credit menu earlier than MY 2017, EPA is allowing use of the credit menu for the GHG program beginning in MY 2014 to facilitate compliance with the GHG standards for MYs 2014–2016. This provision is for the GHG rules only, and does not apply to the 2012–2016 CAFE standards; the off-cycle credit program will not begin until MY 2017 for the CAFE program, as discussed in Section IV.I.4.c. A full description of the program, including an overview of key comments and responses, is provided in Section III.C.5. A number of technical comments were also submitted by a variety of stakeholders, which are addressed in Chapter 5 of the joint TSD.

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

In order to provide temporary regulatory incentives to promote advanced vehicle technologies, EPA is finalizing, as proposed, an incentive multiplier for CO_2 emissions compliance purposes for all electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs) sold in MYs 2017 through 2021. In addition, in response to public comments explaining how infrastructure and technologies for compressed natural gas (CNG) vehicles could serve as a bridge to use of advanced technologies such as hydrogen fuel cells, EPA is finalizing an incentive multiplier for CNG vehicles sold in MYs 2017 through 2021. This multiplier approach means that each EV/PHEV/FCV/CNG vehicle would count as more than one vehicle in the manufacturer's compliance calculation. EPA is finalizing, as proposed, that EVs and FCVs start with a multiplier value of 2.0 in MY 2017 and phase down to a value of 1.5 in MY 2021, and that 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.[86] EPA is finalizing multiplier values for both dedicated and dual fuel CNG vehicles for MYs 2017–2021 that are equivalent to the multipliers for PHEVs. All incentive multipliers in EPA's program expire at the end of MY 2021. See Section III.C.2 for more discussion of these incentive multipliers.

[85] The agencies have developed estimates for the cost and effectiveness of various off-cycle technologies, including active aerodynamics and stop-start. For the final rule analysis, NHTSA assumed that these two technologies are available to manufacturers for compliance with the standards, similar to all of the other fuel economy improving technologies that the analysis assumes are available. The costs and benefits of these technologies are included in the analysis, similar to all other available technologies and therefore, NHTSA has included the assessment of off-cycle credits in the assessment of maximum feasible standards. EPA has included the 2-cycle benefit of stop-start and active aerodynamics in the standards setting analysis because these technologies have 2-cycle, in addition to off-cycle, effectiveness. As with all the technologies considered in TSD Chapter 3 which are modeled as part of potential compliance paths, EPA considers the 2-cycle effectiveness when setting the standard. The only exception where off-cycle effectiveness is reflected in the standard is for improvements to air conditioning leakage and efficiency.

[86] The multipliers are for EV/FCVs: 2017–2019—2.0, 2020—1.75, 2021—1.5; for PHEVs and dedicated and dual fuel CNG vehicles: 2017–2019—1.6, 2020—1.45, 2021—1.3.

NHTSA currently interprets EPCA and EISA as precluding it from offering additional incentives for the alternative fuel operation of EVs, PHEVs, FCVs, and NGVs, except as specified by statute,[87] and thus did not propose and is not including incentive multipliers comparable to the EPA incentive multipliers described above.

For EVs, PHEVs and FCVs, EPA is also finalizing, as proposed, to set a value of 0 g/mile for the tailpipe CO_2 emissions 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 finalizing, as proposed, that 0 g/mi only be allowed up to a per-company cumulative sales cap, tiered as follows: 1) 600,000 EV/PHEV/FCVs for companies that sell 300,000 EV/PHEV/FCVs in MYs 2019–2021; or 2) 200,000 EV/PHEV/FCVs for all other manufacturers. Starting with MY 2022, the compliance value for EVs, FCVs, and the electric portion of PHEVs in excess of individual automaker cumulative production caps must be based on net upstream accounting. These provisions are discussed in detail in Section III.C.2.

As proposed and as discussed above, for EVs and other dedicated alternative fuel vehicles, EPA will calculate fuel economy for the CAFE program (under its EPCA statutory authority, as further described in Section I.E.2.a) using the same methodology as in the MYs 2012–2016 rulemaking.[88] For liquid alternative fuels, this methodology generally counts 15 percent of the volume of fuel used in determining the mpg-equivalent fuel economy. For gaseous alternative fuels (such as natural gas), 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 uses a petroleum equivalency factor to convert to a mpg-equivalent value. The petroleum equivalency factor for electricity includes an adjustment that effectively only counts 15 percent of the actual energy consumed. Counting 15 percent of the fuel volume or energy provides an incentive for alternative fuels in the CAFE program.

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

e. Incentives for Using Advanced, ‘‘Game-Changing’’ Technologies in Full-Size Pickup Trucks

The agencies recognize that the standards presented in this final rule for MYs 2017–2025 will be challenging for large vehicles, including full-size pickup trucks often used in commercial applications. To help address this challenge, the program will, as proposed, adopt incentives for the use of hybrid electric and non-hybrid electric ‘‘game changing’’ technologies in full-size pickup trucks.

EPA is providing the incentive for the GHG program under EPA's CAA authority, and for the CAFE program under EPA's EPCA authority. EPA's GHG and NHTSA's CAFE standards are set at levels that take into account this flexibility as an incentive for the introduction of advanced technology. This provides the opportunity in the program's early model years to begin penetration of advanced technologies into this category of vehicles, and in turn creates more opportunities for achieving the more stringent MYs 2022–2025 truck standards.

EPA is providing a per-vehicle CO_2 credit in the GHG program and an equivalent fuel consumption improvement value in the CAFE program for manufacturers that sell significant numbers of large pickup trucks that are mild or strong hybrid electric vehicles (HEVs). To qualify for these incentives, a truck must meet minimum criteria for bed size, and for towing or payload capability. In order to encourage rapid penetration of these technologies in this vehicle segment, the final rules also establish minimum HEV sales thresholds, in terms of a percentage of a manufacturer's full-size pickup truck fleet, which a manufacturer must satisfy in order to qualify for the incentives.

The program requirements and incentive amounts differ somewhat for mild and strong HEV pickup trucks. As proposed, mild HEVs will be eligible for a per-vehicle CO_2 credit of 10 g/mi (equivalent to 0.0011 gallon/mile for a gasoline-fueled truck) during MYs 2017–2021. To be eligible a manufacturer would have to show that the mild hybrid technology is utilized in a specified portion of its truck fleet beginning with at least 20% of a company's full-size pickup production in MY 2017 and ramping up to at least 80% in MY 2021. The final rule specifies a lower level of technology penetration for MYs 2017 and 2018 than the 30% and 40% penetration rates proposed, based on our consideration of industry comments that too high a penetration requirement could discourage introduction of the technology. The lower required rates will help factor in the early experience gained with this technology and allow for a more efficient ramp up in manufacturing capacity. As proposed, strong HEV pickup trucks will be eligible for a 20 g/mi credit (0.0023 gallon/mile) during MYs 2017–2025 if the technology is used on at least 10% of a company's full-size pickups in that model year. EPA and NHTSA are adopting specific definitions for mild and strong HEV pickup trucks, based on energy flow to the high-voltage battery during testing. These definitions are slightly different from those proposed—reflecting the agencies' consideration of public comments and additional pertinent data. The details of this program are described in Sections II.F.3 and III.C.3, as well as in Chapter 5.3 of the joint TSD.

Because there are other promising technologies besides hybridization that can provide significant reductions in GHG emissions and fuel consumption from full size pickup trucks, EPA is also adopting, as proposed, a performance-based CO_2 emissions credit and equivalent fuel consumption improvement value for full-size pickup trucks. Eligible pickup trucks certified as performing 15 percent better than their applicable CO_2 target will receive a 10 g/mi credit (0.0011 gallon/mile), and those certified as performing 20 percent better than their target will receive a 20 g/mi credit (0.0023 gallon/mile). The 10 g/mi performance-based credit will be available for MYs 2017 to 2021 and, once qualifying; a vehicle model will continue to receive the credit through MY 2021, provided its CO_2 emissions level does not increase. The 20 g/mi performance-based credit will be provided to a vehicle model for a maximum of 5 years within the 2017 to 2025 model year period provided its

[87] 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, 49 U.S.C. 32905(a) expressly requires EPA to calculate the fuel economy of FCVs using a specified incentive, and 49 U.S.C. 32905(c) expressly requires EPA to calculate the fuel economy of natural gas vehicles 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.

[88] *See* 49 U.S.C. 32904 and 32905.

CO_2 emissions level does not increase. Minimum sales penetration thresholds apply for the performance-based credits, similar to those adopted for HEV credits.

To avoid double-counting, no truck will receive credit under both the HEV and the performance-based approaches. Further details on the full-size truck technology credit program are provided in sections II.F.3 and III.C.3, as well as in Chapter 5.3 of the joint TSD.

The agencies received a variety of comments on the proposal for this technology incentive program for full size pickup trucks. Some environmental groups and manufacturers questioned the need for it, arguing that this vehicle segment is not especially challenged by the standards, that hybrid systems would readily transfer to it from other vehicle classes, and that the credit essentially amounts to an economic advantage for manufacturers of these trucks. Other industry commenters requested that it be made available to a broader class of vehicles, or that the minimum penetration thresholds be removed or relaxed. There were also a number of comments on the technical requirements defining eligibility and mild/strong HEV performance. In response to the comments, the agencies made some changes to the proposed program, including adjustments to the penetration thresholds for mild HEVs, clarification that non-gasoline HEVs can qualify, and improvements to the technical criteria for mild and strong hybrids. The comments and changes are discussed in detail in sections II.F.3, and III.C.3, and in Chapter 5 of the TSD.

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 *de novo* rulemaking in order to establish final standards for vehicles for those model years, the agencies will conduct a comprehensive mid-term evaluation and agency decision-making process for the MYs 2022–2025 standards, as described in the proposal.

The agencies received many comments about the importance of the proposed mid-term evaluation due to the long time-frame of the rule and the uncertainty in assumptions due to this long timeframe. Nearly all auto manufacturers and associations predicated their support of the MY 2017–2025 National Program on the agencies conducting this evaluation and decision-making process. In addition, a number of auto manufacturers suggested additional factors that the agencies should consider during the evaluation process and also stressed the importance of completing the evaluation no later than April 1, 2018, the timeframe proposed by the agencies. Several associations also asked for more detail to be codified regarding the timeline, content and procedures of the review process. Several automakers and organizations suggested that the agencies also conduct a series of smaller, focused evaluations or ''check-ins'' on key issues and technological and market trends. Several organizations and associations stressed the importance of involving CARB and broad public participation in the review process.

The agencies also received a number of comments from environmental and consumer organizations expressing concerns about the mid-term evaluation—that it could occur too early, before reliable data on the new standards is available, be disruptive to auto manufacturers' product planning and add uncertainty, and that it should not be used as an opportunity to delay benefits or weaken the overall National Program for MY 2022–2025. Those organizations commented that if the agencies determined that a mid-term evaluation was necessary, it should be used as an opportunity to increase the stringency of the 2022–2025 standards. Some environmental groups opposed the concept of the agencies performing additional interim reviews. Finally, several environmental organizations urged transparency and recommended that the agencies provide periodic updates on technology progress and compliance trends. One commenter, NADA, stated that the rule should not be organized in a way that would require a mid-term evaluation and that the agencies should wait to set standards for MYs 2017–2021 until more information is available. The mid-term evaluation comments are discussed in detail in sections III.B.3 and IV.A.3.b.

The agencies are finalizing the mid-term evaluation and agency decision-making process as proposed. As stated in the proposal, both NHTSA and EPA will develop and compile up-to-date information for the mid-term 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 this final 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. In order to align the agencies' rulemaking for MYs 2022–2025 and to maintain a joint national program, if the EPA determination is that standards will not change, NHTSA will issue its final rule concurrently with the EPA determination. If the EPA determination is that standards may change, the agencies will issue a joint NPRM and joint final rule. The comprehensive evaluation process will lead to final agency action by both agencies, as described in sections III.B.3 and IV.A.3 of this Notice.

NHTSA's final action will be a *de novo* rulemaking conducted, as explained, with fresh inputs and a fresh consideration and balancing of all relevant factors, based on the best and most current information before the agency at that time. EPA will conduct a mid-term evaluation of the later model year light-duty GHG standards (MY2022–2025). The evaluation will determine what standards are appropriate for those model years.

Consistent with the agencies' commitment to maintaining a single national framework for regulation of vehicle GHG emissions and fuel economy, the agencies fully expect to conduct the mid-term evaluation in close coordination with the California Air Resources Board (CARB). In adopting their GHG standards on March 22, 2012, the California Air Resources Board directed the Executive Officer to continue collaborating with EPA and NHTSA as the Federal GHG standards were finalized and also ''to participate in U.S. EPA's mid-term review of the 2022 through 2025 model year passenger vehicle greenhouse gas standards being proposed under the 2017 through 2025 MY National Program''.[89] In addition, in order to align the agencies' proceedings for MYs 2022–2025 and to maintain a joint national program, if the EPA determination is that standards will not change, NHTSA will issue its final rule concurrently with the EPA determination. If the EPA determination is that standards may change, the agencies will issue a joint NPRM and joint final rule.

Further discussion of the mid-term evaluation can be found in Sections III.B.3 and IV.A.3.b of this final rule preamble.

6. Coordinated Compliance

The MYs 2012–2016 final rules established detailed and comprehensive regulatory provisions for compliance and enforcement under the GHG and

[89] *See* California Low-Emission Vehicles (LEV) & GHG 2012 regulations approved by State of California Air Resources Board, Resolution 12–11. *Available at: http://www.arb.ca.gov/regact/2012/cfo2012/res12-11.pdf* (last accessed August 9, 2012).

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 finalizing 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 is also continuing the provisions adopted in the MYs 2012–2016 GHG rule for in-use compliance with the GHG emissions standards.

This 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 instances of noncompliance.

7. Additional Program Elements

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

As proposed, EPA is finalizing provisions which state that CO_2 emissions compliance values for plug-in hybrid electric vehicles (PHEVs) and dual fuel compressed natural gas (CNG) vehicles will be based on estimated use of the alternative fuels, recognizing that if a consumer incurs significant cost for a dual fuel vehicle and can use an alternative fuel that has significantly lower cost than gasoline, it is very likely that the consumer will seek to use the lower cost alternative fuel whenever possible. Accordingly, for CO_2 emissions compliance, EPA is using 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 dual fuel CNG vehicles, along with the CO_2 emissions test values on the alternative fuel and gasoline. Dual fuel CNG vehicles must have a minimum natural gas range-to-gasoline range of 2.0 in order to use this utility factor approach. Any dual fuel CNG vehicles that do not meet this requirement would use a utility factor of 0.50, the value that has been used in the past for dual fuel vehicles under the CAFE program. EPA is also finalizing, as proposed, an option allowing the manufacturer to use this utility factor methodology for CO_2 emissions compliance for dual fuel CNG vehicles for MY 2012 and later model years.

As proposed, EPA is accounting 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 tailpipe emissions reduction attributed to alternative fuels. Unlike PHEV and dual fuel CNG vehicles, there is not a significant cost differential between an FFV and a conventional gasoline vehicle and historically consumers have fueled these vehicles with E85 a very small percentage of the time. But E85 use in FFVs is expected to rise in the future due to Renewable Fuel Standard program requirements. GHG emissions compliance issues for dual fuel vehicles are discussed further in Section III.C.4.a.

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 finalizing its proposal, under its EPCA authority, to use the ''utility factor'' methodology for PHEV and CNG vehicles described above to determine how to apportion the fuel economy when operating on gasoline or diesel fuel and the fuel economy when operating on the alternative fuel. For FFVs under the CAFE program, EPA is using the same methodology it uses for the GHG program to apportion the fuel economy, namely based on actual usage of E85. As proposed, EPA is continuing 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.C.4.b and in Section IV.I.3.a.

b. Exclusion of Emergency and Police Vehicles

Under EPCA, manufacturers are allowed to exclude emergency vehicles from their CAFE fleet [90] and all manufacturers that produce emergency vehicles 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 proposed and is finalizing the same type of exclusion provision for these vehicles for MY 2012 and later because of their unique features. Law enforcement and emergency vehicles are necessarily equipped with features which reduce the ability of manufacturers to sufficiently improve the emissions control without compromising necessary vehicle utility. Manufacturers commented in support of this provision and EPA received only one comment against exempting emergency vehicles. These comments are addressed in Section III.B.8.

c. Small Businesses, Small Volume Manufacturers, and Intermediate Volume Manufacturers

As proposed, EPA is finalizing 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 exempting small businesses—that is, any company that meets the SBA's definition of a small business—from the MY 2017 and later GHG standards. 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, there is no significant impact on emission reductions. As proposed, EPA is also finalizing an opt-in provision that will allow small businesses wishing to waive their exemption and comply with the GHG standards to do so. EPA received no adverse comments on its proposed approach for small businesses.

EPA's final rule also addresses small volume manufacturers, those with U.S. annual sales of less than 5,000 vehicles.

[90] 49 U.S.C. 32902(e).

Under the MYs 2012–2016 program, these small volume manufacturers are eligible for an exemption from the CO_2 standards. As proposed, EPA will 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 to be developed manufacturer-by-manufacturer in a public process. 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.[91] 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.[92] The exemption and alternative standard apply only if the exempted manufacturer also produces fewer than 10,000 passenger cars worldwide in the year for which the exemption was granted. NHTSA is not changing its regulations pertaining to exemptions and alternative standards (49 CFR Part 525) as part of this rulemaking.

Also, EPA requested comment on allowing manufacturers able to demonstrate that they are operationally independent from a parent company (defined as 10% or greater ownership), to also be eligible for small volume manufacturer alternative standards and treatment under the GHG program. Under the current program, the vehicle sales of such companies must be aggregated with the parent company in determining eligibility for small volume manufacturer provisions. The only comments addressing this issue supported including a provision recognizing operational independence in the rules. EPA has continued to evaluate the issue and the final GHG rule includes provisions allowing manufacturers to demonstrate to EPA that they are operationally independent. This is different from the CAFE program, which aggregates manufacturers for compliance purposes if a control relationship exists, either in terms of stock ownership or design control, or both.[93]

EPA sought comment on whether additional lead-time is needed for niche intermediate sized manufacturers. Under the Temporary Lead-time Allowance Alternative Standards (TLAAS) provisions in the MYs 2012–2016 GHG rules (see 75 FR 25414–417), manufacturers with sales of less than 50,000 vehicles were provided additional flexibility through MY 2016. EPA invited comment on whether this or some other form of flexibility is warranted for niche intermediate volume, limited line manufacturers (see section III.B.7).

NRDC commented in support of EPA's proposal not to extend the TLAAS program. EPA received comments from Jaguar Land Rover, Porsche and Suzuki that the standards will raise significant feasibility concerns for some intermediate volume manufacturers that will be part of the expanded TLAAS program in MY 2016, especially in the early transition years of the program. Porsche commented that they would need to meet standards up to 25 percent more stringent in MY 2017 compared to MY 2016, requiring utilization of advanced technologies at rates wholly disproportionate to rates expected for larger manufacturers with more diverse product lines. EPA is persuaded that these manufacturers require additional lead-time to make the transition from the TLAAS regime to the more stringent standards. To provide this needed lead-time, EPA is finalizing provisions for manufacturers with sales below 50,000 vehicles per year that are part of the TLAAS program through MY 2016, which will allow eligible manufacturers to remain at their MY 2016 standards through MY 2018 and then begin making the transition to more stringent standards. The manufacturers that utilize this added lead time will be required to meet the primary program standards in MY 2021 and later. The intermediate volume manufacturer lead-time provisions are discussed in detail in Section III.B.8.

d. Nitrous Oxide and Methane Standards

As proposed, EPA is extending to MY 2017 and later the flexibility for manufacturers to use CO_2 credits on a CO_2-equivalent basis to comply with the nitrous oxides (N_2O) and methane (CH_4) cap standards. These cap standards, established in the MYs 2012–2016 rulemaking were intended to prevent future emissions increases and were generally not expected to result in the application of new technologies or significant costs for manufacturers using current vehicle designs. EPA is also finalizing additional lead time for manufacturers to use compliance statements in lieu of N_2O testing through MY 2016, as proposed. In addition, in response to comments, EPA is allowing the continued use of compliance statements in MYs 2017–2018 in cases where manufacturers are not conducting new emissions testing for a test group, but rather carrying over certification data from a previous year. EPA is also clarifying that manufacturers will not be required to conduct in-use testing for N_2O in cases where a compliance statement has been used for certification. All of these provisions are discussed in detail below in section III.B.9.

D. Summary of Costs and Benefits for the National Program

This section summarizes the projected costs and benefits of the MYs 2017–2025 CAFE and GHG emissions standards for light-duty vehicles. These projections helped inform the agencies' choices among the alternatives considered and provide further confirmation that the final standards are appropriate under the agencies' respective statutory authorities. The costs and benefits projected by NHTSA to result from the CAFE standards are presented first, followed by those projected by EPA to result from the GHG emissions standards.

For several reasons, the estimates for costs and benefits presented by NHTSA and EPA, while consistent, are not directly comparable, and thus should not be expected to be identical. NHTSA and EPA's standards are projected to result in slightly different fuel efficiency improvements. EPA's GHG standard is more stringent in part due to its assumptions about manufacturers' use of air conditioning leakage/refrigerant replacement credits, which will result in reduced emissions of HFCs. NHTSA's final standards are at levels of stringency that assume improvements in the efficiency of air conditioning systems, but these standards do not require reductions in HFC emissions, which are generally not related to fuel economy or energy conservation. In addition, as noted above, the CAFE and GHG standards offer somewhat different program flexibilities and provisions, and the agencies' analyses differ in their accounting for these flexibilities, primarily because NHTSA is statutorily prohibited from considering some flexibilities when establishing CAFE standards,[94] while EPA is not. These differences contribute to differences in the agencies' respective estimates of

[91] 49 U.S.C. 32902(d). Implementing regulations may be found in 49 CFR Part 525.

[92] NHTSA may also apply an alternative average fuel economy standard to all automobiles manufactured by small volume manufacturers, or to classes of automobiles manufactured by small manufacturers, per EPCA, although this particular provision has not yet been exercised. *See* 49 U.S.C. 32902(d)(2).

[93] *See* 49 U.S.C. 32901(a)(4) and 49 CFR Part 534.

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

costs and benefits resulting from the new standards.

Specifically, the projected costs and benefits presented by NHTSA and EPA are not directly comparable because EPA's standards include air conditioning-related improvements in HFC reductions, and reflect compliance with the GHG standards, whereas NHTSA projects some manufacturers will pay civil penalties as part of their compliance strategy, as allowed by EPCA. EPCA also prohibits NHTSA from considering manufacturers' ability to earn, transfer or trade credits earned for over-compliance when setting standards. The Clean Air Act imposes no such limitations. The Clean Air Act also allows EPA to provide incentives for particular technologies, such as for electric vehicles and dual fueled vehicles. For these reasons, EPA's estimates of GHG reductions and fuel savings achieved by the GHG standards are higher than those projected by NHTSA for the CAFE standards. For these same reasons, EPA's estimates of manufacturers' costs for complying with the passenger car and light truck GHG standards are slightly higher than NHTSA's estimates for complying with the CAFE standards.

It also bears discussion here that, for this final rulemaking, the agencies have analyzed the costs and benefits of the standards using two different forecasts of the light vehicle fleet through MY 2025. The agencies have concluded that the significant uncertainty associated with forecasting sales volumes, vehicle technologies, fuel prices, consumer demand, and so forth out to MY 2025, make it reasonable and appropriate to evaluate the impacts of the final CAFE and GHG standards using two baselines.[95] One market forecast (or fleet projection), very similar to the one used for the NPRM, uses (corrected) MY 2008 CAFE certification data, information from AEO 2011, and information purchased from CSM in December of 2009. The agencies received comments regarding the market forecast used in the NPRM suggesting that updates in several respects could be helpful to the agencies' analysis of final standards; given those comments and since the agencies were already considering producing an updated fleet projection, the final rulemakings also utilize a second market forecast using MY 2010 CAFE certification data, information from AEO 2012, and information purchased from LMC Automotive (formerly J.D. Power Forecasting).

These two market forecasts contain certain differences, although as will be discussed below, the differences are not significant enough to change the agencies' decision as to the structure and stringency of the final standards, and indeed corroborate the reasonableness of the EPA final GHG standards and that the NHTSA standards are the maximum feasible. For example, the 2008 based fleet forecast uses the MY 2008 ''baseline'' fleet, which represents the most recent model year for which the industry had sales data that was not affected by the subsequent economic recession. On the other hand, the 2010 based fleet projection employs a market forecast (provided by LMC Automotive) which is more current than the projection provided by CSM (utilized for the MY 2008 based fleet projection). The CSM forecast appears to have been particularly influenced by the recession, showing major declines in market share for some manufacturers (*e.g.,* Chrysler) which the agencies do not believe are reasonably reflective of future trends.

However, the MY 2010 based fleet projection also is highly influenced by the economic recession. The MY 2010 CAFE certification data has become available since the proposal (see section 1.2.1 of the Joint TSD for the proposed rule, which noted the possibility of these data becoming available), and is used in EPA's alternative analysis, and continues to show the effects of the recession. For example, industry-wide sales were skewed down 20% [96] compared to pre-recession MY 2008 levels. For some companies like Chrysler, Mitsubishi, and Subaru, sales were down 30–40% [97] from MY 2008 levels. For BMW, General Motors, Jaguar/Land Rover, Porsche, and Suzuki, sales were down more than 40% [98] from 2008 levels. Using the MY 2008 vehicle data avoids projecting these abnormalities in predicting the future fleet, although it also perpetuates vehicle brands and models (and thus, their outdated fuel economy levels and engineering characteristics) that have since been discontinued. The MY 2010 CAFE certification data accounts for the phase-out of some brands (*e.g.,* Saab) and the introduction of some technologies (*e.g.,* Ford's Ecoboost engine), which may be more reflective of the future fleet in this respect.

Thus, given the volume of information that goes into creating a baseline forecast and given the significant uncertainty in any projection out to MY 2025, the agencies think that the best way to illustrate the possible impacts of that uncertainty for purposes of this rulemaking is the approach taken here of analyzing the effects of the final standards under both the MY 2008-based and the MY 2010-based fleet projections. EPA is presenting its primary analysis of the standards using the same baseline/future fleet projection that was used in the NPRM (i.e., corrected MY 2008 CAFE certification data, information from AEO 2011, and a future fleet forecast purchased from CSM). EPA also conducted an alternative analysis of the standards based on MY 2010 CAFE certification data, updated AEO 2012 (early release) projections of the future fleet sales volumes, and a forecast of the future fleet mix projections to MY 2025 purchased from LMC Automotive. At the same time, given that EPA believes neither projection is strongly superior to the other, EPA has performed a detailed analysis of the final standards using the MY 2010 baseline, and we have concluded that the final standards are likewise appropriate using this alternative baseline/fleet projection. EPA's analysis of the alternative baseline/future fleet (based on MY 2010) is presented in EPA's Final Regulatory Impact Analysis (RIA), Chapter 10. NHTSA's primary analysis uses both market forecasts, and accordingly presents values from both in tables throughout this preamble and in NHTSA's FRIA. Joint TSD Chapter 1 includes a full description of the two market projections and their derivation.

As with the MYs 2012–2016 standards, and the MYs 2014–2018 standards for heavy duty vehicles and engines, NHTSA and EPA have harmonized the programs as much as possible, and continuing the National Program to MYs 2017–2025 will result in significant cost savings and other advantages for the automobile industry by allowing them to manufacture and sell one fleet of vehicles across the U.S., rather than potentially having to comply with multiple state standards that may occur in the absence of the National Program. It is also 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 GHGs. The two agencies' standards together comprise the National Program,

[95] We refer to these baselines as ''fleet projections'' or ''market forecasts'' in Section II.B of the preamble and Chapter 1 of the TSD and elsewhere in the administrative record. The term ''baseline'' has a specific definition and is described in Chapter 1 of the TSD.

[96] These figures are derived from the manufacturer and fleet volume tables in Chapter 1 of the TSD.

[97] These figures are derived from the manufacturer and fleet volume tables in Chapter 1 of the TSD.

[98] These figures are derived from the manufacturer and fleet volume tables in Chapter 1 of the TSD.

and the following discussions of the respective costs and benefits of NHTSA's CAFE standards and EPA's GHG standards do not change the fact that both the CAFE and GHG standards, jointly, are the source of the benefits and costs of the National Program.

1. Summary of Costs and Benefits for the 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 CAFE standards that helps to illustrate their 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 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 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 a range from 180 billion to 184 billion gallons throughout the lives of light duty vehicles sold in MYs 2017–2025. At a 3 percent discount rate, the present value of the economic benefits resulting from those fuel savings is between $513 billion and $525 billion; at a 7 percent private discount rate, the present value of the economic benefits resulting from those fuel savings is between $400 billion and $409 billion.

The agency further estimates that these new CAFE standards will lead to corresponding reductions in CO_2 emissions totaling 1.9 billion metric tons during the lives of light duty vehicles sold in MYs 2017–2025. The present value of the economic benefits from avoiding those emissions is approximately $53 billion, based on a global social cost of carbon value of about $26 per metric ton (in 2017, and growing thereafter).[99] All costs are in 2010 dollars.

Accounting for compliance flexibilities reduces the fuel savings achieved by the standards, as manufacturers are able to comply through credit mechanisms that reduce the amount of fuel economy technology that must be added to new vehicles in order to meet the targets set by the standards. NHTSA estimates that the fuel economy increases would lead to fuel savings totaling about 170 billion gallons throughout the lives of light duty vehicles sold in MYs 2017–2025, when compliance flexibilities are considered. At a 3 percent discount rate, the present value of the economic benefits resulting from those fuel savings is between $481 billion and $488 billion; at a 7 percent private discount rate, the present value of the economic benefits resulting from those fuel savings is between $375 billion and $380 billion. The agency further estimates that these new CAFE standards will lead to corresponding reductions in CO_2 emissions totaling 1.8 billion metric tons during the lives of light duty vehicles sold in MYs 2017–2025. The present value of the economic benefits from avoiding those emissions is approximately $49 billion, based on a global social cost of carbon value of about $26 per metric ton (in 2017, and growing thereafter).

TABLE I–7—NHTSA'S ESTIMATED MYS 2017–2025 COSTS, BENEFITS, AND NET BENEFITS ($BILLION) UNDER THE CAFE STANDARDS (ESTIMATED ACHIEVED)

	Baseline Fleet	Totals		Annualized	
		3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
Cumulative for MYs 2017–2021 Final Standards					
Costs	2010	($61)–	($58)–	($2.4)–	($3.6)–
	2008	($57)	($54)	($2.2)	($3.3)
Benefits	2010	$243–	$195–	$9.2–	$11.3–
	2008	$240	$194	$9.0	$11.0
Net Benefits	2010	$183–	$137–	$6.8–	$7.7–
	2008	$184	$141	$6.8	$7.8

[99] NHTSA also estimated the benefits associated with three more estimates of a one ton GHG reduction in 2017 ($6, $41, and $79), which will likewise grow thereafter. *See* Section II.E for a more detailed discussion of the social cost of carbon.

TABLE I–7—NHTSA'S ESTIMATED MYS 2017–2025 COSTS, BENEFITS, AND NET BENEFITS ($BILLION) UNDER THE CAFE STANDARDS (ESTIMATED ACHIEVED)—Continued

	Baseline Fleet	Totals		Annualized	
		3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
Cumulative for MYs 2017–2025 (Includes MYs 2022–2025 Augural Standards)					
Costs	2010	($154)–	($147)–	($5.4)–	($7.6)–
	2008	($156)	($148)	($5.4)	($7.5)
Benefits	2010	$629–	$502–	$21.0–	$24.2–
	2008	$639	$510	$21.3	$24.4
Net Benefits	2010	$476–	$356–	$15.7–	$16.7–
	2008	$483	$362	$15.9	$16.9

TABLE I–8—NHTSA'S ESTIMATED FUEL SAVED (BILLION GALLONS AND BARRELS) AND CO_2 EMISSIONS AVOIDED (MMT) UNDER THE CAFE STANDARDS (ESTIMATED REQUIRED)

	MY base-line	Earlier	2017	2018	2019	2020	2021	Total through 2021	2022	2023	2024	2025	Total through 2025
Passenger Cars:													
Fuel (b. gallons)	2008	5.3–	2.8–	5.3–	7.7–	10.9–	13.0–	45.0–	14.4–	15.8–	18.0–	19.7–	112.9–
	2010	7.7	3.6	5.3	8.3	10.8	13.0	48.7	14.3	16.2	18.3	20.0	117.4
Fuel (b. barrels)	2008	0.1–	0.1–	0.1–	0.2–	0.3–	0.3–	1.1–	0.3–	0.4–	0.4–	0.5–	2.7–
	2010	0.2	0.1	0.1	0.2	0.3	0.3	1.2	0.3	0.4	0.4	0.5	2.8
CO_2 (mmt)	2008	58.1–	31.0–	58.1–	84.0–	116.9–	139.9–	488.0–	155.5–	171.0–	192.7–	210.9–	1,218.2–
	2010	83.9	39.5	57.2	90.1	117.4	140.9	529.0	155.8	176.3	198.5	216.4	1,275.9
Light Trucks:													
Fuel (b. gallons)	2008	0.5–	1.0–	2.5–	4.8–	6.8–	9.4–	25.0–	10.3–	10.9–	11.8–	12.7–	70.7–
	2010	0.9	0.8	1.5	3.7	5.6	8.2	20.7	8.9	10.0	11.1	12.1	62.9
Fuel (b. barrels)	2008	0.0–	0.0–	0.1–	0.1–	0.2–	0.2–	0.6–	0.2–	0.3–	0.3–	0.3–	1.7–
	2010	0.0	0.0	0.0	0.1	0.1	0.2	0.4	0.2	0.2	0.3	0.3	1.5
CO_2 (mmt)	2008	5.8–	11.1–	26.8–	52.1–	74.0–	102.1–	271.9–	112.1–	118.6–	128.5–	138.0–	769.1–
	2010	10.1	8.6	16.1	39.9	60.1	87.8	222.6	95.8	107.5	119.9	130.8	676.6
Combined													
Fuel (b. gallons)	2008	5.9–	3.9–	7.8–	12.5–	17.7–	22.3–	70.1–	24.7–	26.7–	29.8–	32.4–	183.5–
	2010	8.6	4.4	6.7	12.0	16.4	21.1	69.2	23.2	26.2	29.5	32.1	180.3
Fuel (b. barrels)	2008	0.1–	0.1–	0.2–	0.3–	0.4–	0.5–	1.6–	0.6–	0.6–	0.7–	0.8–	4.4–
	2010	0.2	0.1	0.2	0.3	0.4	0.5	1.7	0.6	0.6	0.7	0.8	4.3
CO_2 (mmt)	2008	63.9–	42.1–	84.9–	136.1–	191.0–	242.0–	760.0–	267.7–	289.6–	321.2–	348.9–	1,987.3–
	2010	93.9	48.1	73.3	130.0	177.5	228.6	751.4	251.6	283.9	318.4	347.2	1,952.5

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 will 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)

	MY base-line	Earlier	2017	2018	2019	2020	2021	Total through 2021	2022	2023	2024	2025	Total through 2025
Passenger Cars:													
Fuel (b. gallons)	2008	5.5–	2.9–	5.1–	7.5–	10.3–	12.0–	43.3–	13.7–	14.9–	16.8–	18.5–	107.3–
	2010	6.1	3.5	5.1	7.8	9.7	12.0	44.2	13.2	15.0	17.1	18.2	107.7
Fuel (b. barrels)	2008	0.1–	0.1–	0.1–	0.2–	0.2–	0.3–	1.0–	0.3–	0.4–	0.4–	0.4–	2.6–
	2010	0.1	0.1	0.1	0.2	0.2	0.3	1.0	0.3	0.4	0.4	0.4	2.6
CO_2 (mmt)	2008	59.9–	32.2–	55.1–	81.5–	111.7–	130.6–	471.0–	148.8–	161.2–	180.8–	196.6–	1,158.3–
	2010	66.5	38.7	55.6	85.3	105.4	130.4	481.9	143.7	162.9	185.4	196.9	1,170.7
Light Trucks:													
Fuel (b. gallons)	2008	0.8–	1.0–	2.2–	4.1–	5.9–	7.9–	21.9–	9.0–	9.6–	10.7–	11.8–	62.8–
	2010	2.0	1.2	1.6	4.2	5.6	7.7	22.3	8.4	9.5	10.4	10.7	61.5
Fuel (b. barrels)	2008	0.0–	0.0–	0.1–	0.1–	0.1–	0.2–	0.5–	0.2–	0.2–	0.3–	0.3–	1.5–
	2010	0.0	0.0	0.0	0.1	0.1	0.2	0.4	0.2	0.2	0.2	0.3	1.5
CO_2 (mmt)	2008	8.1–	10.4–	24.1–	44.5–	63.9–	86.4–	237.4–	97.9–	104.7–	116.2–	128.3–	684.5–
	2010	22.2	13.3	17.8	45.6	60.2	82.4	241.5	90.5	101.8	112.3	115.5	661.5
Combined													
Fuel (b. gallons)	2008	6.3–	3.9–	7.3–	11.6–	16.2–	20.0–	65.3–	22.7–	24.5–	27.4–	30.3–	170.1–
	2010	8.1	4.8	6.7	12.0	15.2	19.7	66.5	21.6	24.5	27.5	28.9	169.2
Fuel (b. barrels)	2008	0.1–	0.1–	0.2–	0.3–	0.4–	0.5–	1.6–	0.5–	0.6–	0.7–	0.7–	4.0–
	2010	0.2	0.1	0.2	0.3	0.4	0.5	1.7	0.5	0.6	0.7	0.7	4.0
CO_2 (mmt)	2008	68.0–	42.6–	79.2–	126.0–	175.5–	216.9–	708.2–	246.6–	265.9–	296.9–	324.9–	1,842.7–
	2010	88.7	51.9	73.5	130.9	165.5	212.8	723.3	234.2	264.7	297.6	312.4	1,832.2

NHTSA estimates that the fuel economy increases resulting from the standards will 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),[100] 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 standards will produce significant net benefits to society. Using a 3 percent discount rate, NHTSA estimates that the present value of these net benefits will range from $498 billion to $507 billion over the lives of the vehicles sold during MYs 2017–2025; using a 7 percent discount rate a narrower range from $372 billion to $377 billion. More discussion regarding monetized benefits can be found in Section IV of this preamble and in NHTSA's FRIA. Note that the benefit calculation in the following tables includes the benefits of reducing CO_2 emissions,[101] but not the benefits of reducing other GHG emissions (those have been addressed in a sensitivity analysis discussed in Section IV of this preamble and in NHTSA's FRIA).

TABLE I–10 NHTSA'S DISCOUNTED BENEFITS ($BILLION) UNDER THE CAFE STANDARDS USING A 3 AND 7 PERCENT DISCOUNT RATE (ESTIMATED REQUIRED)

	MY base-line	Earlier	2017	2018	2019	2020	2021	Total through 2021	2022	2023	2024	2025	Total through 2025
3% discount rate													
Passenger cars	2008	19.2–	10.4–	19.6–	28.6–	40.2–	48.4–	166.4–	54.2–	60.1–	68.6–	75.9–	425.3–
	2010	27.5	13.2	19.3	30.5	40.1	48.5	179.1	54.0	61.6	70.1	77.0	441.9
Light trucks	2008	1.9–	3.7–	8.9–	17.3–	24.8–	34.4–	91.0–	38.1–	40.7–	44.5–	48.3–	262.6–
	2010	3.3	2.8	5.3	13.1	19.9	29.4	73.8	32.4	36.7	41.3	45.6	229.9
Combined	2008	21.1–	14.1–	28.5–	45.9–	65.0–	82.8–	257.4–	92.3–	100.7–	113.1–	124.2–	687.5–
	2010	30.8	16.0	24.5	43.6	60.0	77.9	252.8	86.4	98.3	111.3	122.5	671.4
7% discount rate													
Passenger cars	2008	15.3–	8.3–	15.7–	22.9–	32.2–	38.8–	133.2–	43.4–	48.2–	55.0–	60.8–	340.7–
	2010	22.0	10.6	15.5	24.5	32.1	38.9	143.6	43.3	49.4	56.2	61.7	354.1
Light trucks	2008	1.5–	2.9–	7.0–	13.7–	19.7–	27.3–	72.1–	30.2–	32.3–	35.3–	38.3–	208.2–
	2010	2.6	2.2	4.2	10.4	15.8	23.4	58.6	25.7	29.1	32.8	36.1	182.3
Combined	2008	16.8–	11.2–	22.7–	36.6–	51.9–	66.0–	205.2–	73.6–	80.4–	90.3–	99.1–	548.6–
	2010	24.7	12.8	19.6	34.8	47.9	62.2	202.0	69.0	78.4	88.8	97.8	536.0

Considering manufacturers' ability to employ compliance flexibilities and advanced technologies for meeting the standards, NHTSA estimates the present value of these benefits will 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)

	MY base-line	Earlier	2017	2018	2019	2020	2021	Total through 2021	2022	2023	2024	2025	Total through 2025
3% discount rate													
Passenger cars	2008	19.7–	10.8–	18.7–	27.8–	38.4–	45.2–	160.6–	51.9–	56.8–	64.4–	71.1–	404.8–
	2010	21.8	12.9	18.7	28.9	36.0	44.9	163.2	49.9	57.0	65.4	70.2	405.6
Light trucks	2008	2.7–	3.4–	8.0–	14.8–	21.5–	29.2–	79.6–	33.4–	36.0–	40.3–	44.8–	234.2–
	2010	7.2	4.4	5.9	15.0	19.9	27.6	80.0	30.6	34.7	38.7	40.2	224.1
Combined	2008	22.4–	14.2–	26.6–	42.5–	59.8–	74.4–	239.9–	85.2–	92.7–	104.6–	115.9–	638.5–
	2010	29.0	17.3	24.6	43.8	55.8	72.4	242.9	80.3	91.6	104.0	110.2	629.1
7% discount rate													
Passenger cars	2008	15.8–	8.7–	15.0–	22.3–	30.8–	36.2–	128.8–	41.6–	45.5–	51.6–	57.0–	324.3–
	2010	17.4	10.3	15.0	23.1	28.8	36.0	130.6	40.0	45.7	52.5	56.2	325.0
Light trucks	2008	2.1–	2.7–	6.3–	11.8–	17.1–	23.2–	63.2–	26.5–	28.6–	32.0–	35.5–	185.7–
	2010	5.7	3.5	4.7	11.9	15.8	21.9	63.5	24.3	27.5	30.7	31.8	177.7
Combined	2008	17.9–	11.4–	21.3–	34.0–	47.8–	59.4–	191.8–	68.0–	74.0–	83.5–	92.5–	509.7–
	2010	23.2	13.8	19.6	35.0	44.6	57.8	194.0	64.1	73.1	83.0	88.0	502.2

NHTSA attributes most of these benefits (between $513 billion and $525 billion at a 3 percent discount rate, or between $400 billion and $409 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

[100] 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 its RIA.

[101] CO_2 benefits for purposes of these tables are calculated using the $26/ton SCC value. 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.

forecast from the Annual Energy Outlook (AEO) 2012. NHTSA's RIA accompanying this rulemaking 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)

	MY baseline	Amount	3% discount rate	7% discount rate
2017–2021 standards:				
Fuel savings (billion gallons)	2008 2010	70.1 – 69.2	$196 – $193	$153 – $151
CO_2 emissions reductions (million metric tons)	2008 2010	760 – 751.40	$19.3 – $19	$19.3 – $19
2017–2025 standards:				
Fuel savings (billion gallons)	2008 2010	183.5 – 180.3	$525 – $513	$409 – $400
CO_2 emissions reductions (million metric tons)	2008 2010	1,987 – 1,953	$53 – $52	$53 – $52

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 CAFE standards—that is, outlays by vehicle manufacturers over and above those required to comply with the MY 2016 CAFE standards—will total between about $134 billion and $140 billion.

TABLE I–13—NHTSA'S INCREMENTAL TECHNOLOGY OUTLAYS ($BILLION) UNDER THE CAFE STANDARDS (ESTIMATED REQUIRED)

	MY baseline	Earlier	2017	2018	2019	2020	2021	Total through 2021	2022	2023	2024	2025	Total through 2025
Passenger cars	2008 2010	3.9 – 7.7	2.3 – 3.6	4.3 – 4.8	6.1 – 6.5	9.4 – 8.5	11.7 – 9.9	37.7 – 41.0	13.1 – 11.0	14.6 – 12.4	18.8 – 15.5	20.2 – 16.7	104.4 – 96.6
Light trucks	2008 2010	0.1 – 1.1	0.4 – 0.8	1.1 – 1.1	2.3 – 2.2	3.4 – 3.4	4.8 – 4.9	12.1 – 13.5	5.4 – 5.1	5.6 – 5.7	6.1 – 6.2	6.6 – 6.6	35.9 – 37.1
Combined	2008 2010	4.0 – 8.7	2.8 – 4.4	5.4 – 5.8	8.4 – 8.7	12.8 – 11.9	16.5 – 14.9	49.9 – 54.4	18.5 – 16.1	20.2 – 18.1	24.9 – 21.7	26.8 – 23.3	140.3 – 133.7

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

TABLE I–14—NHTSA'S INCREMENTAL TECHNOLOGY OUTLAYS ($BILLION) UNDER THE CAFE STANDARDS (ESTIMATED ACHIEVED)

	MY baseline	Earlier	2017	2018	2019	2020	2021	Total through 2021	2022	2023	2024	2025	Total through 2025
Passenger cars	2008 2010	3.3 – 4.6	2.0 – 2.8	3.6 – 4.2	5.5 – 6.0	8.5 – 7.6	10.6 – 9.4	33.5 – 34.6	12.2 – 10.3	13.2 – 11.5	15.6 – 13.9	17.5 – 14.4	91.9 – 84.6
Light trucks	2008 2010	0.4 – 1.6	0.5 – 0.9	1.0 – 1.0	1.8 – 2.3	2.6 – 3.2	3.6 – 4.7	9.9 – 13.7	4.2 – 4.9	4.5 – 5.4	5.0 – 5.8	5.8 – 5.7	29.5 – 35.5
Combined	2008 2010	3.7 – 6.2	2.5 – 3.7	4.6 – 5.2	7.3 – 8.3	11.1 – 10.8	14.2 – 14.0	43.4 – 48.2	16.4 – 15.3	17.8 – 16.9	20.6 – 19.7	23.3 – 20.0	121.4 – 120.1

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 will lead to increase in average new vehicle prices ranging from $183 to $287 per vehicle in MY 2017 to between $1,461 and $1,616 per vehicle in MY 2025:

TABLE I–15—NHTSA'S INCREMENTAL INCREASES IN AVERAGE NEW VEHICLE COSTS ($) UNDER THE CAFE STANDARDS (ESTIMATED REQUIRED)

	MY baseline	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger cars	2008	244 –	455 –	631 –	930 –	1,143 –.	1,272 –.	1,394 –.	1,751 –.	1,827 –

TABLE I–15—NHTSA'S INCREMENTAL INCREASES IN AVERAGE NEW VEHICLE COSTS ($) UNDER THE CAFE STANDARDS (ESTIMATED REQUIRED)—Continued

	MY baseline	2017	2018	2019	2020	2021	2022	2023	2024	2025
	2010	364	484	659	858	994	1,091	1,221	1,482	1,578
Light trucks	2008	78 –	192 –	423 –	622 –	854 –	951 –	997 –	1,081 –.	1,183 –
	2010	147	196	397	629	908	948	1,056	1,148	1,226
Combined	2008	183 –	360 –	557 –	823 –	1,043 –.	1,162 –.	1,259 –.	1,528 –.	1,616 –
	2010	287	382	567	779	964	1,042	1,165	1,370	1,461

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

TABLE I–16—NHTSA'S INCREMENTAL INCREASES IN AVERAGE NEW VEHICLE COSTS ($) UNDER THE CAFE STANDARDS (ESTIMATED ACHIEVED)

	MY baseline	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger cars	2008	208–	377–	571–	837–	1,034–	1,168–	1,255–	1,440–	1,577–
	2010	284	424	603	762	934	1,024	1,129	1,328	1,361
Light trucks	2008	87–	179–	331–	470–	648–	752–	808–	888–	1,040–
	2010	158	187	416	596	863	911	1,000	1,081	1,047
Combined	2008	164–	306–	486–	709–	900–	1,025–	1,104–	1,256–	1,400–
	2010	239	340	537	704	909	985	1,085	1,245	1,257

Despite estimated increases in average vehicle prices of between $183 to $287 per vehicle in MY 2017 to between $1,461 and $1,616 per vehicle in MY 2025, NHTSA estimates that discounted fuel savings over the vehicles' lifetimes will be sufficient to offset initial costs. Even discounted at 7%, lifetime fuel savings are estimated to be more than 2.5 times the incremental price increase induced by manufacturers' compliance with the standards. Although NHTSA estimates lifetime fuel cost savings using 3% and 7% discount rates based on OMB guidance, it is possible that consumers use different discount rates when valuing fuel savings, or value savings over a period of time shorter than the vehicle's full useful life. A more nuanced discussion of consumer valuation of fuel savings appears in Section IV.G.6.

Table I-17 NHTSA Estimated Lifetime Fuel Savings ($), Discounted at 3% and 7% for MY 2017–2025 (Estimated Required)

	MY baseline	2017	2018	2019	2020	2021	2022	2023	2024	2025
3% discount rate										
Passenger cars	2008 2010	872–1,090	1,657–1,609	2,390–2,540	3,269–3,311	3,852–3,954	4,216–4,339	4,571–4,880	5,101–5,440	5,496–5,881
Light trucks	2008 2010	537–427	1,340–817	2,665–2,031	3,793–3,142	5,183–4,621	5,707–5,068	6,094–5,747	6,673–6,431	7,180–7,017
Combined	2008 2010	750–855	1,543–1,329	2,488–2,360	3,452–3,252	4,315–4,184	4,729–4,588	5,087–5,173	5,623–5,771	6,048–6,259
7% discount rate										
Passenger cars	2008 2010	685–856	1,301–1,264	1,878–1,994	2,567–2,600	3,025–3,104	3,309–3,405	3,587–3,830	4,003–4,267	4,311–4,612
Light trucks	2008 2010	417–331	1,041–635	2,068–1,576	2,944–2,439	4,020–3,583	4,425–3,929	4,723–4,453	5,171–4,981	5,562–5,434
Combined	2008 2010	587–670	1,207–1,042	1,945–1,847	2,699–2,544	3,371–3,269	3,693–3,584	3,972–4,041	4,391–4,506	4,722–4,885

As is the case with technology costs, accounting for the program's compliance flexibilities reduces savings in lifetime fuel expenditures due to lower levels of achieved fuel economy than are required under the standards.

Table I-18 NHTSA Estimated Lifetime Fuel Savings ($), Discounted at 3% and 7% for MY 2017–2025 (Estimated Achieved)

	MY baseline	2017	2018	2019	2020	2021	2022	2023	2024	2025
3% discount rate										
Passenger cars	2008 2010	904– 1,067	1,574– 1,565	2,325– 2,402	3,123– 2,971	3,600– 3,662	4,045– 4,005	4,324– 4,511	4,783– 5,083	5,186– 5,363
Light trucks	2008 2010	501– 660	1,204– 906	2,277– 2,321	3,275– 3,130	4,388– 4,337	4,983– 4,788	5,385– 5,440	6,033– 6,021	6,678– 6,195
Combined	2008 2010	757– 923	1,441– 1,332	2,308– 2,374	3,176– 3,026	3,874– 3,895	4,367– 4,272	4,683– 4,825	5,198– 5,397	5,676– 5,640
7% discount rate										
Passenger cars	2008 2010	710– 938	1,237– 1,376	1,827– 2,106	2,453– 2,606	2,827– 3,208	3,175– 3,508	3,394– 3,950	3,753– 4,445	4,068– 4,686
Light trucks	2008 2010	389– 513	935– 704	1,767– 1,802	2,542– 2,429	3,404– 3,364	3,865– 3,712	4,175– 4,216	4,676– 4,665	5,174– 4,798
Combined	2008 2010	593– 723	1,128– 1,044	1,805– 1,856	2,484– 2,366	3,028– 3,043	3,412– 3,338	3,658– 3,769	4,060– 4,214	4,431– 4,403

The CAFE standards are projected to produce net benefits in a range from $498 billion to $507 billion at a 3 percent discount rate (a range of $476 billion to $483 billion, with compliance flexibilities), or between $372 billion and $377 billion at a 7 percent discount rate (a range of $356 billion to $362 billion, with compliance flexibilities), over the useful lives of the light duty vehicles sold during MYs 2017–2025.

While the estimated incremental technology outlays and incremental increases in average vehicle costs for the final MYs 2017–2021 standards in today's analysis are similar to the estimates in the proposal, we note for the reader's reference that the incremental cost estimates for the augural standards in MYs 2022–2025 are lower than in the proposal. The lower costs in those later model years result from the updated analysis used in this final rule. In MY 2021, the estimated incremental technology outlays for the combined fleet range from $14.9 billion to $16.5 billion as compared to $17 billion in the proposal, while the estimated incremental increases in average vehicle costs range from $964 to $1,043, as compared to $1,104 in the proposal. In MY 2025, the estimated incremental technology outlays for the combined fleet range from $23.3 billion to $26.8 billion, as compared to $32.4 billion in the proposal, while the estimated incremental increases in average vehicle costs range from $1,461 to $1,616, as compared to $1,988 in the proposal. The changes in the MY 2025 incremental costs reflect the combined result of a number of changes and corrections to the CAFE model and inputs, including (but not limited to) the following items:

- Focused corrections were made to the MY2008-based market forecast;
- A new MY2010-based market forecast was introduced;
- Mild HEV technology and off-cycle technologies are now available in the analysis;
- The amount of mass reduction applied in the analysis [102] has changed;
- The effectiveness of advanced transmissions when applied to conventional naturally aspirated engines has been revised based on a study completed by Argonne National Laboratory for NHTSA;
- Estimates of future fuel prices were updated;
- The model was corrected to ensure that post-purchase fuel prices are

[102] The agencies limited the maximum amount of mass reduction technology that was applied to lighter vehicles in order that the analysis would show a way manufacturers could comply with the standards while maintaining overall societal safety. to demonstrate a path that industry could use to meet standards while maintaining societal safety

applied when calculating the effective cost of available options to add technologies to specific vehicle models; and

• The model was corrected to ensure that the incremental costs and fuel savings are fully accounted for when applying diesel engines.

These changes to the model and inputs are discussed in detail in Sections II.G, IV.C.2, and IV.C.4 of the preamble; Chapter V of NHTSA's FRIA, and Chapters 3 and 4 of the joint TSD.

Acting together, these changes and corrections caused technology costs attributable to the baseline MYs 2009–2016 CAFE standards to increase for both fleets in most model years. In addition, the changes and corrections had the combined effect of reducing the total technology costs (*i.e.,* including technology attributable to the baseline standards) in MYs 2022–2025, when greater levels of fuel economy-improving technologies would be required to comply with the augural standards. Because today's analysis applies these changes simultaneously, and because they likely interact in ways that would complicate attribution of impact, the agency has not attempted to quantify the extent to which each change impacted results. The combined effect of the increase in the baseline technology costs and reduction in the total technology costs in MYs 2022–2025 led to a reduction in the estimated incremental technology cost in MYs 2022–2025 in NHTSA's analysis, although estimated incremental technology costs were higher than or very similar to those reported in the NPRM for model years prior to MY 2022.

While the incremental costs for MYs 2022–2025 are lower than in the NPRM, the total estimated costs for compliance (inclusive of baseline costs) were reduced to a lesser extent. In assessing the appropriate level for maximum feasible standards, NHTSA takes into consideration a number of factors, including technological feasibility, economic practicability (which includes the consideration of cost as well as many other factors), the effect of other motor vehicle standards of the Government on fuel economy, the need of the United States to conserve energy, and safety, as well as other factors. Considering all of these factors, NHTSA continues to believe that the final standards are maximum feasible, as discussed below in Section IV.F.

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

EPA has analyzed in detail the projected costs and benefits of the 2017–2025 GHG standards for light-duty vehicles. Table I–19 shows EPA's estimated lifetime discounted cost, fuel savings, and benefits for all such 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 particulate matter-related health benefits (including premature mortality), the value of additional driving attributed to the VMT rebound effect, the value of reduced refueling time needed to fill up a more fuel efficient vehicle. The analysis also includes estimates of economic impacts stemming from additional vehicle use, such as the economic damages caused by accidents, congestion and noise (from increased VMT rebound driving).

TABLE I–19—EPA'S ESTIMATED 2017–2025 MODEL YEAR LIFETIME DISCOUNTED COSTS, BENEFITS, AND NET BENEFITS ASSUMING THE 3% DISCOUNT RATE SCC VALUE [a b c]

[Billions of 2010 dollars]

Lifetime Present Value [d]—3% Discount Rate	
Program Costs	−$150
Fuel Savings	475
Benefits	126
Net Benefits[d]	451
Annualized Value [f]—3% Discount Rate	
Annualized costs	−6.49
Annualized fuel savings	20.5
Annualized benefits	5.46
Net benefits	19.5
Lifetime Present Value [d]—7% Discount Rate	
Program Costs	−144
Fuel Savings	364
Benefits	106
Net Benefits [e]	326
Annualized Value [f]—7% Discount Rate	
Annualized costs	−10.8
Annualized fuel savings	27.3
Annualized benefits	7.96
Net benefits	24.4

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 2010 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] Projected results using 2008 based fleet projection analysis.

[d] 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 2010 dollar terms). The lifetime present values shown here are the present values of each MY in its first year summed across MYs.

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

[f] 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%.

Table I–20 shows EPA's estimated lifetime fuel savings and CO_2 equivalent emission reductions for all light-duty vehicles sold in the model years 2017–2025. The values in Table I–20 are projected lifetime totals for each model year and are not discounted. As documented in EPA's 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.

TABLE I–20—EPA'S ESTIMATED 2017–2025 MODEL YEAR LIFETIME FUEL SAVED AND GHG EMISSIONS AVOIDED (PRIMARY ANALYSIS) [a]

		2017 MY	2018 MY	2019 MY	2020 MY	2021 MY	2022 MY	2023 MY	2024 MY	2025 MY	Total
Cars:											
Fuel (billion gallons)	2.4	4.5	6.8	9.3	11.9	14.8	17.4	20.2	23.0	110.3	
Fuel (billion barrels)	0.06	0.11	0.16	0.22	0.28	0.35	0.41	0.48	0.55	2.63	
CO_2 EQ (mmt)	29.7	55.7	83.0	113	146	178	207	238	269	1,319	
Light Trucks:											
Fuel (billion gallons)	0.1	1.0	1.7	2.6	5.5	7.5	9.4	11.3	13.1	52.2	
Fuel (billion barrels)	0.00	0.02	0.04	0.06	0.13	0.18	0.22	0.27	0.31	1.24	
CO_2 EQ (mmt)	0.8	13.9	24.6	36	70	92	113	134	154	638	
Combined:											
Fuel (billion gallons)	2.5	5.5	8.5	11.9	17.4	22.3	26.8	31.5	36.2	162.5	
Fuel (billion barrels)	0.06	0.13	0.20	0.28	0.41	0.53	0.64	0.75	0.86	3.87	
CO_2 EQ (mmt)	30.5	69.6	108	149	216	270	320	371	423	1,956	

[a] Projected results using 2008 based fleet projection analysis.

Table I–21 shows EPA's estimated lifetime discounted benefits for all light-duty vehicles sold in model years 2017–2025. Although EPA estimated the benefits associated with four different values of a one ton CO_2 reduction ($6, $26, $41, $79 in CY 2017 and in 2010 dollars, see Section III.H), for the purposes of this overview presentation of estimated benefits EPA is showing the benefits associated with one of these marginal values, $26 per ton of CO_2, in 2010 dollars and 2017 emissions. The values in Table I–21 are discounted values for each model year of vehicles throughout their projected lifetimes. The estimated benefits include GHG reductions, particulate matter-related health impacts (including premature mortality), energy security, reduced refueling time and additional driving as well as the impacts of accidents, congestion and noise from VMT rebound driving. The values in Table I–21 do not include costs associated with new technology projected to be needed to meet the GHG standards and they do not include the fuel savings expected from that technology.

TABLE I–21—EPA'S ESTIMATED 2017–2025 MODEL YEAR LIFETIME DISCOUNTED BENEFITS ASSUMING THE $26/TON SCC VALUE [a b c d]

[Billions of 2010 dollars]

Discount rate	Model year									
	2017	2018	2019	2020	2021	2022	2023	2024	2025	Sum of Present Values
3%	$1.81	$4.05	$6.37	$9.0	$13.4	$17.3	$20.9	$24.7	$28.6	$126
7%	$1.52	$3.41	$5.35	$7.6	$11.3	$14.6	$17.6	$20.8	$24.1	$106

[a] 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. The estimates in this table are based on the average SCC at a 3 percent discount rate. Refer to Section III.H.6 for more detail.

[b] As noted in Section III.H.6, the $26/ton (2010$) value applies to 2017 emissions and grows larger over time. The estimates in this table include monetized benefits for CO_2 impacts but exclude the monetized benefits of impacts on non-CO_2 GHG emissions (HFC, CH_4, N_2O). EPA has instead conducted a sensitivity analysis of the final rule's monetized non-CO_2 GHG impacts in section III.H.6.

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

[d] Projected results using 2008 based fleet projection analysis.

Table I–22 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 light-duty 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–22 are totals for the nine model years throughout these vehicles' projected lifetime and are not discounted. The monetized values shown in Table I–22 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–22 reflect both a 3 percent and a 7 percent discount rate as noted.

TABLE I–22—EPA'S ESTIMATED 2017–2025 MODEL YEAR LIFETIME FUEL SAVINGS, CO_2 EMISSION REDUCTIONS, AND DISCOUNTED MONETIZED SCC BENEFITS USING THE $26/TON SCC VALUE [a,b,c]

[Monetized values in 2010 dollars]

	Amount	$ value (billions)
Fuel savings (3% discount rate)	163 billion gallons (3.9 billion barrels)	$475
Fuel savings (7% discount rate)	163 billion gallons (3.9 billion barrels)	$364
CO_2e emission reductions (CO_2 portion valued assuming $22/ton CO_2 in 2010)	1,956 MMT CO_2e	[a, b] $46.6

[a] $46.6 billion for 1,747 MMT of reduced CO_2 emissions. As noted in Section III.H.6, the $26/ton (2010$) value applies to 2017 emissions and grows larger over time. The estimates in this table include monetized benefits for CO_2 impacts but exclude the monetized benefits of impacts on non-CO_2 GHG emissions (HFC, CH_4, N_2O). EPA has instead conducted a sensitivity analysis of the final rule's monetized non-CO_2 GHG impacts in section III.H.6.

[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. The estimates in this table are based on one of four SCC estimates (average SCC at a 3 percent discount rate). Refer to Section III.H.6 for more detail.

[c] Projected results using 2008 based fleet projection analysis.

Table I–23 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. Also, the technology outlays shown in Table I–21 do not include the estimated maintenance costs which are included in the program costs presented in Table I–19. Table I–24 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 $206 relative to a 2017 model year car meeting the MY 2016 standards. The estimated increase for a 2018 model year car is $374 relative to a 2018 model year car meeting the MY 2016 standards (not $206 plus $374).

TABLE I–23—EPA'S ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS ASSOCIATED WITH THE STANDARDS [a b]

[Billions of 2010 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	$2.03	$3.65	$5.02	$6.43	$7.94	$11.4	$14.7	$18.0	$19.6	$88.8
Trucks	0.33	1.10	1.67	2.29	4.28	6.67	8.75	10.70	11.6	47.4
Combined	2.40	4.78	6.72	8.73	12.2	18.1	23.4	28.7	31.2	136
7% discount rate:										
Cars	1.99	3.58	4.93	6.32	7.80	11.2	14.4	17.7	19.3	87.2
Trucks	0.32	1.08	1.64	2.25	4.20	6.54	8.59	10.51	11.4	46.5
Combined	2.36	4.69	6.59	8.57	12.0	17.7	23.0	28.1	30.6	134

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

[b] Projected results from using 2008 based fleet projection analysis.

TABLE I–24—EPA'S ESTIMATED INCREMENTAL INCREASE IN AVERAGE NEW VEHICLE COST RELATIVE TO THE REFERENCE CASE [a b]

[2010 dollars per unit]

	2017 MY	2018 MY	2019 MY	2020 MY	2021 MY	2022 MY	2023 MY	2024 MY	2025 MY
Cars	$206	$374	$510	$634	$767	$1,079	$1,357	$1,622	$1,726
Trucks	57	196	304	415	763	1,186	1,562	1,914	2,059
Combined	154	311	438	557	766	1,115	1,425	1,718	1,836

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

[b] Projected results from using 2008 based fleet projection analysis.

3. Why are the EPA and NHTSA MY 2025 Estimated Per-Vehicle Costs Different?

In Section I.C.1 and I.C.2 NHTSA and EPA present the agencies' estimates of the incremental costs and benefits of the final CAFE and GHG standards, relative to costs and benefits estimated to occur absent the new standards. Taken as a whole, these represent the incremental costs and benefits of the National Program for Model Years 2017–2025. On a year-by-year comparison for model years 2017–2025, the two agencies' per-vehicle cost estimates are similar for the beginning years of the program, but in the last few model years, EPA's cost estimates are significantly higher than the NHTSA cost estimates. When comparing the CAFE required new vehicle cost estimate in Table I–15 with the GHG standard new vehicle cost estimate in Table I–24, we see that the model year 2025 CAFE incremental new vehicle cost estimate is $1,461–$1,616 per vehicle (when, as required by EISA/EPCA, NHTSA sets aside EVs, pre-MY2019 PHEVs, and credit-based CAFE flexibilities), and the GHG standard incremental cost estimate is $1,836 per vehicle—a difference of $220–$375. The agencies have examined these cost estimate differentials, and as discussed below, it is principally explained by how the two agencies modeled future compliance with their respective standards, and by the application of low-GWP refrigerants attributable only to EPA's standards. As also described below, in reality auto companies will build a single fleet of vehicles to comply with both the CAFE and GHG standards, and the only significant real-world difference in the program costs are is limited to the hydrofluorocarbon (HFC) reductions expected under the GHG standards, which EPA estimates at $68/vehicle cost.

As documented below in Section IV, although NHTSA is precluded by EISA/EPCA from considering CAFE credits, EVs, and pre-MY2019 PHEVs when determining the maximum feasible stringency of new CAFE standards, NHTSA has conducted additional analysis that accounts for EISA/EPCA's provisions regarding CAFE credits, EVs, and PHEVs. Under that analysis, as shown in Table I–16, NHTSA's estimate of the incremental new vehicle costs attributable to the new CAFE standards ranges from $1,257 to $1,400. Insofar as EPA's analysis focuses on the agencies' MY 2008-based market forecast and attempts to account for some CAA-based flexibilities (most notably, unlimited credit transfers between the PC and LT fleets), NHTSA's $1,400 result is based on methods conceptually more similar to those applied by EPA. Therefore, although the difference in MY 2025 is considerably greater than differences in earlier model years, the agencies have focused on understanding the $436 difference between NHTSA's $1,400 result and EPA's $1,836 result, both for the MY 2008-based market forecast.

Of this $436 difference, $247 is explained by NHTSA's simulation of EISA/EPCA's credit carry-forward provisions. EISA/EPCA allows manufacturers to "carry forward" credits up to five model years, applying those credits to offset compliance shortfalls and thereby avoid civil penalties.[103] In meetings with the agency, some manufacturers have indicated that, even under the preexisting MY 2012–2016 standards, they would make full use of these provisions, effectively entering MY 2017 with little, if any, credit "in reserve."[104] As in the NPRM, NHTSA's analysis exercises its CAFE model in a manner that simulates manufacturers' carrying-forward and use of CAFE credits. This simulation of credit carry-forward acts in combination with the model's explicit simulation of multiyear planning—that is, the tendency of manufacturers to apply "extra" technology in earlier model years if doing so would economically facilitate compliance in later model years, considering estimated product cadence (*i.e.,* estimated timing of vehicle redesigns) facilitate. When the potential to carry forward CAFE credits is also simulated, multiyear planning simulation estimates the extent to which manufacturers could generate CAFE credits in earlier model years and use those credits in later model years. In meetings with the agency, manufacturers have often provided forward-looking plans exhibiting this type of strategic timing of investment in technology. For the NPRM, NHTSA estimated that in MY 2025, accounting for credit carry-forward (and other flexibilities offered under EISA/EPCA), manufacturers could, on average, achieve 47.0 mpg, 2.6 mpg less than the agency's 49.6 mpg estimate of the average of manufacturers' fuel economy requirements in that model year. Using the corrected MY 2008-based market forecast, NHTSA today estimates that in MY 2025, manufacturers could achieve 47.4 mpg, 2.3 mpg less than the agency's current 49.7 mpg estimate (also under the corrected MY 2008-based market forecast) of the average of the manufacturers' fuel economy requirements in MY 2025. This 47.4 mpg estimate corresponds to the incremental cost estimate of $1,400 cited above. When credit carry-forward is excluded from this analysis, NHTSA's estimate of manufacturers' average achieved fuel economy in MY 2025 increases to 49.0 mpg, and NHTSA's estimate of the average incremental cost in MY 2025 increases to $1,647, an increase of $247. Although EPA's GHG standards allow manufacturers to bank (*i.e.,* carry forward) GHG-based credits up to five years, EPA's OMEGA model was designed to estimate the costs of a specific standard in a specific year and EPA for this action did not estimate the potential credit bank companies could have on a year-by-year basis. As explained, this difference in simulation capabilities explains $247 of the $436 difference mentioned above.

As it has in past rulemakings and in the NPRM preceding today's final rule, NHTSA has also applied its CAFE model in a manner that simulates the potential that, as allowed under EISA/EPCA and as suggested by their past CAFE levels, some manufacturers could elect to pay civil penalties rather than achieving compliance with future CAFE standards.[105] EISA/EPCA allows NHTSA to take this flexibility into account when determining the maximum feasible stringency of future CAFE standards. As in the NPRM, simulating this flexibility leads NHTSA to estimate that, under EISA/EPCA, some manufacturers (*e.g.,* BMW, Mercedes, Porsche, and Volkswagen) could achieve fuel economy levels 6 to 9 mpg or more short of their respective required CAFE levels in MY 2025. Having set aside the potential to carry forward CAFE credits, when NHTSA also sets aside the potential to pay civil penalties, NHTSA estimates that manufacturers could achieve a fuel economy average of 49.7 mpg in MY 2025, reflecting, on average, manufacturers' achievement of their respective required CAFE levels. For MY 2025, this analysis shows this 0.7 mpg increase in average achieved fuel economy accompanied by a $119 increase in average incremental cost, increasing the average incremental cost to $1,766. Because the Clean Air Act, unlike EISA/EPCA, does not allow manufacturers to pay civil penalties rather than achieving compliance with GHG standards, EPA's OMEGA model

[103] 49 U.S.C. 32903.

[104] On the other hand, although EISA/EPCA also allows manufacturers to carry back CAFE credits, most manufacturers have indicated extreme reluctance to make use of these provisions, insofar as doing so would constitute "borrowing against the future" and incurring risk of paying civil penalties in the future.

[105] 49 U.S.C. 32912.

does not simulate this type of flexibility.[106] Therefore, this further difference in simulation capabilities explains $119 of the $436 difference mentioned above, and results in an estimated average incremental cost of $1,766 in MY 2025.

In addition to these differences in modeling of programmatic features, EPA projects that manufacturers will achieve significant GHG emissions reductions through the use of different air conditioning refrigerants (the HFC refrigerant in today's vehicles is a powerful greenhouse gas, with a global warming potential 1,430 times that of CO2).[107] EPA estimates that in 2025, the incremental cost of the substitute is $68/vehicle. While all other technologies in the agencies' analyses are equally relevant to compliance with both CAFE and GHG standards, CAFE standards do not address HFC emissions, and NHTSA's analysis therefore does not include the costs of this HFC substitution. This factor results in the EPA 2025 cost estimate being $68/vehicle higher than the NHTSA MY 2025 per-vehicle cost estimate.

Taken together, as shown in Table I–25, these three factors suggest a difference of $434, based on $247 and $119 for NHTSA's simulation of EISA/EPCA's credit carry-forward and civil penalty provisions, respectively, and $68 for EPA's estimate of HFC costs. While $2 lower than the $436 difference mentioned above, the agencies consider this remaining difference to be small (about 0.1% of average incremental cost) and well within the range of differences to be anticipated given other structural differences between the agencies analyses and modeling systems.

TABLE I—25—MAJOR FACTORS CONTRIBUTING TO DIFFERENCE IN EPA AND NHTSA ACHIEVED MY2025 PER-VEHICLE COST ESTIMATES (2010 DOLLARS)

Factor contributing to epa and nhtsa my2025 per-vehicle cost estimate difference	Average per-vehicle cost impact in MY 2025
Air conditioning refrigerant substitution	$68
CAFE program provisions for civil penalties	119
CAFE program credit carry-forward value	247
Total impact on the difference between EPAs 2025 estimate and NHTSA's 2025 achieved estimate (sum of individual factors)	434

The agencies' estimates are based on each agency's different modeling tools for forecasting costs and benefits between now and MY 2025. As described in detail in the Joint Technical Support Document, the agencies harmonized inputs for our modeling tools. However, our modeling tools (the NHTSA-developed CAFE model and the EPA-developed OMEGA model), while similar in core function, were developed to estimate the program costs based on each agencies' respective statutory authorities, which in some cases include specific constraints. It is important to note that these are modeling tool differences, but that, while the models result in different estimates of the costs of compliance, manufacturers will ultimately produce a single fleet of vehicles to be sold in the United States that considers both EPA greenhouse gas emissions standards and NHTSA CAFE standards. Manufacturers are currently selling MY2012 and MY2013 vehicles based on considering these standards. Every technology an automotive company applies to its vehicles that improves fuel economy will also lower CO_2 emissions—thus each dollar of technology investment will count towards the company's overall compliance with the CAFE standard as well as the CO_2 standard. The agencies' final footprint curve standards for passenger cars and for light trucks have been closely coordinated, with the principle difference being EPA's estimate of the application of HFC air conditioning refrigerant technology across a company's fleet of vehicles. Thus, within the entire fleet of vehicle models ultimately produced for sale in the United States, the agencies expect the only technology attributable solely to EPA's standards will be the low-GWP refrigerants, which EPA estimates at an average incremental unit cost of $68 in 2025.

E. Background and Comparison of NHTSA and EPA Statutory Authority

Section I.E of the preamble contains a detailed overview discussion of the NHTSA and EPA respective statutory authorities. In addition, each agency discusses comments pertaining to its statutory authority and the agencies' responses in Sections III and IV, respectively and EPA responds as well in its response to comment documents.

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

[106] See 75 FR 25341.

[107] As with the MY 2012–2016 Light Duty rule and the MY 2014–2018 Medium and Heavy Duty rule, the GWPs used in this rule are consistent with 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 1995 IPCC Second Assessment Report are used in the official U.S. GHG inventory submission to the United Nations Framework Convention on Climate Change (UNFCCC) per the reporting requirements under that international convention. The UNFCCC recently agreed on revisions to the national GHG inventory reporting requirements, and will begin using the 100-year GWP values from AR4 for inventory submissions in the future.

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.[108] 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 sought comment in the NPRM on whether or how EPCA, as amended by EISA, could be interpreted to allow such alternate standards for certain parts of the industry. Suzuki requested that NHTSA and EPA both adopt an approach similar to California's of providing more lead time to manufacturers with national average sales below 50,000 units, by allowing those ''limited line manufacturers'' to meet the MY 2017 standards in MY 2020, the MY 2018 standards in MY 2021, and so on, with a 3-year time lag in complying with the standards generally applicable for a compliance category. Suzuki stated simply that the standards are harder for small manufacturers to meet than for larger manufacturers, because the per-vehicle cost of developing or purchasing the necessary technology is higher, and that since the GHG emissions attributable to vehicles built by manufacturers who would be eligible for this option represent a very small portion of overall emissions, the impact should be minimal.[109]

Although EPA is adopting such an approach as part of its final rule (*see* Section I.C.7.c above and III.X), no commenter provided legal analysis that might lead NHTSA to change its current interpretation of EPCA/EISA. Thus, NHTSA is not finalizing such an option for purposes of this rulemaking.

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 decision 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.'' [110] 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.[111] 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.'' [112] Instead, NHTSA is compelled ''to weigh the benefits to the nation of a higher fuel economy standard against the difficulties of individual automobile manufacturers.'' [113] 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.

[108] *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.'').

[109] Suzuki comments, at 2–3. *Available at http://www.regulations.gov*, Docket No. ID No. EPA–HQ–OAR–2010–0799.

[110] 67 FR 77015, 77021 (Dec. 16, 2002).

[111] *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).

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

[113] *Id.*

(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 [114] 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,* 549 U.S. 497 (2007), 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.

In the NPRM, NHTSA sought comment 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. NHTSA explained that the agency had already considered EPA's proposal and the harmonization benefits of the National Program in developing its own proposal. The only comment received was from the Sierra Club, noting that the structure of the National Program accounts for both NHTSA's and EPA's authority and requires no separate action.[115] NHTSA agrees that no further action is required as part of this rulemaking.

(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.'' [116] 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 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 [117] 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,[118] 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.'' [119] In 1988, NHTSA included climate change concepts in its CAFE notices and prepared its first environmental assessment addressing that subject.[120] It cited concerns about climate change as

[114] 42 FR 63184, 63188 (Dec. 15,1977). *See also* 42 FR 33534, 33537 (Jun. 30, 1977).

[115] Sierra Club *et al.* comments, at 10. *Available at http://www.regulations.gov,* Docket No. ID No. EPA–HQ–OAR–2010–0799.

[116] 42 FR 63184, 63188 (1977).

[117] 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.

[118] *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).

[119] 42 FR 63184, 63188 (Dec. 15, 1977) (emphasis added).

[120] 53 FR 33080, 33096 (Aug. 29, 1988).

one of its reasons for limiting the extent of its reduction of the CAFE standard for MY 1989 passenger cars.[121] 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.[122] Under the universal or ''flat'' CAFE standards that NHTSA was previously authorized to establish, the primary risk to safety came from the possibility that manufacturers would respond to higher standards by building smaller, less safe vehicles in order to ''balance out'' the larger, safer vehicles that the public generally preferred to buy. Under the attribute-based standards being presented in this final rule, 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.[123]

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.[124] 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.'' [125] 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,'' [126] and as long as that balancing reasonably accommodates ''conflicting policies that were committed to the agency's care by the statute.'' [127] 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.[128] 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.[129] Standards after 2020 must simply be set at the maximum feasible level.[130]

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.[131] 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 revising the procedures for measuring fuel economy and calculating average fuel economy for the CAFE program, however, to account for certain impacts on fuel economy not currently included

[121] 53 FR 39275, 39302 (Oct. 6, 1988).

[122] As the United States Court of Appeals pointed out in upholding NHTSA's exercise of judgment in setting the 1987–1989 passenger car standards, ''NHTSA has always examined the safety consequences of the CAFE standards in its overall consideration of relevant factors since its earliest rulemaking under the CAFE program.'' *Competitive Enterprise Institute* v. *NHTSA (CEI I),* 901 F.2d 107, 120 at n.11 (D.C. Cir. 1990).

[123] 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.

[124] 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.

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

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

[127] *Id.*

[128] 49 U.S.C. 32902(b)(2)(C).

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

[130] 49 U.S.C. 32902(b)(2)(B).

[131] 49 U.S.C. 32902(b)(3).

in these procedures, specifically 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 pick-up trucks; and incentives for achieving fuel economy levels in a significant percentage pick-up trucks that exceeds the target curve by specified amounts, in the form of increased values assigned for fuel economy. NHTSA has considered manufacturers' ability to comply with the CAFE standards using these efficiency improvements in determining the stringency of the fuel economy standards presented in this final rule. These changes would be the same as program elements that are part of EPA's greenhouse gas performance standards, discussed in Section III.B.10. As discussed below, these three elements will 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 revision to the CAFE calculations is discussed in more detail in Sections III.B.10 and III.C and IV.I.4 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.[132] 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.[133] 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[134] 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

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

[133] 49 U.S.C. 32912(b), 49 CFR 578.6(h)(2).

[134] 49 U.S.C. 30120, Remedies for defects and noncompliance.

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 cost projected by EPA at the time of regulation, which result in even more favorable real world benefit-to-cost ratios.[135] 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 $PM_{2.5}$ 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 $PM_{2.5}$ 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 final rule implements a specific provision from Title II, section 202(a).[136] 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. Indeed, EPA's obligation to do so is mandatory: ''*Coalition for Responsible Regulation* v. *EPA,* No. 09–1322, slip op. at pp. 40–1 (D.C. Cir. June 26, 2012); *Massachusetts* v. *EPA,* 549 U.S. at 533. Moreover, EPA's mandatory legal duty to promulgate these emission standards derives from ''a statutory obligation wholly independent of DOT's mandate to promote energy efficiency.'' *Massachusetts,* 549 U.S. at 532. Consequently, EPA has no discretion to decline to issue greenhouse standards under section 202(a), or to defer issuing such standards due to NHTSA's regulatory authority to establish fuel economy standards. Rather, ''[j]ust as EPA lacks authority to refuse to regulate on the grounds of NHTSA's regulatory authority, EPA cannot defer regulation on that basis.'' *Coalition for Responsible Regulation* v. *EPA,* slip op. at p. 41.

Any standards under CAA section 202(a)(1) ''shall be applicable to such vehicles * * * for their useful life.'' Emission standards set by the EPA under CAA section 202(a)(1) are technology-based, as the levels chosen must be premised on a finding of technological feasibility. Thus, standards promulgated under CAA section 202(a) are to take effect only ''after providing such period as the Administrator finds necessary to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period'' (section 202 (a)(2); see also *NRDC* v. *EPA,* 655 F. 2d 318, 322 (D.C. Cir. 1981)). EPA must consider costs to those entities which are directly subject to the standards. *Motor & Equipment Mfrs. Ass'n Inc.* v. *EPA,* 627 F. 2d 1095, 1118 (D.C. Cir. 1979). Thus, ''the [s]ection 202 (a)(2) reference to compliance costs encompasses only the cost to the motor-vehicle industry to come into compliance with the new emission standards.'' *Coalition for Responsible Regulation* v. *EPA,* slip op. p. 44; see also id. at pp. 43–44 rejecting arguments that EPA was required to, or should have considered costs to other entities, such as stationary sources, which are not directly subject to the emission standards. EPA is afforded considerable discretion under section 202(a) when assessing issues of technical feasibility and availability of lead time to implement new technology. Such determinations are ''subject to the restraints of reasonableness'', which ''does not open the door to 'crystal ball' inquiry.'' *NRDC,* 655 F. 2d at 328, quoting *International Harvester Co.* v. *Ruckelshaus,* 478 F. 2d 615, 629 (D.C. Cir. 1973). However, ''EPA is not obliged to provide detailed solutions to every engineering problem posed in the perfection of the trap-oxidizer. In the absence of theoretical objections to the technology, the agency need only identify the major steps necessary for development of the device, and give plausible reasons for its belief that the industry will be able to solve those problems in the time remaining. The EPA is not required to rebut all speculation that unspecified factors may hinder 'real world' emission control.'' *NRDC,* 655 F. 2d at 333–34. In developing such technology-based standards, EPA has the discretion to consider different standards for appropriate groupings of vehicles (''class or classes of new motor vehicles''), or a single standard for a larger grouping of motor vehicles (*NRDC,* 655 F. 2d at 338). Finally, with respect to regulation of vehicular greenhouse gas emissions, EPA is not ''required to treat NHTSA's * * * regulations as establishing the baseline for the [section 202 (a) standards].'' *Coalition for Responsible Regulation* v. *EPA,* slip op. at p. 42 (noting further that ''the [section 202 (a) standards] provid[e] benefits above and beyond those resulting from NHTSA's fuel-economy standards''.)

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

[135] 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, 2011. *http://www.whitehouse.gov/omb/inforeg_regpol_reports_congress/* (Last accessed on August 12, 2012). Several commenters asserted that EPA had underestimated costs of rules controlling emissions of criteria pollutants from heavy duty diesel engines. These comments, which are incorrect and misplaced, are addressed in EPA's Response to Comments Section 18.2.

[136] 42 U.S.C. 7521 (a)

consumers,[137] and energy impacts associated with use of the technology. See *George E. Warren Corp.* v. *EPA,* 159 F.3d 616, 623–624 (D.C. Cir. 1998) (ordinarily permissible for EPA to consider factors not specifically enumerated in the Act).

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 (D.C. 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.[138]

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

One commenter mistakenly characterized section 202(a) as a ''technology-forcing'' provision. Comments of CBD p. 5. As just explained, it is not, but even if it were, EPA retains considerable discretion to balance the various relevant statutory factors, again as just explained. The same commenter maintained that the GHG standards should ''protect the public health and welfare with an adequate margin of safety.'' *Id.* p. 2. The commenter paraphrases the statutory standard for issuing health-based National Ambient Air Quality Standards under section 109(b) of the CAA.[139] Section 202(a) is a technology-based provision with an entirely different legal standard. Moreover, the commenter's assertion that the standards must reduce the amount of greenhouse gases emitted by light duty motor vehicles (id. pp. 2–3) has no statutory basis. Section 202(a)(2) does not spell out any minimum level of effectiveness for standards, but instead directs EPA to set the standards at a level that is reasonable in light of applicable compliance costs and technology considerations. Nor is there any requirement that the GHG standards result in some specific quantum of amelioration of the endangerment to which light-duty vehicle emissions contribute. See *Coalition for Responsible Regulation* v. *EPA,* slip op. pp. 42–43. In addition, substantial GHG emission reductions required by section 202(a) standards in and of themselves constitute ''meaningful mitigation of greenhouse gas emissions'' without regard to the extent to which these reductions ameliorate the endangerment to public health and welfare caused by greenhouse gas emissions. *Coalition for Responsible Regulation* v. *EPA,* slip op. p. 43.

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.[140] 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.[141] 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.[142] 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 final 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

[137] 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'').

[138] 70 FR 69664, 69676, November 17, 2005.

[139] 42 U.S.C. 7409(b).

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

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

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

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 finalizing in-use standards as well as standards based on testing performed at time of production. See section III.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. See 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 U.S.C. § 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 (HFET) 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 25439; 76 FR 57252. In this rule, EPA is retaining the FTP and HFET for purposes of testing the fleetwide average standards, and is further modifying 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 rule takes into account reductions of direct air conditioning emissions, and establishes standards for methane and N_2O, but NHTSA's do not, because these emissions generally do not relate to fuel economy. A second important difference is that EPA is adopting certain compliance flexibilities, such as the multiplier for advanced technology vehicles, and has taken those flexibilities into account in its technical analysis and modeling supporting the GHG standards. 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.[143] The Clean Air Act, on the other hand, contains no such prohibition. As explained earlier, these considerations result in some differences in the technical analysis and modeling used to support the agencies' respective 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 truck fleets. 49 U.S.C. 32903(g)(3). Under CAA section 202(a), EPA is continuing 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 CAFE standards and the GHG 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. Among the other factors that is considers in determining maximum

[143] 49 U.S.C. 32902(h).

feasible standards, 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).[144] 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 these 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 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' standards are fully justified under their respective statutory criteria. The 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 assessment of the technologies that could be employed by each manufacturer supports this conclusion. The agencies also carefully assessed the costs of the 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 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 standards, to the extent practicable. The agencies' analyses to date indicate that the overall quantified benefits of the standards far outweigh the projected costs. All of these factors support the reasonableness of the standards. See Section III (GHG standards) and Section IV (CAFE standards) for a detailed discussion of each agency's basis for its selection of its standards.

The fact that the benefits are estimated to considerably exceed their costs supports the view that the standards represent an appropriate balance of the relevant statutory factors.[145] 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 Final Rule

A. Introduction

In this section, NHTSA and EPA discuss several aspects of our joint technical analyses. These analyses are common to the development of each agency's standards. Specifically we discuss: The development of the vehicle market forecasts 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 credit programs for air conditioning; off-cycle technology, and full-sized pickup trucks; as well as the effects of the standards on vehicle safety. The Joint Technical Support Document (TSD) discusses the agencies' joint technical work in more detail.

The agencies have based this final rule 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 Joint TSD, the NHTSA RIA, and the EPA RIA, new information has become available since the proposal from a range of sources. These include work the agencies have completed (e.g., work on technology costs and effectiveness and creating a second future fleet forecast based on model year 2010 baseline data). In addition, information from other sources is now incorporated into our analyses, including the Energy Information

[144] It should be noted, however, that the D.C. Circuit noted the absence of an explicit obligation for EPA to consider NHTSA fuel economy standards as one basis for holding that the existence of NHTSA's fuel economy regulatory program provides no basis for EPA deferring regulation of vehicular greenhouse gas emissions. *Coalition for Responsible Regulation* v. *EPA,* slip op. pp. 41–42.

[145] The comment that the standards are insufficiently stringent because estimated benefits of the standards substantially exceed the estimated costs shows (Comment of CBD p.8) is misplaced. Neither EPCA/EISA nor the CAA dictates a particular weighing of costs and benefits, so the commenter's insistence that the respective statutes require ''maximized societal benefits, where the benefits most optimally compare to the anticipated costs'' (id. p. 23) is not correct.

Agency's Annual Energy Outlook 2012 Early Release, as well as other information from the public comment process. Wherever appropriate, and as summarized throughout this preamble, we have used inputs for the final rule based on information from the proposal as well as new data and information that has become available since the proposal (either through the comments or through the agencies' analyses).

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

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

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 regulatory action, to provide a reference point relative to which costs, benefits, and effects of the regulations are assessed. As in the NPRM, EPA and NHTSA have developed comparison fleets in two parts. The first step was to develop baseline estimates of the fleets of new vehicles to be produced for sale in the U.S. through MY2025, one starting with the actual MY 2008 fleet, and one starting with the actual MY 2010 fleet. These baselines include vehicle sales volumes, GHG/fuel economy performance levels, and contain listings of the base technologies on every MY 2008 or MY 2010 vehicle sold. This information comes from CAFE certification data submitted by manufacturers to EPA, and for purposes of rulemaking analysis, was supplemented with publicly and commercially available information regarding some vehicle characteristics (*e.g.,* footprint). The second step was to project the baseline fleet volumes into model years 2017–2025. The vehicle volumes projected out to MY 2025 are referred to as the reference fleet volumes. The third step was to modify those MY 2017–2025 reference fleets such that they reflect the technology that manufacturers could apply if the MY 2016 standards were extended without change through MY 2025.[146] Each agency used its modeling system to develop modified or final reference fleets, or adjusted baselines, for use in its analysis of regulatory alternatives, as discussed below and in each agency's 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 fleets and the reference fleets.

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.[147]

2. What comments did the agencies receive regarding fleet projections for the NPRM?

During the comment period, the agencies also received formal comments regarding the NPRM baseline and reference fleets. Chrysler questioned the agencies' assumption that the company's sales would decline by 53% over 17 years, and stated that the forecast had implications not just for the agencies' analysis, but also, indirectly, for Chrysler's competitiveness, because suppliers and customers who ''see [such] projections supported by Federal agencies * * * are potentially given a highly negative view of the viability of the company * * * [which] may result in less favorable contracts with suppliers and lower sales to customers.'' Chrysler requested that the agencies update their volume projections for the final rule.[148]

The agencies' projection that Chrysler's sales would steadily decline was primarily attributable to the manufacturer- and segment-level forecasts provided in December 2009 by CSM. The agencies thought that forecast to have been credible at the time considering economic and industry conditions during the months before CSM provided the agencies with a long-range forecast, when the overall light vehicle market was severely depressed and Chrysler and GM were—with nascent federal assistance—in the process of reorganizing. We recognize that Chrysler's production has since recovered to levels suggesting much better long-term prospects than forecast by CSM in 2009. While the agencies are continuing to use the market forecast developed for the NPRM (after minor corrections unrelated to Chrysler's comments), we are also using a second market forecast we have developed for today's final rule, making use of a newer forecast (in this case, from LMC) of manufacturer- and segment-level shares, a forecast that shows significantly higher sales (more than double that of the earlier forecast) for Chrysler in 2025.

Environmental Consultants of Michigan commented that use of 4-year-old certification data was ''unconscionable'' and unreflective of technology improvements already made to vehicles since then, requesting that the agencies delay the final rule until the market forecast can be updated with appropriate data.[149] As described in this chapter, even though the year of publication of this rule is 2012, model year 2010 was the most recent baseline dataset available due to the lag between the actual conclusion of a given model year and the submission (for CAFE compliance purposes) of production volumes for that model year. Moreover, as explained below in the joint TSD and in our respective RIAs, EPA and NHTSA measure the costs and benefits of new standards as incremental levels beyond those that would result from the application of technology given continuation of baseline standards (*i.e.,* continuation of the standards that will be in place in MY 2016). Therefore, our analysis of manufacturers' capabilities is informed by analysis of technology that could be applied in the future even absent the new standards, not just technology that had been applied in 2008 or 2010. We further note that, while NHTSA has, in the past, made use of confidential product planning information provided to the agency by many manufacturers—information that typically extended roughly five years into the future—other stakeholders previously commented negatively regarding the agency's resultant inability to publish some of the detailed inputs to and outputs of its analysis. As during the rulemaking establishing the MYs 2012–2016 standards, EPA and NHTSA have determined that the benefits of a fully transparent market forecast outweigh the disbenefits of a market forecast that may not fully reflect likely forthcoming changes in manufacturers' products.

The agencies also received a comment from Volkswagen, stating that ''Volkswagen sees *no evidence* that would suggest a *near 30% decline in truck market share from domestic OEMs*

[146] EPA's MY 2016 GHG standards under the CAA would continue into the future absent this final rule. 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.

[147] 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.*

[148] Chrysler, Docket No. NHTSA–2010–0131–0241, at 21.

[149] Environmental Consultants of Michigan, Docket No. NHTSA–2010–0131–0166, at 7.

[original emphasis].'' [150] Volkswagen further suggested that the agencies' forecast was based on confidential ''strategic plans by [Volkswagen's] competitors''. On the contrary, the agencies' forecast was based on public and commercial information made fully available to all stakeholders, including Volkswagen. Also, while the agencies' 2008 based fleet projection showed a decline in the share of light trucks expected to be produced by the aggregate of Chrysler, Ford, and General Motors, Volkswagen's statement mischaracterized the magnitude and nature of the decline. Between MY2008 and MY2025, the agencies' forecast showed declines from 17.8% to 5.8% for Chrysler, from 14.5% to 12.0% for Ford, from 26.8% to 27.8% from General Motors, and from 58.3% to 44.5% for the aggregate of these three manufacturers. The latter represents a 22.5% reduction, not the 30% reduction cited by Volkswagen, and is dominated by the underlying forecast regarding Chrysler's overall position in the market; for General Motors, the agencies' forecast showed virtually no loss of share in the light truck market. As discussed above, the agencies' market forecast for the NPRM was informed by CSM's forecast of manufacturer- and segment-level shares, and by EIA's forecast of overall volumes of the passenger car and light truck markets, and CSM's forecast, in particular, was provided at a time when market conditions were economically severe. While the agencies are continuing to use this forecast, this agency is also using a second forecast, informed by MY 2010 certification data, an updated AEO-based forecast of overall volumes of passenger cars and light trucks, and an updated manufacturer- and segment-level market forecast from LMC Automotive.

The Union of Concerned Scientists (UCS) expressed concern that if the light vehicle market does not shift toward passenger cars as indicated in the agencies' market forecast, energy and environmental benefits of the new standards could be less than projected.[151] As discussed below, our MY 2008-based and MY 2010-based market forecasts, while both subject to uncertainty, reflect passenger car market shares estimated using EIA's National Energy Modeling System (NEMS). For both market forecasts, we re-ran NEMS by holding standards constant after MY 2016 and also preventing the model from increasing the passenger car market share to achieve increases in fleetwide average fuel economy levels. Having done so, we obtained a somewhat lower passenger car market share than EIA obtained for AEO 2011 and AEO 2012, respectively. In our judgment, this approach provides a reasonable basis for developing a forecast of the overall sales of passenger cars and light trucks, while remaining consistent with our use of EIA's reference case estimates of future fuel prices. In any event, we note that EPCA/EISA requires NHTSA to ensure that the overall new vehicle fleet achieves average fuel economy of at least 35 mpg by MY 2020. Our analysis, discussed below, indicates based on the information currently before us that the fleet could achieve 39.9–40.8 mpg by MY 2020 (accounting for flexibilities available under EPCA)—well above the 35 mpg statutory requirement. However, NHTSA will monitor the fleet's progress and, if necessary, adjust standards to ensure that EPCA/EISA's ''35-by-2020'' requirement is met, even if this requires issuing revised fuel economy standards before the planned joint mid-term evaluation process has been completed. However, insofar as NHTSA's current analysis indicates the fleet could achieve 40–41 mpg by MY 2020, NHTSA currently expects the need for such a rulemaking to be unlikely. Beyond MY 2020, EPCA/EISA does not provide a minimum requirement for the overall fleet, but requires NHTSA to continue setting separate standards for passenger cars and light trucks, such that each standard is at the maximum feasible level in each model year. In other words, as long as the ''35-by-2020'' requirement is achieved, NHTSA is required to consider stringency for passenger cars and light trucks separately, not to set those standards at levels achieving any particular level of average performance for the overall fleet.

Nonetheless, the agencies recognize that overall fuel consumption and GHG emissions by the light vehicle fleet will depend on, among many other things, the relative market shares of passenger cars and light trucks. In its probabilistic uncertainty analysis, presented in NHTSA's RIA accompanying today's notice as required by OMB for significant rulemakings, NHTSA has varied the passenger car share (as a function of fuel price), such that the resultant distributions of estimated model results—including fuel savings and CO_2 emission reductions—reflect uncertainty regarding the relative market shares of passenger cars and light trucks. The results of the probabilistic uncertainty analysis along with the other analysis in this rulemaking support that the NHTSA standards are maximum feasible standards. The probabilistic uncertainty analysis is discussed in NHTSA's RIA Chapter XII. Like all other aspects of the outlook for the future light vehicle market, the agencies will closely monitor the relative market shares of passenger cars and light trucks in preparation for the planned midterm review.

3. Why were two fleet projections created for the FRM?

Although much of the discussion in this and following sections describes the methodology for creating a single baseline and reference fleet, for this final rule the agencies actually developed two baseline and reference fleets. In the NPRM, the agencies used MY 2008 CAFE certification data to establish the ''2008-based fleet projection.'' [152] The agencies noted that MY 2009 CAFE certification data was not likely to be representative of future conditions since it was so dramatically influenced by the economic recession (Joint Draft TSD section 1.2.1). The agencies further noted that MY 2010 CAFE certification data might be available for use in the final rulemaking for purposes of developing a baseline fleet. The agencies stated that a copy of the MY 2010 CAFE certification data would be put in the public docket if it became available during the comment period. The MY 2010 data was reported by the manufacturers throughout calendar year 2011 as the final sales figures were compiled and submitted to the EPA database. Due to the lateness of the CAFE data submissions,[153] however, it was not possible to submit the new 2010 data into the docket during the public comment period. As explained below, however, consistent with the agencies' expectations at proposal, and with the agencies' standard practice of updating relevant information as practicable between proposals and final rules, the agencies are using these data in one of the two fleet-based projections we are using to estimate the impacts of the final rules.

For analysis supporting the NPRM, the agencies developed a forecast of the light vehicle market through MY 2025

[150] Volkswagen, NHTSA–2010–0131–0247, at 9.

[151] UCS, Docket No. EPA–HQ–OAR–2010–0799–9567, p. 8.

[152] ''2008 based fleet projection'' is a new term that is the same as the reference fleet. The term is added to clarify when we are using the 2008 baseline and reference fleet vs. the 2010 baseline and reference fleet.

[153] Partly due to the earthquake and tsunami in Japan and the significant impact this had on their facilities, some manufacturers requested and were granted an extension on the deadline to submit their CAFE data.

based on (a) the vehicle models in the MY 2008 CAFE certification data, (b) the AEO 2011 interim projection of future fleet sales volumes, and (c) the future fleet forecast conducted by CSM in 2009. In the proposal, the agencies stated we would consider using MY 2010 CAFE certification data, if available, for analysis supporting the final rule (Joint Draft TSD, p. 1–2). Shortly after the NPRM was issued, the agencies reiterated this intention in statements to *Automotive News* in response to a pending article by that publication.[154] The agencies also indicated our intention to, for analysis supporting the final rule, use the most recent version of EIA's AEO available, and a market forecast updated relative to that purchased from CSM (Joint Draft TSD section 1.3.5).

For this final rulemaking, the agencies have analyzed the costs and benefits of the standards using two different forecasts of the light vehicle fleet through MY 2025. The agencies have concluded that the significant uncertainty associated with forecasting sales volumes, vehicle technologies, fuel prices, consumer demand, and so forth out to MY 2025 makes it reasonable and appropriate to evaluate the impacts of the final CAFE and GHG standards using two baselines. One market forecast, similar to the one used for the NPRM, uses corrected data regarding the MY 2008 fleet, information from AEO 2011, and information purchased from CSM. As noted above, the agencies received comments regarding the market forecast used in the NPRM suggesting that updates in several respects could be helpful to the agencies' analysis of final standards; given those comments and since the agencies were already planning to produce an updated market forecast, the final rule also contains another market forecast using MY 2010 CAFE certification data, information from AEO 2012, and information purchased from LMC Automotive (formerly JD Powers Automotive).

The two market forecasts contain certain differences, although as will be discussed below, the differences are not significant enough to change the agencies' decision as to the structure and stringency of the final standards. For example, MY 2008 certification data represents the most recent model year for which the industry's offerings were not strongly affected by the subsequent economic recession, which may make it reasonable to use if we believe that the future vehicle mix of models are more likely to be reflective of the pre-recession mix than mix of models produced after MY 2008 (*e.g.,* in MY 2010). Also, the MY 2010-based fleet projection employs a future fleet forecast provided by LMC Automotive, which is more current than the projection provided by CSM in 2009. The CSM forecast, utilized for the MY 2008-based fleet projection, appears to have been influenced by the recession, in particular in predicting major declines in market share for some manufacturers (*e.g.,* Chrysler) which the agencies do not believe are reasonably reflective of future trends.

The MY 2010 based fleet projection, which is used in EPA's alternative analysis and in NHTSA's co-analysis, employs a future fleet forecast provided by LMC Automotive, which is more current than the projection provided by CSM in 2009, and which reflects the post-proposal MY 2010 CAFE certification data. However, this MY 2010 CAFE data also shows effects of the economic recession. For example, industry-wide sales were skewed down 20% compared to MY 2008 levels. For some companies like Chrysler, Mitsubishi, and Subaru, sales were down by 30–40% from MY 2008 levels, as documented in today's joint TSD. For BMW, General Motors, Jaguar/Land Rover, Porsche, and Suzuki, sales were down by more than 40%. Employing the MY 2008 vehicle data avoids using these baseline market shifts when projecting the future fleet. On the other hand, it also perpetuates vehicle brands and models (and thus, their outdated fuel economy levels and engineering characteristics) that have since been discontinued. The MY 2010 CAFE certification data accounts for the phase-out of some brands (*e.g.,* Saab, Pontiac, Hummer)[155] and the introduction of some technologies (*e.g.,* Ford's Ecoboost engine), which may be more reflective of the future fleet in this respect.

Thus, given the volume of information that goes into creating a baseline forecast and given the significant uncertainty in any projection out to MY 2025, the agencies think that a reasonable way to illustrate the possible impacts of that uncertainty for purposes of this rulemaking is the approach taken here of analyzing the effects of the final standards under both the MY 2008-based baseline and the MY 2010-based baseline. The agencies' analyses are presented in our respective RIAs and preamble sections.

4. How did the Agencies develop the MY 2008 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 used for the NPRM and was updated for this FRM.

There was only one change since the NPRM. A contractor working on a market share model noted some problems with some of the 2008 MY vehicle wheelbase data. Each of the affected vehicle's wheelbase and footprint were corrected for the MY 2008-based fleet used for this final rule. A more complete discussion of these changes is available in Chapter 1.3.1 of the TSD.

The 2008 baseline fleet reflects all fuel economy technologies in use on MY 2008 light duty vehicles as reported by manufacturers in their CAFE certification data. 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.[156] 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.[157] 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 TSD.

5. How did the Agencies develop the projected MY 2017–2025 vehicle reference fleet for the 2008 model year based fleet?

As in the NPRM, 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 (EIAEIA 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

[154] ''For CAFE rules, feds look at aging sales data'', *Automotive News,* December 22, 2011. *Available at http://www.autonews.com/article/20111222/OEM11/111229956* (last accessed Jun. 27, 2012).

[155] Based on our review of the CAFE certification, the MY 2010-based fleet contains no Saabs, and compared to the MY 2008-based fleet, about 90% fewer Hummers and about 75% fewer Pontiacs.

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

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

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 and early release AEO came out in December of 2011, but for consistency with the NPRM, EPA and NHTSA chose to use the data from February 2011.

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 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 NPRM analysis, the agencies developed a new projection of passenger car and lighttruck 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 a long range forecast[158] from CSM Worldwide (CSM) the firm which, at the time of proposal development, offered the most detailed forecasting for the model years in question. 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. Since proposal, the agencies have worked with LMC Automotive (formerly J.D. Powers Forecasting) and found them to be capable of doing forecasting of equivalent detail and are using the LMC forecast for the 2010 baseline fleet projection.

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.

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

[158] 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).

TABLE II–1—ANNUAL SALES OF LIGHT-DUTY VEHICLES BY MANUFACTURER IN 2008 AND ESTIMATED FOR 2025—Continued

	Cars		Light trucks		Total	
	2008 MY	2025 MY	2008 MY	2025 MY	2008 MY	2025 MY
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 Mazda5. SUV—Sport Utility Vehicle, CUV—Crossover Utility Vehicle.

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

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 [159]	2021	2025
Old Cars Definition	6,981,307	8,576,717	8,911,173	9,836,330
New Cars Definition	8,230,568	10,140,463	10,505,165	11,541,560
Old Truck Definition	6,870,454	7,618,459	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 1.3.2 of the TSD.

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

[159] In the NPRM, MY 2016 values reported for the New Cars Definition and Old Truck Definition were erroneously reversed.

TABLE II–4—CSM MANUFACTURER VOLUMES IN 2016, 2021, AND 2025—Continued

	2016	2021	2025
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 (percent)	2021 (percent)	2025 (percent)
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

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 represented the agencies' best forecast available at the time of its publishing 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. While the agencies have not included variations in the market forecast as aspects of our respective sensitivity analyses, we have conducted our central analyses twice—once each for the MY 2008- and MY 2010-based market forecasts that reflect differences in available vehicle models, differences in manufacturer- and segment-level market shares, and differences in the overall volumes of passenger cars and light trucks. In addition, as discussed above, NHTSA's probabilistic uncertainty analysis accounts for uncertainty regarding the relative market shares of passenger cars and light trucks.

The final step in the construction of the 2008 based fleet projection 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 in the agencies' respective RIAs.

6. How did the agencies develop the model year 2010 baseline vehicle fleet as part of the 2010 based fleet projection?

NHTSA and EPA also developed a baseline fleet comprised of model year

2010 data gathered from EPA's emission and fuel economy database. This alternative baseline fleet has the model year 2010 vehicle volumes and attributes. The 2010 baseline fleet reflects all fuel economy technologies in use on MY 2010 light duty vehicles as reported by manufacturers in their CAFE certification data. The 2010 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, as with the 2008 baseline fleet, the agencies relied on publicly available data like the more complete technology descriptions from Ward's Automotive Group. 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. A description of all of the technologies used in modeling the 2010 vehicle fleet and how it was constructed are available in Chapter 1.4 of the Joint TSD.

7. How did the Agencies develop the projected my 2017–2025 vehicle reference fleet for the 2010 model year based fleet?

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). EIA published its Early Annual Energy Outlook for 2012 in December 2011. EIA released updated data to NHTSA in February (AEO Early Release). The final version of AEO 2012 was released June 25, 2012, after the agencies had already completed our analyses using the early release results.

As the we did with the Interim 2011 AEO data, the agencies developed a new projection of passenger car and light truck sales shares by running scenarios from the Early Release AEO 2012 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 2012 Early Release 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 8.7 million (55 percent) and truck sales are projected to be 7.1 million (45 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 1.4.3 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 2012 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 a custom long range forecast purchased from LMC Automotive (formerly J.D. Powers Forecasting). NHTSA and EPA decided to use the forecast from LMC for the 2010 model year based fleet for several reasons discussed in Chapter 1 of the Joint TSD, and believe the projection provides a useful cross-check for the forecast used for the projections reflected in the 2008 model year based fleet. For the public's reference, a copy of LMC's long range forecast has been placed in the docket for this rulemaking.[160]

The next step was to project the LMC forecasts for relative sales of cars and trucks by manufacturer and by market segment onto the total sales estimates of AEO 2012. Table II–7 and Table II–8 show the resulting projections for the reference 2025 model year and compare these to actual sales that occurred in the baseline 2010 model year. Both tables show sales using the traditional definition of cars and light trucks. As discussed above, the new forecast from LMC shown in Table II–7 shows a significant increase in Chrysler/Fiat's sales (1.6 million) from those projected by CSM (768 thousand).

TABLE II–7—ANNUAL SALES OF LIGHT-DUTY VEHICLES BY MANUFACTURER IN 2010 AND ESTIMATED FOR 2025

	Cars		Light trucks		Total	
	2010 MY	2025 MY	2010 MY	2025 MY	2010 MY	2025 MY
Aston Martin	601	639	0	0	601	639
BMW	143,638	363,380	26,788	101,013	170,426	464,394
Chrysler/Fiat	496,998	899,843	665,806	726,403	1,162,804	1,626,246
Daimler	157,453	261,242	72,393	119,090	229,846	380,332
Ferrari	1,780	1,894	0	0	1,780	1,894
Ford	940,241	1,441,350	858,798	997,694	1,799,039	2,439,045
Geely	28,223	65,883	29,719	31,528	57,942	97,411
GM	1,010,524	1,696,474	735,367	1,261,546	1,745,891	2,958,020
Honda	845,318	1,295,234	390,028	504,020	1,235,346	1,799,254
Hyundai	375,656	935,619	35,360	117,662	411,016	1,053,281
Kia	226,157	350,765	21,721	37,957	247,878	388,723
Lotus	354	377	0	0	354	377
Mazda	249,489	262,732	61,451	53,183	310,940	315,916
Mitsubishi	54,263	67,925	9,146	15,464	63,409	83,389
Nissan	619,918	919,920	255,566	312,005	875,484	1,231,925
Porsche	11,937	17,609	3,978	19,091	15,915	36,701
Spyker	0	0	0	0	0	0
Subaru	184,587	218,870	73,665	96,326	258,252	315,196
Suzuki	25,002	48,710	3,938	4,173	28,940	52,883

[160] The LMC Automotive's Sales Forecast Excel file (''LMC North America Sales Forecasts 2017–2025 for the Docket'') is available in the docket (Docket EPA–HQ–OAR–2010–0799).

TABLE II–7—ANNUAL SALES OF LIGHT-DUTY VEHICLES BY MANUFACTURER IN 2010 AND ESTIMATED FOR 2025—Continued

	Cars		Light trucks		Total	
	2010 MY	2025 MY	2010 MY	2025 MY	2010 MY	2025 MY
Tata/JLR	11,279	30,949	37,475	50,369	48,754	81,319
Tesla	0	0	0	0	0	0
Toyota	1,508,866	1,622,242	696,324	921,183	2,205,190	2,543,426
Volkswagen	284,046	479,423	36,327	105,009	320,373	584,432
Total	7,176,330	10,981,082	4,013,850	5,473,718	11,190,180	16,454,800

TABLE II–8—ANNUAL SALES OF LIGHT-DUTY VEHICLES BY MARKET SEGMENT IN 2010 AND ESTIMATED FOR 2025

Cars			Light Trucks		
	2010 MY	2025 MY		2010 MY	2025 MY
Compact Conventional	2,107,568	2,380,540	Compact CUV	1,201,018	1,172,645
Compact Premium Conventional	498,107	868,582	Compact MPV	250,816	409,034
Compact Premium Sporty	45,373	59,523	Compact Premium CUV	154,808	204,204
Compact Sporty	136,464	170,121	Compact Utility	216,634	234,737
Large Conventional	485,656	832,113	Large Pickup	992,473	1,426,193
Large Premium Conventional	61,291	187,898	Large Premium Utility	72,411	139,719
Large Premium Sporty	8,551	21,346	Large Utility	164,416	323,992
Midsize Conventional	1,742,494	3,353,080	Large Van	17,516	31,198
Midsize Premium Conventional	176,193	412,950	Midsize CUV	825,743	1,351,888
Midsize Premium Sporty	27,023	67,005	Midsize Pickup	288,508	443,502
Midsize Sporty	244,895	257,865	Midsize Premium CUV	333,790	493,977
Sub-Compact Conventional	336,971	748,210	Midsize Premium Utility	18,584	33,087
Unity Class *	7,351	7,820	Midsize Utility	267,035	331,291
			Midsize Van	508,491	492,280
Total Sales **	5,877,937	9,367,054		5,312,243	7,087,746

* Unity Class—Is a special class created by the EPA for luxury brands that were not covered by the forecast.
** Total Sales are based on the classic Car/Truck definition.

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–9 shows the different volumes for car and trucks based on the new and old NHTSA definition. The table shows the difference in 2010, 2021, and 2025 to give a feel for how the change in definition changes the car/truck split.

TABLE II–9—NEW AND OLD CAR AND TRUCK DEFINITION IN 2010, 2016, 2021, AND 2025

Vehicle type	2010	2016	2021	2025
Old Cars Definition	6,016,063	8,725,700	8,898,400	9,525,700
New Cars Definition	7,176,330	10,227,185	10,310,594	10,981,082
Old Truck Definition	5,174,117	7,136,500	6,831,700	6,929,100
New Truck Definition	4,013,850	5,635,015	5,419,506	5,473,718

The LMC forecast provides estimates of car and truck sales by manufacturer 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–10 is an example of the data received from LMC. The task of estimating future sales using these tables is complex. Table II–11 is the LMC projected volumes for each manufacturer.

Table II–12 has the LMC segment percentages for 2016, 2021, and 2025. We used a new methodology that is different than we used for the 2008 fleet projection. A detailed description of how the projection process was done is found in Chapter 1 of the TSD.

TABLE II–10—EXAMPLE OF THE LMC SEGMENTED CHRYSLER VOLUMES IN 2016, 2021, AND 2025

Manufacturer	LMC segment	2016	2021	2025
Chrysler/Fiat	Compact Basic	0	0	0
Chrysler/Fiat	Compact Conventional	66,300	80,131	90,032
Chrysler/Fiat	Compact CUV	66,861	73,867	79,812
Chrysler/Fiat	Compact MPV	42,609	73,673	108,134

TABLE II–10—EXAMPLE OF THE LMC SEGMENTED CHRYSLER VOLUMES IN 2016, 2021, AND 2025—Continued

Manufacturer	LMC segment	2016	2021	2025
Chrysler/Fiat	Compact Premium Conventional	32,080	36,654	40,287
Chrysler/Fiat	Compact Premium CUV	10,780	11,229	11,811
Chrysler/Fiat	Compact Premium Sporty	164	151	140
Chrysler/Fiat	Compact Utility	227,901	249,383	274,171
Chrysler/Fiat	Large Conventional	182,468	231,692	251,766
Chrysler/Fiat	Large Pickup	334,980	366,592	382,492
Chrysler/Fiat	Large Van	19,981	20,639	21,569
Chrysler/Fiat	Midsize Conventional	106,105	108,965	112,637
Chrysler/Fiat	Midsize CUV	82,615	90,608	95,281
Chrysler/Fiat	Midsize Pickup	31,246	42,374	48,862
Chrysler/Fiat	Midsize Premium Conventional	9,078	13,074	15,891
Chrysler/Fiat	Midsize Premium CUV	10,983	19,432	24,749
Chrysler/Fiat	Midsize Premium Sporty	4,132	3,753	3,728
Chrysler/Fiat	Midsize Sporty	0	0	0
Chrysler/Fiat	Midsize Utility	219,206	185,386	162,149
Chrysler/Fiat	Midsize Van	181,402	155,543	145,019
Chrysler/Fiat	Sub-Compact Conventional	77,361	75,478	79,533
Chrysler/Fiat	Unity Class*	3,163	3,163	3,163

*Note: Unity Class is created by EPA to account for luxury brands.

TABLE II–11 LMC MANUFACTURER VOLUMES IN 2016, 2021, AND 2025

Manufacturer	2016	2021	2025
Aston Martin	601	601	601
BMW	411,137	441,500	461,752
Daimler	354,175	385,197	404,899
Chrysler/Fiat	1,709,415	1,841,787	1,951,226
Ford	2,692,193	2,818,737	2,935,409
Geely	91,711	97,548	100,912
GM	3,382,343	3,532,217	3,676,282
Honda	1,635,473	1,758,092	1,838,444
Hyundai	1,325,712	1,378,186	1,438,427
Lotus	354	354	354
Mazda	309,864	308,298	318,450
Mitsubishi	69,397	80,028	87,468
Nissan	1,221,374	1,247,279	1,288,609
Subaru	313,619	321,934	339,206
Spyker			
Suzuki	44,935	48,861	52,594
Tata/JLR	83,824	87,169	89,011
Toyota	2,492,707	2,582,404	2,658,145
Volkswagen	608,484	604,255	619,274

TABLE II–12—LMC SEGMENT PERCENTAGES IN 2016, 2021, AND 2025

LMC segment	2016 (percent)	2021 (percent)	2025 (percent)
Unity Class*	0.04	0.04	0.04
Compact Basic	0.00	0.00	0.00
Compact Conventional	12.44	12.07	12.03
Compact CUV	7.74	7.38	7.30
Compact MPV	2.61	2.47	2.56
Compact Premium Conventional	4.59	4.68	4.69
Compact Premium CUV	1.49	1.54	1.55
Compact Premium Sporty	0.41	0.34	0.31
Compact Sporty	0.95	0.91	0.88
Compact Utility	1.37	1.45	1.53
Large Conventional	3.95	4.27	4.27
Large Pickup	12.62	12.95	12.92
Large Premium Conventional	0.88	0.95	0.98
Large Premium Pickup	0.00	0.00	0.00
Large Premium Sporty	0.09	0.11	0.11
Large Premium Utility	0.91	0.91	0.91
Large Utility	2.32	2.21	2.11
Large Van	2.24	2.34	2.40
Midsize Conventional	16.49	17.04	17.17
Midsize CUV	9.28	8.84	8.92
Midsize Pickup	2.56	2.79	2.89

TABLE II–12—LMC SEGMENT PERCENTAGES IN 2016, 2021, AND 2025—Continued

LMC segment	2016 (percent)	2021 (percent)	2025 (percent)
Midsize Premium Conventional	2.06	2.18	2.21
Midsize Premium CUV	2.87	3.08	3.11
Midsize Premium Sporty	0.40	0.36	0.34
Midsize Premium Utility	0.23	0.22	0.22
Midsize Sporty	1.59	1.41	1.33
Midsize Utility	2.57	2.42	2.16
Midsize Van	3.53	3.32	3.21
Sub-Compact Conventional	3.77	3.72	3.85

* Note: Unity Class is created by EPA to account for luxury brands.

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 LMC forecast. These sales splits are shown in Table II–13 below.

TABLE II–13—CAR AND TRUCK VOLUMES AND SPLIT BASED ON NHTSA NEW TRUCK DEFINITION

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Car Volume*	10,227	10,213	10,089	10,140	10,194	10,311	10,455	10,594	10,812	10,981
Truck Volume*	5,635	5,599	5,516	5,522	5,436	5,420	5,432	5,413	5,435	5,474
Car Split	64.5%	64.6%	64.7%	64.7%	65.2%	65.5%	65.8%	66.2%	66.5%	66.7%
Truck Split	35.5%	35.4%	35.3%	35.3%	34.8%	34.5%	34.2%	33.8%	33.5%	33.3%

* In thousands.

The final step in the construction of the 2010 model year based fleet involves applying additional technology to individual vehicle models—that is, technology beyond that already present in MY 2010——reflecting already-promulgated standards through MY 2016, and reflecting the assumption that MY 2016 standards would continue to apply in each model year through MY 2025. A description of the agencies' modeling work to develop their respective final reference (or adjusted baseline) fleets appear in the agencies' respective RIAs.

8. What are the Differences in the Sales Volumes and Characteristics of the MY 2008 Based and the MY 2010 Based Fleets Projections?

Table II–14 is the difference in actual and projected sales volumes between the 2010 based and the 2008 based fleet forecast. This summary table is the most convenient way to compare the projections from CSM and LMC, since the forecasting companies use different segmentations of vehicles. It also provides a comparison of the two AEO forecasts since the projections are normalized to AEO's total volume of cars and trucks in each year of the projection. The table shows a total projected reduction from the 2008 fleet to the 2010 fleet in 2025 of .5 million cars and .8 million trucks. The largest manufacturer changes in the 2025 model projections are for Chrysler and Toyota. The newer projection increases Chrysler's total vehicles by .9 million vehicles, while it decreases Toyota's total vehicles by .8 million.

The table also shows that the total actual reduction in cars from 2008 MY to 2010 MY is 1.0 million vehicles, and the reduction in trucks is 1.6 million vehicles.

TABLE II–14—DIFFERENCES IN ANNUAL SALES OF LIGHT-DUTY VEHICLES BY MANUFACTURER

	Cars		Light trucks		Total	
	2010–2008 MY	2025 MY	2010–2008 MY	2025 MY	2010–2008 MY	2025 MY
Aston Martin	−769	−543	0	0	−769	−543
BMW	−148,158	−41,876	−34,536	−44,396	−182,694	−86,271
Chrysler/Fiat	−206,160	463,364	−290,986	394,641	−497,146	858,005
Daimler	−50,742	−79,477	−6,742	18,023	−57,484	−61,454
Ferrari	330	−5,764	0	0	330	−5,764
Ford	−16,458	−98,759	44,604	313,218	28,146	214,459
Geely	−37,426	−35,224	−3,029	−11,060	−40,455	−46,285
GM	−576,867	22,538	−772,430	−262,462	−1,349,297	−239,923
Honda	−161,321	−45,087	−115,112	−53,677	−276,433	−98,764
Hyundai	37,787	258,369	−17,798	−50,474	19,989	207,895
Kia	4,177	−12,018	−37,751	−59,696	−33,574	−71,713
Lotus	102	61	0	0	102	61
Mazda	2,828	−44,072	5,566	−8,185	8,394	−52,256
Mitsubishi	−31,095	−5,380	−6,225	−20,923	−37,320	−26,303
Nissan	−97,951	−94,855	−49,980	−114,449	−147,931	−209,304
Porsche	−6,972	−23,087	−14,819	7,872	−21,791	−15,214
Spyker	−21706	−23130	−4250	−3475	−25956	−26605
Subaru	68,552	−38,100	−8,881	21,604	59,671	−16,496

TABLE II–14—DIFFERENCES IN ANNUAL SALES OF LIGHT-DUTY VEHICLES BY MANUFACTURER—Continued

	Cars		Light trucks		Total	
	2010–2008 MY	2025 MY	2010–2008 MY	2025 MY	2010–2008 MY	2025 MY
Suzuki	−54,337	−54,444	−31,381	−17,201	−85,718	−71,645
Tata/JLR	1,683	−34,469	−18,109	−6,436	−16,426	−40,904
Tesla	−800	−31974	0	0	−800	−31974
Toyota	248,502	−485,811	−254,812	−288,833	−6,310	−774,643
Volkswagen	−7,437	−150,740	9,328	−49,275	1,891	−200,015
Total	−1,054,238	−560,478	−1,607,343	−235,181	−2,661,581	−795,659

Table II–15 shows the change in volumes between the two forecasts for cars and trucks based on the new and old NHTSA definition. The table shows the change to give a feel for how the change in definition impacts the car/truck split. Many factors impact the changes shown here including differences in AEO, differences in the number of SUV and CUV vehicles becoming cars, and the future volume projected by CSM and LMC.

TABLE II–15—DIFFERENCES IN NEW AND OLD CAR AND TRUCK DEFINITION IN 2008, 2016, 2021, AND 2025

Vehicle type	2010–2008	2016	2021	2025
Old Cars Definition	−965,244	148,983	−12,773	−310,630
New Cars Definition	−1,054,238	86,722	−194,571	−560,478
Old Truck Definition	−1,696,337	−481,959	−446,194	−485,029
New Truck Definition	−1,607,343	−419,698	−264,396	−235,181

Table II–16 is the changes in car and truck split due to the difference between the 2010 and 2008 forecast. The table shows that the different AEO forecasts, CSM and LMC projections have an insignificant impact on the car and truck split.

TABLE II–16—DIFFERENCES IN CAR AND TRUCK VOLUMES AND SPLIT BASED ON NHTSA NEW TRUCK DEFINITION

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Car Volume *	87	225	184	144	−98	−194	−281	−374	−446	−561
Truck Volume *	−419	−220	−155	−61	−168	−264	−272	−274	−241	−235
Car Split	1.9%	1.4%	1.1%	0.5%	0.5%	0.6%	0.5%	0.3%	0.0%	−0.2%
Truck Split	−1.9%	−1.4%	−1.1%	−0.5%	−0.5%	−0.6%	−0.5%	−0.3%	0.0%	0.2%

* in thousands.

The joint TSD contains further comparisons of the two projections at the end of Chapter 1.

So, given all of the discussion above, the agencies have created these two baselines to illustrate possible uncertainty in the future market forecast. The industry-wide differences between the forecasts are relatively minor, even if there are some fairly significant differences for individual manufacturers. Analysis under both baselines supports the agencies' respective decisions as to the stringency of the final standards, as discussed further in Sections III and IV below.

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 promulgating 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.[161] 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,[162] in the recent GHG standards for heavy duty pickups and vans using a work factor attribute,[163] and in the MYs 2012–2016 GHG rule itself which used vehicle footprint as the attribute). As for the MYs 2012–2016 rulemaking, public comments on the MYs 2017–2025 proposal widely supported attribute-based standards for both agencies' standards as further discussed in section II.C.2.

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 final rule, footprint, as discussed below). Each manufacturers' fleet average standard is determined by the production-weighted[164] 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

[161] 49 U.S.C. 32902(a)(3)(A).

[162] 69 FR 38958 (June 29, 2004).

[163] 76 FR 57106, 57162–64, (Sept. 15, 2011).

[164] Production for sale in the United States.

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.[165] 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.[166]

Third, attribute-based standards provide a more equitable regulatory framework for different vehicle manufacturers.[167] 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 have the incentive to invest in technologies that improve the fuel economy of the vehicles they sell rather than shifting their 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 adopting, 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 promulgating CAFE and CO_2 standard curves 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 for the vehicles covered by this rulemaking, 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 less safe. While NHTSA's research of historical crash data also indicates that reductions in vehicle mass tend to compromise overall highway safety, reductions in vehicle footprint do so to a much greater extent. If footprint-based standards are defined in a way that creates a relatively uniform burden for compliance for vehicles of all sizes, then footprint-based standards should not create incentives for manufacturers to downsize their fleets as a strategy for compliance which could compromise societal safety, or to upsize their fleets which might reduce the program's fuel savings and GHG emission reduction benefits. Footprint-based standards also enable manufacturers to apply weight-efficient materials and designs to their vehicles while maintaining footprint, as an effective means to improve fuel economy and reduce GHG emissions. On the other hand, depending on their design, weight-based standards can create disincentives for manufacturers to apply weight-efficient materials and designs. This is because weight-based standards would become more stringent as vehicle mass is reduced. The agencies discuss mass reduction and its relation to safety in more detail in Preamble section II.G.

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 to 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[168] that the possibility of gaming an attribute-based standard 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.[169] This is not to say that a footprint-based system will eliminate gaming, or that a footprint-based system eliminates the possibility that manufacturers will change vehicles in ways that compromise occupant protection. Such risks cannot be completely avoided, and in the agencies' judgment, footprint-based standards achieved the best balance among affected considerations.

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. The agencies recognize that a recent independent analysis, discussed below, suggests that the NPRM form of the MY 2014 standards could, under some circumstances posited by the authors, induce some increases in vehicle footprint. Underlining the potential uncertainty, considering a range of scenarios, the authors obtained a wide range of results in their analyses. As discussed in later in this section,

[165] 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.

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

[167] 2002 NAS Report at 4–5, finding 10.

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

[169] However, for heavy-duty pickups and vans not covered by today's standards, the agencies determined that use of footprint and work factor as attributes for heavy duty pickup and van GHG and fuel consumption standards could reasonably avoid excessive risk of gaming. See 76 FR 57106, 57161–62 (Sept. 15, 2011).

slopes of the linear relationships underlying today's standards are within the range of technically reasonable analyses of the relationships between fuel consumption and footprint, and the agencies continue to expect that there will not be significant shifts in the distribution of footprints as a direct consequence of this final rule. The agencies also recognize that some attribute-based standards in other countries/regions use attributes other than footprint and that there could be benefits for some 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 fuel economy and related GHG emissions test procedures and standards might be approached in ways that least burden manufacturers while respecting each country's need to meet its own particular challenges.

In the NPRM, the agencies stated that we 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 sought comment on whether the agencies should consider setting standards for the final rule based on another attribute or another combination of attributes. The agencies also specifically requested that the commenters address the concerns raised in the paragraphs above regarding the use of other attributes, and explain how standards should be developed using the other attribute(s) in a way that contributes more to fuel savings and CO_2 reductions than the footprint-based standards, without compromising safety.

The agencies received several comments regarding the attribute(s) upon which post-MY 2016 CAFE and GHG standards should be based. The National Auto Dealers Association (NADA)[170] and the Consumer Federation of America (CFA)[171] expressed support for attribute-based standards, generally, indicating that such standards accommodate consumer preferences, level the playing field between manufacturers, and remove the incentive to push consumers into smaller vehicles. Many commenters, including automobile manufacturers, NGOs, trade associations and parts suppliers (*e.g.,* General Motors,[172] Ford,[173] American Chemistry Council,[174] Alliance of Automobile Manufacturers,[175] International Council on Clean Transportation,[176] Insurance Institute for Highway Safety,[177] Society of the Plastics Industry,[178] Aluminum Association,[179] Motor and Equipment Manufacturers Association,[180] and others) expressed support for the continued use of vehicle footprint as the attribute upon which to base CAFE and CO_2 standards, citing advantages similar to those mentioned by NADA and CFA. Conversely, the Institute for Policy Integrity (IPI) at the New York University School of Law questioned whether non-attribute-based (flat) or an alternative attribute basis would be preferable to footprint-based standards as a means to increase benefits, improve safety, reduce ''gaming,'' and/or equitably distribute compliance obligations.[181] IPI argued that, even under flat standards, credit trading provisions would serve to level the playing field between manufacturers. IPI acknowledged that NHTSA, unlike EPA, is required to promulgate attribute-based standards, and agreed that a footprint-based system could be at much less risk of gaming than a weight-based system. IPI suggested that the agencies consider a range of options, including a fuel-based system, and select the approach that maximizes net benefits.

[170] NADA, Docket No. NHTSA–2010–0131–0261, at 11.

[171] CFA, Docket No. EPA–HQ–OAR–2010–0799–9419 at 810, 44.

[172] GM, Docket No. NHTSA–2010–0131–0236, at 2.

[173] Ford, Docket No. NHTSA–2010–0131–0235, at 8.

[174] ACC, Docket No. EPA–HQ–OAR–2010–0799–9517 at 2.

[175] Alliance, Docket No. NHTSA–2010–0131–0262, at 85.

[176] ICCT, Docket No. NHTSA–2010–0131–0258, at 48.

[177] IIHS, Docket No. NHTSA–2010–0131–0222, at 1.

[178] SPI, Docket No. EPA–HQ–OAR–2010–0799–9492 at 4.

[179] Aluminum Association, Docket No. NHTSA–2010–0131–0226, at 1.

[180] MEMA, Docket No. EPA–HQ–OAR–2010–0799–9478 at 1.

[181] IPI, Docket No. EPA–HQ–OAR–2010–0799–11485 at 13–15.

Ferrari and BMW suggested that the agencies consider weight-based standards, citing the closer correlation between fuel economy and footprint, and BMW further suggested that weight-based standards might facilitate international harmonization (*i.e.,* between U.S. standards and related standards in other countries).[182] Porsche commented that the footprint attribute is not well suited for manufacturers of high performance vehicles with a small footprint.[183]

Regarding the comments from IPI, as IPI appears to acknowledge, EPCA/EISA expressly requires that CAFE standards be attribute-based and defined in terms of mathematical functions. Also, NHTSA has, in fact, considered and reconsidered options other than footprint, over the course of multiple CAFE rulemakings conducted throughout the past decade. When first contemplating attribute-based systems, NHTSA considered attributes such as weight, ''shadow'' (overall area), footprint, power, torque, and towing capacity. NHTSA also considered approaches that would combine two or potentially more than two such attributes. To date, every time NHTSA (more recently, with EPA) has considered options for light-duty vehicles, the agency has concluded that a properly designed footprint-based approach provides the best means of achieving the basic policy goals (*i.e.,* by reducing disparities between manufacturers' compliance burdens, increasing the likelihood of improved fuel economy and reduced GHG emissions across the entire spectrum of footprint targets; and by reducing incentives for manufacturers to respond to standards by reducing vehicle size in ways that could compromise overall highway safety) involved in applying an attribute-based standards, and at the same time structuring footprint-based standards in a way that furthers the energy and environmental policy goals of EPCA and the CAA by not creating inappropriate incentives to increase vehicle size in ways that could increase fuel consumption and GHG emissions. As to IPI's suggestion to use fuel type as an attribute, although neither NHTSA nor EPA have presented quantitative analysis of standards that differentiate between fuel type, such standards would effectively use fuel type to identify different subclasses of vehicles, thus requiring mathematical functions—not addressed by IPI's comments—to

[182] BMW, Docket No. NHTSA–2010–0131–0250, at 3.

[183] Porsche, Docket No. EPA–HQ–OAR–2010–0799–9264.

recombine these fuel types into regulated classes. Insofar as EPCA/EISA already specifies how different fuel types are to be treated for purposes of calculating fuel economy and CAFE levels, and moreover, insofar as the EISA revisions to EPCA removed NHTSA's previously-clear authority to set separate CAFE standards for different classes of light trucks, using fuel type to further differentiate subclasses of vehicles could conflict with the intent, and possibly the letter, of NHTSA's governing statute. Finally, in the agencies' judgment, while regarding IPI's suggestion that the agencies select the attribute-based approach that maximizes net benefits may have merit, net benefits are but one of many considerations which lead to the setting of the standard. Also, such an undertaking would be impracticable at this time, considering that the mathematical forms applied under each attribute-based approach would also need to be specified, and that the agencies lack methods to reliably quantify the relative potential for induced changes in vehicle attributes.

Regarding Ferrari's and BMW's comments, as stated previously, in the agencies' judgment, footprint-based standards (a) discourage vehicle downsizing that might compromise occupant protection, (b) encourage the application of technology, including weight-efficient materials (*e.g.,* high-strength steel, aluminum, magnesium, composites, *etc.*), and (c) are less susceptible than standards based on other attributes to ''gaming'' that could lead to less-than-projected energy and environmental benefits. It is also important to note that there are many differences between both the standards and the on-road light-duty vehicle fleets in Europe and the United States. The stringency of standards, independent of the attribute used, is another factor that influences harmonization. While the agencies agree that international harmonization of test procedures, calculation methods, and/or standards could be a laudable goal, again, harmonization is not simply a function of the attribute upon which the standards are based. Given the differences in the on-road fleet, in fuel composition and availability, in regional consumer preferences for different vehicle characteristics, in other vehicle regulations besides for fuel economy/CO_2 emissions, and in the balance of program goals given all of these factors in the model years affected, among other things, it would not necessarily be expected that the CAFE and GHG emission standards would align with standards of other countries. Thus, the agencies continue to judge vehicle footprint to be a preferable attribute for the same reasons enumerated in the proposal and reiterated above.

Finally, as explained in section III.B.6 and documented in section III.D.6 below, EPA agrees with Porsche that the MY2017 GHG standards, and the GHG standards for the immediately succeeding model years, pose special challenges of feasibility and (especially) lead time for intermediate volume manufacturers, in particular for limited-line manufacturers of smaller footprint, high performance passenger cars. It is for this reason that EPA has provided additional lead time to these manufacturers. NHTSA, however, is providing no such additional lead time. As required under EISA/EPCA, manufacturers continue—as since the 1970s—to have the option of paying civil penalties in lieu of achieving compliance with the standards, and NHTSA is uncertain as to what authority would allow it to promulgate separate standards for different classes of manufacturers, having raised this issue in the proposal and having received no legal analysis with suggestions from Porsche or other commenters.

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

By requiring NHTSA to set CAFE standards that are attribute-based and defined by a mathematical function, NHTSA interprets Congress as intending that 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 attribute chosen and fuel economy.[184] EPA is also setting 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,[185] 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.[186] 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 since the statutes do not dictate a particular mathematical function for curve shape. 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 reduce GHG emissions.[187] 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 reflect legitimate policy judgments, where the agencies adjust the function that would define the relationship in order to achieve environmental goals, reduce petroleum consumption, encourage application of fuel-saving technologies, not adversely affect highway safety, reduce disparities of manufacturers' compliance burdens (increasing the likelihood of improved fuel economy and reduced GHG emissions across the entire spectrum of footprint targets), 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 target curves that define

[184] 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.

[185] *See* 76 FR 74913 *et seq.* (Dec. 1, 2011).

[186] 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.

[187] 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.

the MYs 2017–2025 CAFE and CO_2 standards presented in this final rule, and the technical work supporting selection of the curves defining those standards.

4. What curves are the agencies promulgating for MYs 2017–2025?

The mathematical functions for the MYs 2017–2025 curves are somewhat changed from the functions for the MYs 2012–2016 curves, in response to comments received from stakeholders pre-proposal in order to address technical concerns and policy goals that the agencies judge more significant in this rulemaking than in the prior one, given their respective timeframes, and have retained those same mathematical functions for the final rule as supported by commenters. 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 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 curves to account 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, as in past rules, the agencies added equivalent levels of technology to the baseline fleet as a starting point for the curve analysis. The agencies continue to believe that this is a valid method to adjust for technology differences between actual vehicle models in the MY 2008 and MY 2010 fleets. The statistical method for fitting that curve, however, was revisited by the agencies in this rule. For the NPRM, the agencies chose to fit the proposed standard 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 represented 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. In preparing for analysis supporting today's final rule, the agencies updated analytical inputs, including by developing two market forecasts (as discussed above in Section II.B of the preamble and in Chapter 1 of the joint TSD). Using all of this information, the agencies repeated the curve fitting analysis, once for each market forecast. The agencies obtained results that were broadly similar, albeit not identical, to those supporting the NPRM. Results obtained for the NPRM and for today's final rule span similar regions in footprint—fuel economy space, areas within which it would be technically reasonable to select specific linear relationships upon which to base new attribute-based standards. The agencies thus believe it is reasonable to finalize the curves as proposed. This updated analysis is presented in Chapter 2 of the joint TSD.

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 between when the MYs 2012–2016 final rule was issued and when the MYs 2017–2025 NPRM was issued, NHTSA and EPA 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 production of 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.[188] 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 improvements without compromising load carrying and towing capacity. The related issue of the stringency of the CAFE and GHG standards for light trucks is discussed in sections and III.D and IV.F of the preamble to this final rule.

In developing the curve shapes for the 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 continued to believe that the methodology for fitting curves for the MYs 2012–2016 standards was technically sound, we recognized manufacturers' concerns regarding their abilities to comply with a similarly shallow curve after MY 2016 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 the economic losses that could be incurred if curve shapes unduly discourage market shifts—including vehicle upsizing—that have vehicle buyers value. In addition, the agencies sought to improve the balance of compliance burdens among manufacturers, and thereby increase the likelihood of improved fuel economy and reduced GHG emissions across the entire spectrum of footprint targets. 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, potentially compromising highway safety.
- Flatter standards potentially impact the utility of vehicles by providing an incentive for vehicle downsizing.
- Steeper footprint-based standards may create incentives to upsize

[188] See footnote 186

vehicles, thus increasing the possibility 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 level, flatter standards tend to place greater compliance burdens on full-line manufacturers.
- Given the same industry-wide average required fuel economy or CO_2 level, 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 could compromise overall 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 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 weighing and consideration. Ultimately, the agencies did not agree that the MY 2017 target curves for the proposal, on a relative basis, should be made significantly flatter than the MY 2016 curve,[189] as we believed 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 recognized full-line OEM concerns and tentatively concluded that further increases in the stringency of the light truck standards would be more feasible if the light truck curve was made steeper than the MY 2016 truck curve and the right (large footprint) cut-point was extended over time to larger footprints. This conclusion was supported by the agencies' technical analyses of regulatory alternatives defined using the curves developed in the manner described below.

The Alliance, GM, and the UAW commented in support of the reasonableness of the agencies' proposals regarding the shape and slope of the curves and how they were developed, although the Alliance stated that the weighting and regression analysis used to develop the curves for MYs 2022–2025 should be reviewed during the mid-term evaluation process.

Other commenters objected to specific aspects of the agencies' approach to developing the curves. ACEEE provided extensive comments, arguing generally that agencies appeared to be proposing curve choices in response to subjective policy concerns (namely, protecting large trucks) rather than on a sound technical basis.[190] ACEEE recommended that the agencies choose ''the most robust technical approach,'' and then make policy-driven adjustments to the curves for a limited time as necessary, and explain the curves in those terms, revisiting this issue for the final rule.[191]

The agencies reaffirm the reasonable technical and policy basis for selecting the truck curve. Three primary drivers form this technical basis: (a) The largest trucks have unique equipment and design, as described in the Ford comment referenced below in section II.C.4.f; (b) the agencies agree with those large truck manufacturers who indicated in discussions prior to the proposal that they believed that the light truck standard should be somewhat steeper after MY 2016, primarily because, after more than ten recent years of progressive increases in the stringency of applicable CAFE standards (after nearly ten years during which Congress did not allow NHTSA to increase light truck CAFE standards), manufacturers of large pickups would have limited options to comply with more stringent standards without resorting to compromising large truck load carrying and towing capacity; and (c) given the relatively few platforms which comprise the majority of the sales at the largest truck footprints, the agencies were concerned about requiring levels of average light truck performance that might lead to overly aggressive technology penetration rates in this important segment of the work fleet. Specifically, the agencies were concerned at proposal, and remain concerned about issues of lead time and cost with regard to manufacturers of these work vehicles. As noted later in this chapter, while the largest trucks are a small segment of the overall truck fleet, and an even smaller segment of the overall fleet, [192] these changes to the truck slope have been made in order to provide a clearer path toward compliance for manufacturers of these vehicles, and reduce the potential that new standards would lead these manufacturers to choose to downpower, modify the structure, or otherwise reduce the utility of these work vehicles.

As discussed in the NPRM and in Chapter 2 of the TSD, as well as in section III.D and IV.E below, we considered all of the utilized methods of normalizing (including not normalizing) fuel economy levels and the different methods for fitting functional forms to the footprint and fuel economy and CO_2 levels, to be technically reasonable options. We indicated that, within the range spanned by these technically reasonable options, the selection of curves for purposes of specifying standards involves consideration of technical concerns and policy implications. Having considered the above comments on the estimation and selection of curves, we have not changed our judgment about the process—that is, that the agencies can make of policy-informed selection within the range spanned by technically reasonable quantitative methods. We disagree with ACEEE's portrayal of this involving the ''protection'' of large trucks. We have selected a light truck slope that addresses real engineering aspects of large light trucks and real fleet aspects of the manufacturers producing these trucks, and sought to avoid creating an incentive for such manufacturers to reduce the hauling and towing capacity of these vehicles, an undesirable loss of utility. Such concerns are applicable much more directly to light trucks than to passenger cars. The resulting curves are well within the range of curves we have estimated. The steeper slope at the right hand of the truck curve recognizes the physical differences in these larger vehicles [193] and the fleet differences in

[189] While ''significantly'' flatter is subjective, the year over year change in curve shapes is discussed in greater detail in Section II.C.6.a and Chapter 2 of the joint TSD.

[190] ACEEE comments, Docket No. EPA–HQ–OAR–2010–0799–9528 at 6.

[191] *Id.*

[192] The agencies' market forecast used at proposal 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, In the MY2010 based market forecast, there are 14 vehicle configurations with a total volume of 130,000 vehicles or less during any MY in the 2017–2025 time frame. This is a similarly small portion of the overall number of vehicle models or vehicle sales.

[193] As Ford Motor Company detailed, in its public comments, ''towing capability generally requires increased aerodynamic drag caused by a modified frontal area, increased rolling resistance, and a heavier frame and suspension to support this additional capability.'' Ford further noted that these vehicles further require auxiliary transmission oil coolers, upgraded radiators, trailer hitch connectors

Continued

manufacturers that produce them. Further, we disagree with ACEEE's suggestion that the agencies should commit to a particular method for selecting curves; as the approaches we have considered demonstrate that the range of technically reasonable curve fitting methods spans a wide range, indicating uncertainty that could make it unwise to ''lock in'' a particular method for all future rulemakings. The agencies plan on observing fleet trends in the future to see if there are any unexpected shifts in the distribution of technology and utility within the footprint range for both cars and trucks.

We note that comments by CBD, ACEEE, NACAA, and an individual, Yegor Tarazevich, referenced a 2011 study by Whitefoot and Skerlos, ''Design incentives to increase vehicle size created from the U.S. footprint-based fuel economy standards.'' [194] This study concluded that MY 2014 standards, as proposed, ''create an incentive to increase vehicle size except when consumer preference for vehicle size is near its lower bound and preference for acceleration is near its upper bound.'' [195] The commenters who cited this study generally did so as part of arguments in favor of flatter standards (*i.e.,* curves that are flatter across the range of footprints) for MYs 2017–2025. While the agencies consider the concept of the Whitefoot and Skerlos analysis to have some potential merits, it is also important to note that, among other things, the authors assumed different inputs than the agencies actually used in the MYs 2012–2016 rule regarding the baseline fleet, the cost and efficacy of potential future technologies, and the relationship between vehicle footprint and fuel economy.

Were the agencies to use the Whitefoot and Skerlos methodology (*e.g.,* methods to simulate manufacturers' potential decisions to increase vehicle footprint) with the actual inputs to the MYs 2012–2016 rules, the agencies would likely obtain different findings. Underlining the potential uncertainty, the authors obtained a wide range of results in their analyses. Insofar as Whitefoot and Skerlos found, for some scenarios, that manufacturers might respond to footprint-based standards by deliberately increasing vehicle footprint, these findings are attributable to a combination of (a) the assumed baseline market characteristics, (b) the assumed cost and fuel economy impacts involved in increasing vehicle footprint, (c) the footprint-based fuel economy targets, and (d) the assumed consumer preference for vehicle size. Changes in any of these assumptions could yield different analytic results, and potentially result in different technical implications for agency action. As the authors note when interpreting their results: ''Designing footprint-based fuel-economy standards in practice such that manufacturers have no incentive to adjust the size of their vehicles appears elusive at best and impossible at worst.''

Regarding the cost impacts of footprint increases, that authors make an *ad hoc* assumption that changes in footprint would incur costs linearly, such that a 1% change in footprint would entail a 1% increase in production costs. The authors refer to this as a conservative assumption, but present no supporting evidence. The agencies have not attempted to estimate the engineering cost to increase vehicle footprint, but we expect that it would be considerably nonlinear, with costs increasing rapidly once increases available through small incremental changes—most likely in track width—have been exhausted. Moreover, we expect that were a manufacturer to deliberately increase footprint in order to ease compliance burdens, it would confine any significant changes to coincide with vehicle redesigns, and engaging in multiyear planning, would consider how the shifts would impact compliance burdens and consumer desirability in ensuing model years. With respect to the standards promulgated today, the standards become flatter over time, thereby diminishing any ''reward'' for deliberately increasing footprint beyond normal market expectations.

Regarding the fuel economy impacts of footprint increases, the authors present a regression analysis based on which increases in footprint are estimated to entail increases in weight which are, in turn, estimated to entail increases in fuel consumption. However, this relationship was not the relationship the agencies used to develop the MY 2014 standards the authors examine in that study. Where the target function's slope is similar to that of the tendency for fuel consumption to increase with footprint, fuel economy should tend to decrease approximately in parallel with the fuel economy target, thereby obviating the ''benefit'' of deliberate increases in vehicle footprint. The agencies' analysis supporting today's final rule indicates relatively wide ranges wherein the relationship between fuel consumption and footprint may reasonably be specified.

As part of the mid-term evaluation and future NHTSA rulemaking, the agencies plan to further investigate methods to estimate the potential that standards might tend to induce changes in the footprint. The agencies will also continue to closely monitor trends in footprint (and technology penetration) as manufacturers come into compliance with increasing levels of the footprint standards.

b. What methodologies and data did the agencies consider in developing the MYs 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 proposed standard developed by a given combination of these statistical methods was 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. As discussed below, for today's final rule, the agencies used updated information to repeat these analyses, found that results were generally similar and spanned a similarly wide range, and found that the curves underlying the

and wiring harness equipment, different steering ratios, upgraded rear bumpers and different springs for heavier tongue load (for upgraded towing packages), body-on-frame (vs. unibody) construction (also known as ladder frame construction) to support this capability and an aggressive duty cycle, and lower axle ratios for better pulling power/capability.

[194] *Available at* Docket No. EPA–HQ–OAR–2010–0799.

[195] page 410.

proposed standards were well within this range.

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 the proposal (*i.e.,* the baseline fleet), with vehicles' fuel economy levels and technological characteristics at MY 2008 levels.[196] For today's final rule, the agencies made minor corrections to this market forecast, and also developed a MY 2010-based market forecast. The development, scope, and content of these market forecasts are discussed in detail in Chapter 1 of the joint Technical Support Document supporting the 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.[197] 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 support policy outcomes the agencies judged to be more desirable.

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, ISGs, strong HEVs, PHEVs, EVs, and FCVs. The agencies included 15 percent mass reduction on all vehicles.[198]

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 most multi-attribute standards to be more subject to gaming than a footprint-only standard.[199,200] 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 promulgating a multi-attribute standard; the proposed fuel economy and CO_2 targets for each vehicle are still functions of footprint alone. No adjustment will be used in the compliance process.

For the proposal, 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' MY 2008-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 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. While the agencies considered this technique for purposes of fitting curves, the agencies are not promulgating a multi-attribute standard, as the proposed fuel economy and CO_2 targets for each vehicle are still functions of footprint alone. No adjustment will be used in the compliance process.

For today's final rule, the agencies repeated the above analyses, using the corrected MY 2008-based market forecast and, separately, the MY 2010-based market forecasts. As discussed in section 2.6 of the joint TSD and further detailed in a memorandum available at Docket No. NHTSA–2010–0131–0325, doing so produced results similar to the analysis used in the proposal.

The agencies sought comment on the appropriateness of the adjustments 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

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

[197] 68 FR 74920–74926.

[198] As described in the preceding paragraph, applying technology in this manner helps to reduce the effect of technology differences across the vehicle fleet. The particular technologies used for the normalization were chosen as a reasonable selection of technologies which could potentially be used by manufacturers over this time period.

[199] 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 be 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.)

[200] 74 FR 14359.

and reduce CO_2 emissions. The agencies also sought comment regarding whether these adjustments effectively ''lock in'' through MY 2025 relationships that were observed in MY 2008.

ACEEE objected to the agencies' adjustments to the truck curves, arguing that if the truck slope needs to be adjusted for ''density,'' then that suggests that the MY 2008-based market forecast used to build up the reference fleet must be ''incorrect and show * * * unrealistically low pickup truck fuel consumption, due to the overstatement of the benefits of certain technologies.''[201] ACEEE stated that ''If that is the case, the agencies should revisit the adjustments made to generate the reference fleet and remove technologies from pickups that are not suited to those trucks,'' which ''would be a far more satisfactory approach than the speculative and non-quantitative approach of adjusting for vehicle density.''[202]

ACEEE further stated that ''the fuel consumption trend that the density adjustment is meant to correct appears in the unadjusted fleet as well as the technology-adjusted fleet of light trucks (TSD Figures 2–1 and 2–2),'' which they argued is evidence that ''the flattening of fuel consumption at higher footprints is not a byproduct of unrealistic technology adjustments, but rather a reflection of actual fuel economy trends in today's market.''[203] ACEEE stated that therefore it did not make sense to adjust the fuel consumption of ''low-density'' trucks upwards before fitting the curve.[204] ACEEE pointed out that it would appear that trucks' HP-to-weight ratio should be higher than the agencies' analysis indicated, and stated that the weight-based EU CO_2 standard curves are adjusted for HP-to-weight, which resulted in flatter curves, and which are intended to avoid incentivizing up-weighting.[205] ACEEE argued that by not choosing this approach and by adjusting for density, along with using sales-weighting and an OLS method instead of MAD, the proposed curves encourage vehicle upsizing.[206]

Thus, ACEEE stated, the deviations from the analytical approach previously adopted were not justified with data provided in the NPRM, and the resulting ''*ad hoc* adjustments'' to the curve-fitting process detracted from the agencies' argument for the proposals.

[201] ACEEE comments, Docket No. EPA–HQ–OAR–2010–0799–9528 at 3–4.

[202] *Id.*

[203] *Id.*

[204] *Id.*

[205] *Id.*

[206] *Id.*

ACEEE further commented that increasing the slope of the truck curve would be ''counter-productive'' from a policy perspective as well, implying that challenging light truck standards have helped manufacturers of light trucks to recover from the recent downturn in the light vehicle market.[207] The Sierra Club and CBD also opposed increasing the slope of the truck curve for MYs 2017 and beyond as compared to the MY 2016 truck curve, on the basis that it would encourage upsizing and reduce fuel economy and CO_2 emissions improvements.[208]

Conversely, the UAW strongly supported the agencies' balancing of ''the challenges of adding fuel-economy improving technologies to the largest light trucks with the need to maintain the full functionality of these vehicles across a wide range of applications''[209] through their approach to curve fitting. The Alliance also expressed support for the agencies' analyses (including the consideration of different weightings), and the selected relationships between the fuel consumption and footprint for MYs 2017–2021.[210] Both ACEEE and the Alliance urged the agencies to revisit the estimation and selection of curves during the mid-term evaluation, and the agencies plan to do so.

In response, the agencies maintain that the adjustments (including no adjustments) considered in the NPRM are all reasonable to apply for purposes of developing potential fuel economy and GHG target curves, and that it is left to policy makers to determine an appropriate perspective involved in selecting weights (if any) to be applied, and to interpret the consequences of various alternatives. As described above and in Chapter 2 of the TSD, the agencies believe that the adjustments made to the truck curve are appropriate because work trucks provide utility (towing and load-carrying capability) that requires more torque and power, more cooling and braking capability, and more fuel-carrying capability (*i.e.,* larger fuel tanks) than would be the case for other vehicles of similar size and curb weight. Continuing the 2016 truck curve would disadvantage full-line manufacturers active in this portion of the fleet disproportionately to the rest of the trucks. The agencies do not include power to weight, density, towing, or hauling, as a technology. Neither does the agency consider them as part of a multi-attribute standard. Considering these factors, the agencies believe that the ''density'' adjustment, as applied to the data developed for the NPRM, provided a reasonable basis to develop curves for light trucks. Having repeated our analysis using a corrected MY 2008-based market forecast and, separately, a new MY 2010-based market forecast, we obtained results spanning ranges similar to those covered by the analysis we performed for the NPRM. See section 2.6 of the Joint TSD. In the agencies' judgment, considering the above comments (and others), the curves proposed in the NPRM strike a sound balance between the legitimate policy considerations discussed in section II.C. 2—the interest in discouraging manufacturers from responding to standards by reducing vehicle size in ways that might compromise highway safety, the interest in more equitably balancing compliance burdens among limited- and full-line manufacturers, and the interest in avoiding excessive risk that projected energy and environmental benefits might be less than expected due to regulation-incented increases in vehicle size.

[207] *Id.* at 6

[208] Sierra Club *et al.* comments, Docket No. EPA–HQ–OAR–2010–0799–9549 at 6.

[209] UAW comments, Docket No. EPA–HQ–OAR–2010–0799–9563, at 2.

[210] Alliance comments, Docket No. EPA–HQ–OAR–2010–0799–9487, at 86.

Regarding ACEEE's specific comments about the application of these adjustments to the light truck fleet, we disagree with the characterization of the adjustments as *ad hoc.* Choosing from among a range of legitimate possibilities based on relevant policy and technical considerations is not an arbitrary, *ad hoc* exercise. Throughout multiple rulemaking analyses, NHTSA (more recently, with EPA) has applied normalization to adjust for differences in technologies. Also, while the agencies have previously considered and declined to apply normalizations to reflect differences in other characteristics, such as power, our judgment that some such normalizations could be among the set of technically reasonable approaches was not *ad hoc,* but in fact based on further technical analysis and reconsideration. Moreover, that reconsideration occurred with respect to passenger cars as well as light trucks. Still, we recognize that results of the different methods we have examined depend on inputs that are subject to uncertainty; for example, normalization to adjust for differences in technology depend on uncertain estimates of technology efficacy, and sales-weighted regressions depend on uncertain forecasts of future market volumes. Such uncertainties support the agencies' strong preference to avoid permanently ''locking in'' any particular curve estimation technique.

e. What statistical methods did the agencies evaluate?

For the NPRM, 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. Beginning with the corrected MY 2008-based market forecast and the MY 2010-based market forecast developed for today's final rule, the above approaches resulted in six data sets—three for each of the two market forecasts.

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.[211] 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 used OLS in early development of attribute-based CAFE 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[212] and because the MAD approach helped achieve the agencies' policy goals with regard to curve slope in those rulemakings.[213] In the interest of taking a fresh look at appropriate regression methodologies as promised in the 2012–2016 light duty rulemaking, in developing this rule, 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 sought comment on the use of robust regression techniques under such circumstances. ACEEE stated that either MAD (*i.e.,* one robust regression technique) or OLS was ''technically sound,''[214] and other stakeholders that commented on the agencies' analysis supporting the selection of curves did not comment specifically on robust regression techniques. On the other hand, ACEEE did suggest that the application of multiple layers of normalization may provide tenuous results. For this rulemaking, we consider the range of methods we have examined to be technically reasonable, and our selected curves fall within those ranges. However, all else being equal, we agree that simpler or more stable methods are likely preferable to more complex or unstable methods, and as mentioned above, we agree with ACEEE and the Alliance that revisiting the selection of curves would be appropriate as part of the required future NHTSA rulemaking and mid-term evaluation.

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 differed by less than 10,000 in the MY 2021 market forecast (in the MY 2008-based forecast), 62 F–150s models and 38 Silverado models were reported in the agencies baselines. Without sales-weighting, the F–150 models, because there are more of them, were 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 MYs 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 MY 2008-based 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' MY 2008-based 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.[215] The MY 2010-based market forecast includes similar examples of extreme disparities in production volumes, and therefore, degree of influence over sales-

[211] *See* 75 FR 25359.

[212] *Id.* at 25362–63.

[213] *Id.* at 25363.

[214] ACEEE comments, Docket No. EPA–HQ–OAR–2010–0799–9528 at 4.

[215] 75 FR 25362 and n. 64.

weighted regression results. Moreover, unlike unweighted approaches, sales-weighted approaches are subject to more uncertainties surrounding sales volumes. For example, in the MY 2008-based market forecast, Chrysler's production volumes are projected to decline significantly through MY 2025, in stark contrast to the prediction for that company in the MY 2010-based market forecast. Therefore, under a sales-weighted approach, Chrysler's vehicle models have considerably less influence on regression results for the MY 2008-based fleet than for the MY 2010-based fleet.

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.'' [216] 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. To expand on this point, low volume cars in the agencies' MY 2008 and 2010 baseline include specialty vehicles such as the Bugatti Veyron, Rolls Royce Phantom, and General Motors Funeral Coach Hearse. These vehicle models all represent specific engineering designs, and in a regression without sales weighting, they are given equal weighting to other vehicles with single models with more relevance to the typical vehicle buyer including mass market sedans like the Toyota Prius referenced above. Similar disparities exist on the truck side, where small manufacturers such as Roush manufacturer numerous low sale vehicle models that also represent specific engineering designs. Given that the curve fit is ultimately used in compliance, and compliance is based on sales-weighted average performance, although the agencies are not currently attempting to estimate consumer responses to today's standards, sales weighting could be a reasonable approach to fitting curves.

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

[216] 75 FR 25632/3.

iii. Analyses Performed

For the NPRM, 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.D and IV.G below) as well as our discussions with large number of automotive companies and suppliers. Supporting today's final rule, we repeated all of this analysis twice—once for the corrected MY 2008-based market forecast, and once for the MY 2010-based market forecast. Doing so produced results generally similar to those documented in the joint TSD supporting the NPRM. See section 2.6 of the joint TSD and the docket memo.

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 sought comments on the application of the weights as described above, and the implications for interpreting the relationship between fuel efficiency (or CO_2) and footprint. As discussed above, ACEEE questioned adjustment of the light truck data. The Alliance, in contrast, generally supported the weightings applied by the agencies, and the resultant relationships between fuel efficiency and footprint. Both ACEEE and the Alliance commented that the agencies should revisit the application of weights—and broader aspects of analysis to develop mathematical functions—in the future. We note that although ACEEE expressed concern regarding the outcomes of the application of the weight/footprint adjustment, ACEEE did not indicate that all adjustment would be problematic, rather, they endorsed the method of adjusting fuel economy data based on differences in vehicle models' levels of applied technology. As we have indicated above, considering the policy implications, the agencies have selected curves that fall within the range spanned by the many methods we have evaluated and consider to be technically reasonable. We disagree with ACEEE that we have selected curves that are, for light trucks, too steep. However, recognizing uncertainties in the estimates underlying our analytical results, and recognizing that our analytical results span a range of technically reasonable outcomes, we agree with ACEEE and the Alliance that revisiting the curve shape would be appropriate as part of the required future NHTSA rulemaking and planned mid-term evaluation.

f. What results did the agencies obtain and why were the selected curves reasonable?

For both the NPRM and today's final rule, 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 rule on those obtained by NHTSA. Chapter 2 of the joint TSD contains a large set of illustrative 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.

For the curves presented in the NPRM and finalized today, the choice among the alternatives presented in Chapter 2 of the draft Joint TSD was to use the OLS formulation, on sales-weighted data developed for the NPRM (with some errors not then known to the agencies), 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 represented a technically reasonable approach for purposes of developing target curves to define the proposed standards, and that it represented 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 have provided 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' 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 helped 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 the proposed rule likely outweigh the potential that resultant curves might somehow encourage reduced load carrying capability or vehicle performance (note that 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 agreed 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 MY 2008-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 have adjusted the slope of the curve defining fuel economy and CO_2 targets.

Several comments were submitted subsequent to the NPRM with regard to the non-homogenous nature of the truck fleet, and the ''unique'' attributes of pickup trucks. As noted above, Ford described the attributes of these vehicles, noting that ''towing capability generally requires increased aerodynamic drag caused by a modified frontal area, increased rolling resistance, and a heavier frame and suspension to support this additional capability.'' [217] Ford further noted that these vehicles further require auxiliary transmission oil coolers, upgraded radiators, trailer hitch connectors and wiring harness equipment, different steering ratios, upgraded rear bumpers and different springs for heavier tongue load (for upgraded towing packages), body-on-frame (vs. unibody) construction (also known as ladder frame construction) to support this capability and an aggressive duty cycle, and lower axle ratios for better pulling power/capability. ACEEE, as discussed above, objected to the adjustments to the truck curves.

In the agencies' judgment, the curves and cutpoints defining the light truck standards appropriately account for engineering differences between different types of vehicles. For example, the agencies' estimates of the applicability, cost, and effectiveness of different fuel-saving technologies differentiate between small, medium, and large light trucks. While we acknowledge that uncertainties regarding technology efficacy affect the outcome of methods including normalization to account for differences in technology, the other normalizations we have considered are not intended to somehow compensate for this uncertainty, but rather to reflect other analytical concepts that could be technically reasonable for purposes of estimating relationships between footprint and fuel economy. Furthermore, we agree with Ford that pickup trucks have distinct attributes that warrant consideration of slopes other than the flattest within the range spanned by technically reasonable options. We also note that, as documented in the joint TSD, even without normalizing light truck fuel economy values for *any* differences (even technology), unweighted MAD and OLS yielded slopes close to or steeper than those underlying today's light truck standards. We will revisit the estimation and selection of these curves as part of NHTSA's future rulemaking and the mid-term evaluation.

As described above, however, other approaches are also technically reasonable, and also represent a way of expressing the underlying relationships. The agencies revisited the analysis for the final rule, having corrected the underlying 2008-based market forecast, having developed a MY 2010-based market forecast, having updated estimates of technology effectiveness, and having considered relevant public comments. In addition, the agencies updated the technology cost estimates, which altered the NPRM analysis results, but not the balance of the trade-offs being weighed to determine the final curves.

As discussed above, based in part on the Whitefoot/Skerlos paper and its findings regarding the implied potential for vehicle upsizing, some commenters, such as NACAA and Center for Biological Diversity, considered the slopes for both the car and truck curves to be too steep, and ACEEE, Sierra Club, Volkswagen, Toyota, and Honda more specifically commented that the truck slope was too steep. On the other hand, the UAW, Ford, GM, and Chrysler supported the slope of both the car and truck curves. ICCT commented, as they have in prior rulemakings, that the car and the truck curve should be identical, and UCS commented that the curves should be adjusted to minimize the ''gap'' in target stringency in the 45 ft^2 (+/− 3 ft^2) range to avoid giving manufacturers an incentive to classify CUVs as trucks rather than as cars.[218]

As also discussed above, the agencies continue to believe that the slopes for both the car and the truck curves finalized in this rulemaking remain appropriate. There is also good reason for the slopes of the car and truck curves potentially to be distinct from one another—for one, our analysis produces different results for these fleets based on their different characteristics, and more importantly for NHTSA, EPCA/EISA requires that standards for passenger cars and light trucks be established separately. The agencies agree with Ford (and others) that the properties of cars and trucks are different. The agencies agree with Ford's observation (and illustration) that ''* * * cars and trucks have different functional characteristics, even if they have the same footprint and nearly the same base curb weights. For example, the Ford Edge and the Ford Taurus have the same footprint, but vastly different capabilities with respect to cargo space and towing capacity. Some of the key features incorporated on the Edge that enable the larger tow capability include an engine oil cooler, larger radiator and updated cooling fans. This is just one of the many examples that show the functional difference between cars and trucks * * *'' [219] On balance, given the agencies' analysis, and all of the issues the agencies have taken into account, we believe that the slopes of cars and trucks have been

[217] Ford comments, Docket No. EPA–HQ–OAR–2010–0799–9463 at 5–6.

[218] UCS comments, Docket No. EPA–HQ–OAR–2010–0799–9567 at 9.

[219] Ford comment, Docket No. EPA–HQ–OAR–2010–0799–9463 at 5.

selected with proper consideration and represent a reasonable and appropriate balance of technical and policy factors.

g. Implications of the slope compared to MY 2016

The slope has several implications relative to the MY 2016 curves, with the majority of changes on the truck curve. For the NPRM, the agencies selected a car curve slope similar to that finalized in the MYs 2012–2016 final rulemaking (4.7 g/mile-ft^2 in MY 2016, vs. 4.5 g/mile-ft^2 proposed in MY 2017). By contrast, the selected truck curve is steeper in MY 2017 than in MY 2016 (4.0 g/mile-ft^2 in MY 2016 vs. 4.9 g/mile-ft^2 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.

5. Once the agencies determined the slope, 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 rule, 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 Passenger Car Curve

The passenger car fleet upon which the agencies based the target curves proposed for MYs 2017–2025 was 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 again proposed to cut off the sloped portion of the passenger car function at 41 square feet, consistent with the MYs 2012–2016 rulemaking. The agencies recognized 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 rule, 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. The MY 2010 fleet was similar, with three BMW models, the Maybach 57S, the Rolls Royce Ghost, and four versions of the Rolls Royce Phantom in this size range. As in the MYs 2012–2016 rulemaking, NHTSA and EPA therefore proposed 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 thus proposed to again ''cut off'' the passenger car curve at 41 square feet, notwithstanding these comments.

The agencies sought comment on setting cutpoints for the MYs 2017–2025 passenger car curves at 41 square feet and 56 square feet. IIHS expressed some concern regarding the ''breakpoint'' of the fuel economy curve at the lower extreme where footprint is the smallest–that is, the leveling-off point on the fuel economy curve where the fuel economy requirement ceases to increase as footprint decreases.[220] IIHS stated that moving this breakpoint farther to the left so that even smaller vehicles have increasing fuel economy targets would reduce the chance that manufacturers would downsize the lightest vehicles for further fuel economy credits.[221]

The agencies agree with IIHS that moving the 41 square foot cutpoint to an even smaller value would additionally discourage downsizing of the smallest vehicles—that is, the vehicles for which downsizing would be most likely to compromise occupant protection. However, in the agencies' judgment, notwithstanding narrow market niches for some types vehicles (exemplified by, *e.g.,* the Smart Fortwo), consumer preferences are likely to remain such that manufacturers will be unlikely to deliberately respond to today's standards by downsizing the smallest vehicles. However, the agencies will monitor developments in the passenger car market and revisit this issue as part of NHTSA's future rulemaking to establish final MYs 2022–2025

[220] IIHS comments, Docket No. NHTSA–2010–0131–0222, at 1.

[221] *Id.*

standards and the concurrent mid-term evaluation process.

b. Cutpoints for Light Truck Curve

The light truck fleet upon which the agencies based the proposed target curves for MYs 2017–2025, like the passenger car fleet, was 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 proposed to cut off the sloped portion of the light truck function at the same footprint, 41 square feet, although we recognized 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 the proposal of the MY 2017–2025 standards that the location of the cutpoint in the MYs 2012–2016 rules, 66 square feet, resulted in challenging targets for the largest light trucks in the later years of that rulemaking. See 76 FR 74864–65. 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 was legitimate basis for these comments. The agencies' MY 2008-based market forecast supporting the NPRM included 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 a 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 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 supported the gradual extension of the cutpoint for large light trucks in the proposal from 66 square feet in MY 2016 out to a larger footprint square feet before MY 2025.

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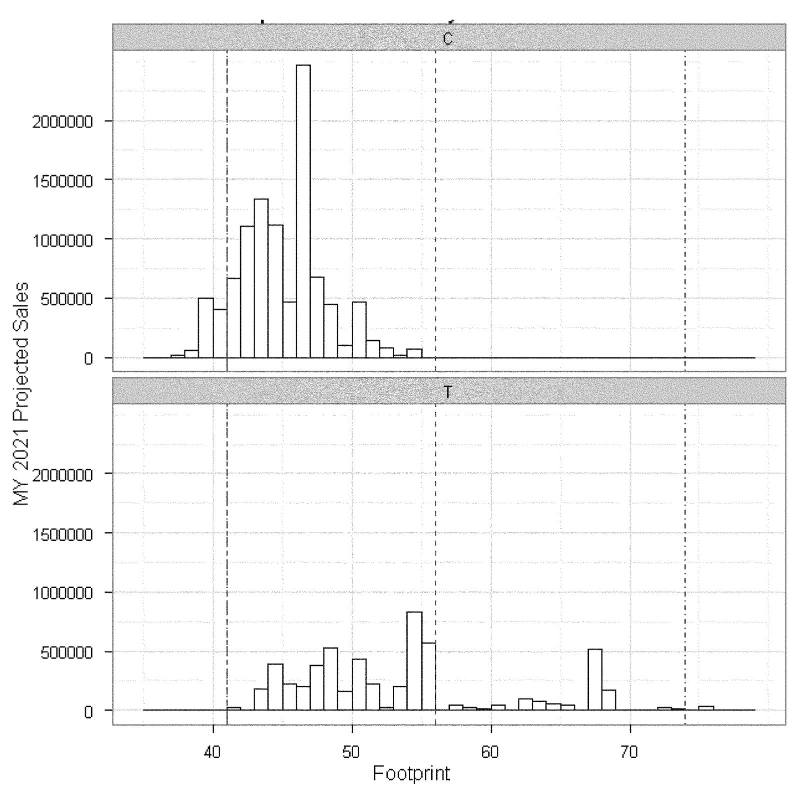
Figure II-1 Footprint Distribution by Car and Truck (NPRM Analysis)*



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

The agencies proposed 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 reasonable 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 proposed 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.'' [222] 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 were no curve crossing issues in the proposed (or final) standards.

The agencies received some comments on the selection of these cutpoints. ACEEE commented that the extension of the light truck cutpoint upward from 66 square feet to 74 square feet. would reduce stringency for large trucks even though there is no safety-related reason to discourage downsizing of these trucks.[223] Sierra Club [224] and Volkswagen commented that moving this cutpoint could encourage trucks to get larger and may be detrimental to societal fatalities, and the Sierra Club suggested that the agencies could mitigate this risk by providing an alternate emissions target for light trucks of 60 square feet or more that exceed the sales projected in the rule in the year that sales exceed the projection.[225] ACEEE similarly suggested that the agencies include a provision to fix the upper bound for the light truck targets at the 66 square foot target once sales of trucks larger than that in a given year reach the level of MY 2008 sales, to discourage upsizing.[226] Global Automakers commented that the cutpoint for the smallest light trucks should be set at approximately ten percent of sales (as for passenger cars) rather than at 41 square feet.[227] Conversely, IIHS commented that, for both passenger cars and light trucks, the 41 square foot cutpoint should be moved further to the left (*i.e.,* to even smaller footprints), to reduce the incentive for manufacturers to downsize the lightest vehicles.[228]

The agencies have considered these comments regarding the cutpoint applied to the high footprint end of the target function for light trucks, and we judge there to be minimal risk that manufacturers would respond to this upward extension of the cutpoint by deliberately increasing the size of light trucks that are already at the upper end of marketable vehicle sizes. Such vehicles have distinct size, maneuverability, fuel consumption, storage, and other characteristics as opposed to the currently more popular vehicles between 43 and 48 square feet, and are likely not suited for all consumers in all usage scenarios. Further, larger vehicles typically also have additional production costs that make it unlikely that these vehicles will become the predominant vehicles in the fleet. Therefore, we remain concerned that not to extend this cutpoint to 74 square feet would fail to take into adequate consideration the challenges to improving fuel economy and CO_2 emissions to the levels required by this final rule for vehicles with footprints larger than 66 square feet, given their increased utility. As noted above, because CAFE and GHG standards are based on average performance, manufacturers need not ensure that every vehicle model meets its CAFE and GHG targets. Still, the agencies are concerned that standards with stringent targets for large trucks would unduly burden full-line manufacturers active in the market for full-size pickups and other large light trucks, as discussed earlier, and evidenced by the agencies' estimates of differences between compliance burdens faced by OEMs active and not active in the market for full-size pickups. While some manufacturers have recently indicated [229] that buyers are currently willing to pay a premium for fuel economy improvements, the agencies are concerned that disparities in long-term regulatory requirements could lead to future market distortions undermining the economic practicability of the standards. Absent an upward extension of the cutpoint, such disparities would be even greater. For these reasons, the agencies do not expect that gradually extending the cutpoint to 74 square feet will create incentives to upsize large trucks and, thus, believe there will be no adverse effects on societal safety. Therefore, we are promulgating standards that, as proposed, gradually extend the cutpoint to 74 square feet We have also considered the above comments by Global Automakers and IIHS on the cutpoints for the smallest passenger cars and light trucks. In our judgment, placing these cutpoints at 41 square feet continues to strike an appropriate balance between (a) not discouraging manufacturers from introducing new small vehicle models in the U.S. and (b) not encouraging manufacturers to downsize small vehicles.

We have considered the Sierra Club and ACEEE suggestion that the agencies provide an alternate emissions target for light trucks larger than 60 square feet (Sierra Club) or 66 square feet (ACEEE) that exceed the sales projected in the rule in the year that sales exceed the projection. Doing so would effectively introduce sales volume as a second ''attribute''; in our judgment, this would introduce additional uncertainty regarding outcomes under the standards, and would not clearly be within the scope of notice provided by the NPRM.

6. 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 affected both the shape of the curve, and the location of the curve, that helped the agencies determine curves that defined 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

[222] 74 FR 14370 (Mar. 30, 2009).

[223] ACEEE, Docket No. EPA–HQ–OAR–2010–0799–9528 at 4–5.

[224] Sierra Club *et al.,* Docket No. EPA–HQ–OAR–2010–0799–9549 at 6.

[225] Sierra Club *et al.,* Docket No. EPA–HQ–OAR–2010–0799–9549 at 6.

[226] ACEEE, Docket No. EPA–HQ–OAR–2010–0799–9528 at 7.

[227] Global Automakers, Docket No. NHTSA–2010–0131–0237, at 4.

[228] IIHS, Docket No. NHTSA–2010–0131–0222, at 1.

[229] For example, in its June 11, 2012 edition, *Automotive News* quoted a Ford sales official saying that ''fuel efficiency continues to be a top purchaser driver.'' (''More MPG—ASAP'', *Automotive News,* Jun 11, 2012.)

adjustments cause neither the GHG nor CAFE curves (with A/C) to contact the 2016 curves when charted.

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 the proposal for MYs 2017–2025, the agencies reconsidered the use of this approach, and 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 fuel consumption without the technology. It is, therefore, more consistent with the agencies' estimates of technology effectiveness to develop 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 concluded 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 invited 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. As indicated earlier, ACEEE [230] and the Alliance [231] both expressed support for the application of relative adjustments in order to develop year-over-year increases in the stringency of fuel consumption and CO_2 targets, although the Alliance also commented that this approach should be revisited as part of the mid-term evaluation. EPCA/EISA requires NHTSA to establish the maximum feasible passenger car and light truck standards separately in each specific model year—a requirement that is not necessarily compatible with any predetermined approach to year-over-year changes in stringency. As part of the future NHTSA rulemaking to finalize standards for MYs 2022–2025 and the concurrent mid-term evaluation, the agencies plan to reexamine potential approaches to developing regulatory options for successive model years.

b. Adjusting for Anticipated Improvements to Mobile Air Conditioning Systems

The fuel economy values in the agencies' market forecasts 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 was 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 was included based on air conditioning system efficiency, leakage and refrigerant improvements. As discussed above in Chapter 5 of the joint 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 adjusted 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 MYs 2012–2016 rules. For the CAFE target curves, NHTSA for the first time is accounting 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 that air conditioning system technologies, creating a series of curve shapes that are ''fanned'' based on two-cycle performance. Then the curves were offset vertically by the air conditioning improvement by an equal amount at every point.

While the agencies received many comments regarding the provisions for determining adjustments to reflect improvements to air conditioners, the agencies received no comments regarding how curves developed considering 2-cycle fuel economy and CO_2 values should be adjusted to reflect the inclusion of A/C adjustments in fuel economy and CO_2 values used to determine compliance with corresponding standards. For today's final rule, the agencies have maintained the same approach as applied for the NPRM.

D. Joint Vehicle Technology Assumptions

For the past five years, the agencies have been working together closely to follow the development of fuel consumption- and GHG-reducing technologies, which continue to evolve rapidly. We based the proposed rule on the results of two major joint technology analyses that EPA and NHTSA had recently completed—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 and was also done in conjunction with CARB). For this final rule, we relied on our joint analyses for the proposed rule, as well as new information and analyses, including information we

[230] ACEEE, Docket No. EPA–HQ–OAR–2010–0799–9528 at 6.

[231] Alliance, Docket No. NHTSA–2010–0131–0262, at 86.

received during the public comment period.

In the proposal, we presented our assessments of the costs and effectiveness of all the technologies that we believe manufacturers are likely to use to meet the requirements of this rule, including the latest information on several quickly-changing technologies. The proposal included new estimates for hybrid costs based on a peer-reviewed ANL battery cost model. We also presented in the proposal new cost data and analyses relating to several technologies based on a study by FEV: an 8-speed automatic transmission replacing a 6-speed automatic transmission; an 8-speed dual clutch transmission replacing a 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. Also in the proposal, we presented an updated assessment of our estimated costs associated with mass reduction.

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 (2010 dollars are used in this final rule while 2009 dollars were used in the proposal). As proposed, we have also updated our methodology for calculating indirect costs associated with new technologies since completing 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.

Since the MYs 2012–2016 rule and TAR, the agencies 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. Additionally for the final rule, NHTSA conducted a vehicle simulation project with Argonne National Laboratory (ANL), as described in NHTSA's FRIA, that performed additional analyses on mild hybrid technologies and advanced transmissions to help NHTSA develop effectiveness values better tailored for the CAFE model's incremental structure. The effectiveness values for the mild hybrid vehicles were applied by both agencies for the final rule.[232] Additionally, NHTSA updated the effectiveness values of advanced transmissions coupled with naturally-aspirated engines for the final rule.[233]

The agencies also reviewed the findings and recommendations in the updated NAS report ''Assessment of Fuel Economy Technologies for Light-Duty Vehicles'' that was completed and issued after the MYs 2012–2016 final rule.[234] NHTSA's sensitivity analysis examining the impact of using some of the NAS cost and effectiveness estimates on the proposed standards is presented in NHTSA's final RIA.

The agencies received comments to the proposal on some of these assessments as discussed further below. Also, since the time of the proposal, in some cases we have been able to improve on our earlier assessments. We note these comments and the improvements made in the assessments in the discussion of each technology, below. However, the agencies did not receive comments for most of the technical and cost assessments presented in the proposal, and the agencies have concluded the assessments in the proposal remain valid for this final rule.

Key changes in the final rule relative to the proposal are the use of 2010 dollars rather than 2009 dollars, updates to all battery pack and non-battery costs for hybrids, plug-in hybrids and full electric vehicles (because an updated version of the Argonne National Labs BatPaC model was available which more appropriately included a battery discharge safety system in the costs), and the inclusion of a mild hybrid technology that was not included in the proposal. NHTSA updated the effectiveness values of advanced transmissions coupled with naturally-aspirated engines based on ANL's simulation work. We describe these changes below and in Chapter 3 of the Joint TSD. We next provide a brief summary of the technologies that we considered for this final rule; Chapter 3 of the Joint TSD presents our assessments of these technologies in much greater detail.

[232] EPA's lumped parameter model gave similar results as ANL's model for three of five vehicle classes, which served as a valuable validation to the tool. However EPA used the same ANL effectiveness values for mild hybrids to be harmonized with NHTSA's inputs.

[233] The Ricardo simulations did not include this technology combination, and EPA did not include this combination in their packages.

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

1. What technologies did the agencies consider?

The agencies conclude 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 was essential to have a thorough understanding of the technologies available to the manufacturers. As was the case for the proposal, the analyses we performed for this final rule included 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 Joint TSD, the point in time when we project that a technology can be applied affects our estimates of the costs as well as the technology penetration rates (''phase-in caps'').

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 we considered are available today, are in production of some vehicles, and could be incorporated into vehicles more widely as manufacturers make their product development decisions. 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, we also considered other technologies 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 that the agencies believe that manufacturers can, for the most part, apply both to cars and trucks, and that we expect will 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 final rule 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 manufacturers may be able to use them to generate credits under a number of the flexibility and incentive programs provided in this final rule.

The technologies that we 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).[235] We discuss the specific technologies within each broad group below. The list of technologies presented below and in the proposal 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; mild hybrid technologies that were not included in the proposal; 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 preamble and in Chapter 5 of the Joint TSD.

Few comments were received specific to these technologies. The Alliance emphasized the agencies should examine the progress in the development of powertrain improvements as part of the mid-term evaluation and determine if researchers are making the kind of breakthroughs anticipated by the agencies for technologies like high-efficiency transmissions. VW cautioned the agencies about the uncertainties with high BMEP engines, including the possible costs due to increased durability requirements and questioned the potential benefit for this type of engine of engine technology. VW commented that additional development is necessary to overcome the significant obstacles of these types of engines. ICCT emphasized that many of the powertrain effectiveness values, derived by Ricardo, were too conservative as technology in this area is expected to improve at a faster pace during the rulemaking period. As described in the joint TSD, the agencies relied on a number of technical sources for this engine technology. Additionally as described in the Ricardo report, Ricardo was tasked with extrapolating technologies to their expected performance and efficiency levels in the 2020–2025 timeframe to account for future improvements. The agencies continue to believe that the modeling and simulation conducted by Ricardo is robust, as they have built prototypes of these engines and used their knowledge to help inform the modeling. The agencies will, of course, continue to watch the development of this key technology in the future. For transparency purposes and full disclosure, it is important to note the ICCT partially funded the Ricardo study.

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 MY 2017 and reach nearly 100 percent in MY 2025.[236]

Reduction of engine friction losses (first level) 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 the efficiency of engine operation. This level of engine friction reduction is expected to exceed 70 percent penetration by MY 2017

Advanced low friction lubricants and reduction of engine friction losses (second level) are new for our analysis for the proposal and this final rule. As technologies advance in the coming years, we expect that there will be further development in both low friction lubricants and engine friction reductions. The agencies grouped the development in these two related 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 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 electro-hydraulic system in which valve timing is changed as lift height is controlled. This yields a wide range of opportunities for optimizing volumetric efficiency and performance, 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.

Turbocharging 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

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

[236] The penetration rates shown in this section are general results applicable to either the NHTSA or EPA analysis, to either the 2008 based or the 2010 based fleet projection.

range of engine operation than conventional 18 bar BMEP engines. The 27 bar BMEP technology would require higher boost levels 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 the proposal and this final rule, 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. This technology is included because it exists in the baseline fleets, but its penetration is expected to decrease over time as it is replaced by other more efficient technologies.

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 selecting 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 MYs 2012–2016 final rule limited DCT applications to a maximum of 6 speeds. For the proposal and this final rule, 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 rule 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) represents 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. For the proposal and final rule, we considered two levels of lower rolling resistance tires that reduce frictional losses even further. The first level of low rolling resistance tires would have 10 percent rolling resistance reduction while the 2nd level would have 20 percent rolling resistance reduction compared to 2008 baseline vehicle. This second level of development marks an advance over low rolling resistance tires considered during the MYs 2014–2018 medium- and heavy- duty vehicle greenhouse gas emissions and fuel efficiency rulemaking, see 76 FR 57207, 57229.) The first level of lower rolling resistance tires is expected to exceed 90 percent penetration by the 2017.

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. We estimate that the first level of aerodynamic drag improvement will reduce aerodynamic drag by 10 percent relative to the baseline 2008 vehicle while the second level would reduce aerodynamic 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 through either substitution of lower density and/or higher strength materials, or changing the design to use less material. With design optimization, part consolidation, and improved manufacturing processes, these strategies can be applied while maintaining the performance attributes of the component, system, or vehicle. The agencies applied mass reduction of up to 20 percent relative to MY 2008 levels in this final rule compared to only 10 percent in the MYs 2012–2016 final rule. The agencies also determined effectiveness values for hybrid, plug-in and electric vehicles based on net mass reduction, or the difference 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 levels of vehicle mass reduction that, in our estimation, would not adversely affect overall fleet safety. An extensive discussion of mass reduction technologies and their associated costs is provided in Chapter 3 of the Joint TSD, and the discussion on safety is in Section II.G of the Preamble.

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 the engine-driven and 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, lacking data about when these transitions will occur, 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 and 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 rule is a second level of IACC (IACC2), which consists of the IACC technologies with 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 50 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 technology was mentioned but not included in the proposal because the agencies had incomplete information at that time. Since the proposal, the agencies have obtained better data on the costs and effectiveness of this technology (see Chapter 3.4.3 of the joint TSD). Therefore, the agencies have revised their technical analysis on both the cost and effectiveness and found that the technology is now competitive with the others in NHTSA's technology decision trees and EPA's technology packages. EPA and NHTSA are providing incentives to encourage this and other hybrid technologies on full-size pick-up trucks, as described in Section II.F.3.

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 and 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 rule because we believe that other technologies provide better cost effectiveness, although it is included as a baseline technology because it exists in our 2008 and 2010 baseline fleets.

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, provides similar efficiency at lower cost than 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 rule because we believe that other technologies provide better cost effectiveness, although it is included as a baseline technology because it exists in our 2008 and 2010 baseline fleets.

Power-split Hybrid is a hybrid electric drive system that replaces the traditional transmission with a single planetary gearset and two motor/generators. One 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 rule because we believe that other technologies provide better cost effectiveness, 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/electrical 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, the agencies have included PHEVs with several all-electric ranges as potential technologies. EPA's analysis includes a 20-mile and 40-mile range PHEVs, while NHTSA's analysis only includes a 30-mile PHEV.

Electric vehicles (EV) are equipped with all-electric drive and with systems powered by energy-optimized batteries charged primarily from grid electricity. For this rule, the agencies have included EVs with several ranges—75 miles, 100 miles, and 150 miles—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. Most automakers that currently have FCEVs under development use high-pressure gaseous hydrogen storage tanks. 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 marketplace in the time frame of this rule, we expect the total number of vehicles produced with this technology will be relatively small. Thus, the agencies did not consider FCEVs in the modeling analysis conducted for this rule.

There are a number of other potential technologies available to manufacturers in meeting the 2017–2025 standards that the agencies have evaluated but have not considered in our final analyses. 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 final rule 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, our estimated 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.

New for the final rule relative to the proposal are the use of 2010 dollars rather than 2009 dollars, updates to all battery pack and non-battery costs for hybrids, plug-in and full electric vehicles because an updated version of the ANL BatPaC model was available and because we wanted to include a battery discharge safety system in the costs, and the inclusion of a mild hybrid technology that was not included in the proposal. We describe these changes below and in Chapter 3 of the Joint TSD.

The agencies note that the technology costs included in this final rule take into account those associated with the initial build of the vehicle. We received comments on the proposal for this rule suggesting that there could be additional maintenance required with some new technologies, and that additional maintenance costs could occur as a result because ''the technology will be more complicated and time consuming for mechanics to repair.''[237] For this final rule, the agencies have estimated such maintenance costs. The maintenance costs are not included as new vehicle costs and are not, therefore, used in either agency's modeling work. However, the maintenance costs are included when estimating costs to society in each agency's benefit-cost analyses. We discuss these maintenance costs briefly in section II.D.5 below, and in detail in Chapter 3 of the final Joint TSD and in sections III and IV of this preamble.

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 ''tear-down'' studies (see below). 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 Chapter 3 of the Joint TSD. We discuss each of these briefly here and in more detail in the Joint TSD. For the majority of the other technologies considered in this rule and described above, and where no new data were available, the agencies have relied on the MYs 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. EPA documented FEV's methodology in a report published as part of the MYs 2012–2016 rulemaking, detailing the costing of the first tear-down conducted in this work (#1 in the list below).[238]

[237] See NADA (OAR–2009–0472–7182.1, p.10) and Dawn Brooks (OAR–2009–0472–3851, pp.1–2).

[238] U.S. EPA, ''Light-Duty Technology Cost Analysis Pilot Study,'' Contract No. EP–C–07–069, Work Assignment 1–3, December 2009, EPA–420–

This report was peer reviewed by experts in the industry, who focused especially on the methodology used in the tear-down study, and revised by FEV in response to the peer review comments.[239] EPA documented subsequent tear-down studies (#2–#5 in the list below) using the peer reviewed methodology in follow-up FEV reports made available in the public docket for the MYs 2012–2016 rulemaking, although the results for some of these additional studies were not peer reviewed.[240]

Since then, FEV's work under this contract has continued. Additional cost studies have been completed and are available for public review.[241] The most extensive study, performed after the MYs 2012–2016 final rule, involved whole-vehicle tear-downs of a 2010 Ford Fusion power-split hybrid and a conventional 2010 Ford Fusion. (The latter served as a baseline vehicle for comparison.) In addition to providing power-split HEV costs, the results for individual components in these vehicles were subsequently used by FEV/Munro to estimate the cost of 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 to provide supplemental battery costing information to that associated with the NiMH battery in the Fusion. FEV has extensively documented this HEV cost work, including the extension of results to P2 HEVs, in a new report.[242] Because of the complexity and comprehensive scope of this HEV analysis, EPA commissioned a separate peer review focused exclusively on the new tear down costs developed for the HEV analysis. 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.[243,244]

Over the course of this contract, 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. New for this final rule, the agencies have used portions of this tear-down study in estimating mild hybrid costs.
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 because the technology is under a very recently awarded patent and we have chosen not to base our analyses on its widespread use across the industry in the 2017–2025 timeframe.)

Items 6 through 10 in the list above are new since the MYs 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 HEVs, EVs & PHEVs

The agencies have also reevaluated the costs for HEVs, PHEVs, and EVs since we issued the MYs 2012–2016 final rule and the 2010 TAR. In the proposal, we noted that electrified vehicle technologies were developing rapidly and the agencies sought to capture results from the most recent analysis. Further, we noted that the MYs 2012–2016 rule employed a single $/kWh 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 $/kWh as the power to energy ratio of the battery varies for different applications.

To address those issues for the proposal, the agencies did two things. First, EPA developed a spreadsheet tool[245] that the agencies used to size the motor and battery based on the different road loads of various vehicle classes. Second, the agencies used a battery cost model developed by Argonne National Laboratory (ANL) for the Vehicle Technologies Program of the Office of Energy Efficiency and Renewable Energy (U.S. Department of Energy (DOE)).[246] 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

R–09–020, Docket EPA–HQ–OAR–2009–0472–11282.

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

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

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

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

[243] 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.

[244] 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.

[245] See "LDGHG 2017–2025 Cost Development Files," CD in Docket No. EPA–HQ–OAR–2010–0799.

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

energy storage technologies for future HEV, PHEV and EV applications. Since publication of the 2010 TAR, ANL's battery cost model underwent peer-review and ANL subsequently 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, and other changes.[247]

Subsequent to the proposal for this rule, the agencies requested changes to the BatPaC model. These requests were that an option be added to select between liquid or air thermal management and that adequate surface area and cell spacing be determined accordingly. Also, the agencies requested a feature to allow battery packs to be configured as subpacks in parallel or modules in parallel, as additional options for staying within voltage and cell size limits for large packs. ANL added these features in a version of the model distributed March 1, 2012. This version of the model is used for the battery cost estimates in the final rule.

The agencies have chosen to use the ANL model as the basis for estimating the cost of large-format lithium-ion batteries for this assessment for several reasons. The model was developed by scientists at ANL who have significant experience in this area. Also, 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 generally consistent with the supplier cost estimates that EPA received from large-format lithium-ion battery pack manufacturers. This includes data the EPA received during on-site visits in the 2008–2011 time frame. Finally, the agencies chose to use the ANL model because it 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).

[247] Nelson, P.A., Santini, 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*).

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 updated BatPaC model and supports its use in this final rule.

As we did in the proposal, we have also estimated the costs (hardware and labor) associated with in-home electric vehicle charging equipment, which we expect to be necessary for PHEVs and EVs, and their installation. New for the final rule are costs associated with an on-vehicle battery discharge system. These battery discharge systems allow the batteries in HEVs, PHEVs and EVs to be discharged safely at the site of an accident prior to moving affected vehicles to storage or repair facilities. Charging equipment and battery discharge system costs are covered in more detail in Chapter 3 of the 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 rule, 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. Both agencies have mass reduction feasibility and cost studies that were completed in time for the final rule. However the results from these studies were not employed in the rulemaking analysis because the peer reviews had not been completed and changes to the studies based on the peer reviews were not completed. Both have since been completed. For the primary analyses, both agencies use the same mass reduction costs as were used in the proposal, although they have been updated to 2010 dollars. All of these studies are discussed in Chapter 3 of the Joint TSD as well as in the respective publications. The use of the new cost results from the studies would have made little difference to the final rule cost analysis for two reasons:

(1) The NPRM (+/− 40%) sensitivity analysis conducted by the agencies showed little difference in overall costs due to the change in mass reduction costs;

(2) The agencies project even less mass reduction levels in the final rule compared to the NPRM based on the use of revised fatality coefficients from NHTSA's updated study of the effects on vehicle mass and size on highway safety, which is discussed in section II.G of this preamble.

b. Indirect Costs (IC)

i. Markup Factors To Estimate Indirect Costs

As done in the proposal, the agencies have estimated the indirect costs by applying indirect cost multipliers (ICM) to direct cost estimates. EPA derived ICMs a basis for estimating the impact on indirect costs of individual vehicle technology changes that would result from regulatory actions. EPA derived separate ICMs 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. The agencies also applied ICMs in our MYs 2012–2016 rulemaking.

Prior to the development of the ICM methodology,[248] 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

[248] 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.

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 rule group all technologies into four broad categories in terms of complexity 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.[249] Both of these processes were carried out by panels composed of EPA staff members with previous background in the automobile industry; the memberships of the two panels overlapped but were not identical.[250] 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 used 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 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.'' [251] 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.[252]

As EPA has developed its ICM approach to indirect cost estimation, the agency has publicly discussed and responded to comment on its approach during the MYs 2012–2016 light-duty GHG rule, and also in the more recent heavy-duty GHG rule (see 76 FR 57106) and in the 2010 TAR. The agency published its work in the Journal of Production Economics [253] and has also published a memorandum furthering the development of ICMs.[254] 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. For the proposal for this rule, EPA concluded that ICMs are fully developed for regulatory purposes and used these factors in developing the indirect costs presented in the proposal.

The agencies received comments on the approach used to estimate indirect costs in the proposal. One commenter (NADA) argued that the ICM approach was not valid and an RPE approach was the only appropriate approach.[255] Further, that commenter argued that the RPE factor should be 2.0 times direct costs rather than the 1.5 factor that is supported by filings to the Securities and Exchange Commission. Another commenter (ICCT) commented positively on the new ICM approach as presented in the proposal, but argued that sensitivity analyses examining the impact of using an RPE should be deleted from the final rule.[256] Both agencies have conducted thorough analysis of the comments received on the RPE versus ICM approach. Regarding NADA's concerns about the accuracy of ICMs, although the agencies recognize that there is uncertainty regarding the impact of indirect costs on vehicle prices, they have retained ICMs for use in the central analysis because it offers advantages of focusing cost estimates on only those costs impacted by a regulatory imposed change, and it provides a disaggregated approach that better differentiates among technologies. The agencies disagree with NADA's contention that the correct factor to reflect the RPE should be 2.0, and we cite data in Chapter 3 of the joint TSD that demonstrates that the overall RPE should average about 1.5. Regarding ICCTs contention that NHTSA should delete sensitivity analyses examining the impact of using an RPE, NHTSA rejects this proposal. OMB Circular No. A–94 establishes guidelines for conducting benefit-cost analysis of Federal programs and recommends sensitivity analyses to address uncertainty and imprecision in both underlying data and modeling assumptions. The agencies have addressed uncertainty in separate sensitivity analyses, with NHTSA examining uncertainty stemming from the shift away from the use of the RPE and EPA examining uncertainty around the ICM values. Further analysis of NADA's comments is summarized in

[249] 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.

[250] 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.

[251] NRC, Finding 3–2 at page 3–23.

[252] NRC at page 3–19.

[253] 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.

[254] 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.

[255] NADA, Docket No. NHTSA–2010–0131–0261, at 4.

[256] ICCT, Docket No. NHTSA–2010–0131–0258, at 19–20.

Chapter 3 of the Joint TSD and in Chapter 7 of NHTSA's FRIA and in EPA's Response to Comments document. NHTSA's full response to ICCT is also presented in chapter 7 of NHTSA's FRIA. For this final rule, each agency is using an ICM approach with ICM factors identical to those used in the proposal. The impact of using an RPE rather than ICMs to calculate indirect costs is examined in sensitivity and uncertainty analyses in chapters 7, 10, and 12 of NHTSA's FRIA where NHTSA shows that even under the higher cost estimates that result using the RPE, the rulemaking is highly cost beneficial. The impact of alternate ICMs is examined in Chapter 3 of EPA's RIA.

Note that our ICM, while identical to those used in the proposal, have changed since the MYs 2012–2016 rule. The first change—increased ICM factors—was 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 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 was a re-evaluation by agency staff of the complexity classification of each of the technologies that were not directly examined in the RTI and modified Delphi studies. As a result, more technologies have been classified as medium complexity and fewer as low complexity. The third change—the way the factors are applied—resulted 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 third 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 made as part of this ICM recalculation. 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 are applied to future years' data and, therefore, NHTSA and EPA staffs believed that it would be appropriate to base ICMs on the historical average rather than a single year's result. Therefore, ICMs were adjusted to reflect this average level. These changes to the ICMs since the MYs 2012–2016 rule and the methodology are described in greater detail in Chapter 3 of the Joint TSD. NHTSA also has further discussion of ICMs in Chapter 7 of NHTSA's FRIA.

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 standards in this final rule 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 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.[257]

[257] 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 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.

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 RIA. The methodology used by NHTSA in applying the results to the technology costs is described in NHTSA's RIA section V.

In their written comments on the proposal, the Center for Biological Diversity and the International Council on Clean Transportation argued that the long lead times being provided for the phase-in of new standards, stretching out as they do over two complete redesign cycles, will virtually eliminate any capital stranding, making it inappropriate to carry over what they consider to be a "relic" from shorter-term rulemakings. As discussed above, it is difficult to quantify accurately any capital stranding associated with new technology phase-ins, especially given the projected and unprecedented deployment of technologies in the rulemaking timeframe. The FEV analysis attempted to define the possible stranded capital costs, for a select set of technologies, using the above set of assumptions. Since the direct manufacturing costs developed by FEV assumed a 10 year production life (*i.e.,* capital costs amortized over 10 years) the agencies applied the FEV derived stranded capital costs whenever technologies were replaced prior to being utilized for the full 10 years. The other option would be to assume a 5 year product life (*i.e.,* capital costs amortized over 5 years), which would have increased the direct manufacturing costs. It seems only reasonable to account for stranded capital costs in the instances where the fleet modeling performed by the agencies replaced technologies before the capital costs were fully amortized. The agencies did not derive or apply stranded capital costs to all technologies only the ones analyzed by FEV. While there is uncertainty about the possible stranded capital costs (*i.e.,* understated or overstated), their impact would not call into question the overall results of our cost analysis or otherwise affect the stringency of the standards, since costs of stranded capital are a relatively minor component of the total estimated costs of the rules.

c. Cost Adjustment to 2010 Dollars

This simple change from the earlier analyses and from the proposal is to update any costs presented in earlier analyses to 2010 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, 2008 and 2009 dollars to 2010 dollars are shown below.

TABLE II–17—GDP PRICE DEFLATORS USED IN THIS FINAL RULE

	2007	2008	2009	2010
Price Index for Gross Domestic Product	106.2	108.6	109.7	111.0
Factor applied to convert to 2010 dollars	1.04	1.02	1.01	1.00

Source: Bureau of Economic Analysis, Table 1.1.4. Price Indexes for Gross Domestic Product, downloaded 2/9/2012, last revised 1/27/2012.

d. Cost Effects Due to Learning

The agencies have not changed the approach to manufacturer learning since the proposal. 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. For this rule, 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, in the proposal, we 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 Joint TSD. NHTSA has further discussion in Chapter 7 of the NHTSA FRIA. 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.

The agencies did not receive comments on the issue of manufacturer learning.

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

For this final rule, EPA has conducted another peer reviewed study with the global engineering consulting firm, Ricardo, Inc., adding to and refining the results of the 2007 study, consistent with a longer-term outlook through model years MYs 2017–2025. The 2007 study was a detailed, peer reviewed vehicle simulation project to quantify the effectiveness of a multitude of technologies for the MYs 2012–2016 rule (as well as the 2010 NOI) published in 2008. The extent of the new study 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 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 for low-friction lubricants, depending on the vehicle class, 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 that must be balanced between fuel efficiency, safety, and performance. Aerodynamic drag reduction is much the same—it can improve fuel economy and reduce CO_2 emissions, but it is also highly dependent on vehicle-specific functional objectives. For purposes of this rule, NHTSA and EPA believe that employing average values for technology effectiveness estimates, as adjusted depending on vehicle class, 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.

As discussed in the proposal, the U.S. D.O.T. Volpe Center entered into a contract with Argonne National Laboratory (ANL) to provide full vehicle simulation modeling support for this MYs 2017–2025 rulemaking. While modeling was not complete in time for use in the NPRM, the ANL results were available for the final rule and were used to define the effectiveness of mild hybrids for both agencies, and NHTSA used the results to update the effectiveness of advanced transmission technologies coupled with naturally-aspirated engines for the CAFE analysis, as discussed in the Joint TSD and more fully in NHTSA's RIA. This simulation modeling was 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 that includes sophisticated models for advanced vehicle technologies. The ANL simulation modeling process and results are documented in multiple reports and are peer reviewed. Both the ANL reports and peer review report can be found in NHTSA's docket.[258]

4. How did the agencies consider real-world limits when defining the rate at which technologies can be deployed?

a. Refresh and Redesign Schedules

During MYs 2017–2025 manufacturers are expected to go through the normal automotive business cycle of redesigning and upgrading their light-duty vehicle products, and in some cases introducing entirely new vehicles not in the market today. The MYs 2017–2025 standards timeframe allows manufacturers the time needed to incorporate GHG reduction and fuel-saving technologies into their normal business cycle while considering the requirements of the MYs 2012–2016 standards. This is important because it has the potential to avoid the much higher costs that could occur if manufacturers need to add or change technology at times other than their scheduled vehicle redesigns. This time period also provides manufacturers the opportunity to plan for compliance using a multi-year time frame, again consistent with normal business practice. Over these 9 model years, and the 5 prior model years that make up the MYs 2012–2016 standards, there will be an opportunity for manufacturers to evaluate, presumably, every one of their vehicle platforms and models and add technology in a cost effective way to control GHG emissions and improve fuel economy. This includes all the technologies considered here and the redesign of the air conditioner systems in ways that will further reduce GHG emissions and improve fuel economy.

Because of the complexities of the automobile manufacturing process, manufacturers are generally only able to add new technologies to vehicles on a specific schedule; just because a technology exists in the marketplace or is made available, does not mean that it is immediately available for applications on all of a manufacturer's vehicles. 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. Across the industry, redesign of models generally takes place about every 5 years. However, while 5 years is a typical design period, there are many instances where redesign cycles can be longer or shorter. For example, it has generally been the case that pickup trucks and full size vans have longer redesign cycles (*e.g.,* 6 to 7 years), while high-volume cars have shorter redesign cycles in order to remain competitive in the market. There are many other factors that can also affect redesign such as availability of capital and engineering resources and the extent of platform and component sharing between models, or even manufacturers.

We have a more detailed discussion in Chapter 3.4 of the joint TSD that describes how refresh and redesign cycles play into the modeling each agency has done in support of the final standards.

b. Vehicle Phase-In Caps

GHG-reducing and fuel-saving technologies for vehicle applications vary widely in function, cost, effectiveness and availability. Some of these attributes, like cost and availability vary from year to year. New technologies often take several years to become available across the entire market. The agencies use phase-in caps to manage the maximum rate that the CAFE and OMEGA models can apply new technologies.

Phase-in caps are intended to function as a proxy for a number of real-world limitations in deploying new technologies in the auto industry. These limitations can include but are not limited to, engineering resources at the OEM or supplier level, restrictions on intellectual property that limit deployment, and/or limitations in material or component supply as a market for a new technology develops. Without phase-in caps, the models may apply technologies at rates that are not representative of what the industry is actually capable of producing, which would suggest that more stringent standards might be feasible than actually would be.

[258] Docket No: NHTSA–2010–0131.

EPA applies the caps on an OEM vehicle platform basis for most technologies. For a given technology with a cap of x%, this means that x% of a vehicle platform can receive that technology. On a fleet average basis, since all vehicle platforms can receive x% of this technology, x% of a manufacturer's fleet can also receive that technology. EVs and PHEVs are an exception to this rule as the agencies limit the availability of these technologies to some subclasses. Unlike other technologies, in order to maintain utility, EPA only allows non-towing vehicle types to be electrified in the OMEGA model. As a result, the PHEV and EV cap was applied so that the average manufacturer could produce to the cap levels. As would be expected, manufacturers that make more non-towing vehicles can have a higher fraction of their fleet converted to EVs and PHEVs, while those that make fewer non-towing vehicles have a lower potential maximum limit on EV and PHEV production.

NHTSA applies phase-in caps in addition to 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, Unlike vehicle-level cycle settings, phase-in caps, defined on a percent per year basis, constrain technology application at the OEM level. As discussed above phase-in caps are intended to reflect a manufacturer's overall resource capacity available for implementing new technologies (such as engineering and development personnel and financial resources) 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 CAFE modeling process out-pacing an OEM's limited pool of available resources during the rulemaking time frame, especially in years where many models may be scheduled for refresh or redesign. This helps to ensure technological feasibility and economic practicability in determining the stringency of the standards.

We have a more detailed discussion of phase-in caps in Chapter 3.4 of the joint TSD.

5. Maintenance and Repair Costs Associated With New Technologies

In the proposal, we requested comment on maintenance, repair, and other operating-costs and whether these might increase or decrease with the new technologies. (See 76 FR 74925) We received comments on this topic from NADA. These comments stated that the agencies should include maintenance and repair costs in estimates of total cost of ownership (i.e., in our payback analyses).[259] NADA proffered their Web site [260] as a place to find information on operating costs that might be used in our final analyses. This Web site tool is meant to help consumers quantify the cost of ownership of a new vehicle. The tool includes estimates for depreciation, fees, financing, insurance, fuel maintenance, opportunity costs and repairs for the first five years of ownership. The agencies acknowledge that the tool may be useful for consumers; however, there is no information provided on how these estimates were determined. Without documentation of the basis for estimates, the Web site information is of limited use in this rulemaking where the agencies document the source and basis for each factual assertion. There are also evident substantive anomalies in the Web site information.[261] For these reasons, the agencies have performed an independent analysis to quantify maintenance costs.

For the first time in CAFE and GHG rulemaking, both agencies now include maintenance costs in their benefit-cost analyses and in their respective payback analyses. This analysis is presented in Chapter 3.6 of the joint TSD and the maintenance intervals and costs per maintenance event used by both agencies are summarized in Table II–18. For information on how each agency has folded the maintenance costs into their respective final analyses, please refer to each agency's respective RIA (Chapter 5 of EPA's RIA, Chapter VIII of NHTSA's FRIA).

TABLE II–18—MAINTENANCE EVENT COSTS & INTERVALS

[2010 dollars]

New technology	Reference case	Cost per maintenance event	Maintenance interval (mile)
Low rolling resistance tires level 1	Standard tires	$6.44	40,000
Low rolling resistance tires level 2	Standard tires	43.52	40,000
Diesel fuel filter replacement	Gasoline vehicle	49.25	20,000
EV oil change	Gasoline vehicle	−38.67	7,500
EV air filter replacement	Gasoline vehicle	−28.60	30,000
EV engine coolant replacement	Gasoline vehicle	−59.00	100,000
EV spark plug replacement	Gasoline vehicle	−83.00	105,000
EV/PHEV battery coolant replacement	Gasoline vehicle	117.00	150,000
EV battery health check	Gasoline vehicle	38.67	15,000

Note: Negative values represent savings due to the EV not needing the maintenance required of the gasoline vehicle; EPA applied a battery coolant replacement cost to PHEVs and EVs, while NHTSA applied it to EVs only.

E. Joint Economic and Other Assumptions

The agencies' analysis of CAFE and GHG standards for the model years covered by this final rule rely on a range of forecast information, estimates of economic variables, and input parameters. This section briefly describes the sources of the agencies' 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 final rule, NHTSA and EPA considered comments received in

[259] See NADA (EPA–HQ–OAR–2010–0799–0639, p.10).

[260] *http://www.nadaguides.com/Cars/Cost-to-Own.*

[261] For example, comparing the 2012 Hyundai Sonata showed the same cost for fuel ($11,024) regardless of whether it is a hybrid option or not. The HEV fuel economy rating is 35/40 mpg City/Highway for the HEV and 2.4L non HEV rating is 24/35. Another example is the 2012 Ford Fusion SEL: the front wheel drive and the all-wheel drive versions have identical fuel cost despite having different fuel economies.

response to the proposed rule, and also reviewed newly available literature. For this final rule, we made several changes to the economic assumptions used in our proposed rule, including revised technology costs to reflect more recently available data; updated values of the cost of owning a vehicle based on new data; updated fuel price and transportation demand forecasts that reflect the Annual Energy Outlook (AEO) 2012 Early Release; and changes to vehicle miles travelled (VMT) schedules, survival rates, and projection methods. The final values summarized below are discussed in greater detail in Chapter 4 of the joint TSD and elsewhere in the preamble and in the agencies' respective RIAs.

• *Costs of fuel economy-improving technologies*—These inputs are discussed in summary form in Section II.D above and in more detail in the agencies' respective sections of this preamble, in Chapter 3 of the joint TSD, and in the agencies' respective RIAs. The direct manufacturing cost estimates for fuel economy improving and GHG emissions reducing technologies that are used in this analysis are intended to represent manufacturers' direct costs for high-volume production of vehicles equipped with these technologies in the year for which we state the cost is considered ''valid.'' Technology direct manufacturing cost estimates are the same as those used to analyze the proposed rule, with the exception of those for hybrid electric vehicles, plug-in hybrid electric vehicle (PHEV) and electric vehicle (EV) battery costs which have been updated using an updated version of Argonne National Laboratory's (ANL's) BatPaC model.[262] 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. As explained at proposal, the indirect cost markup factors have been revised from the MYs 2012–2016 rulemaking and the Interim Joint TAR to reflect the agencies current thinking regarding a number of issues. The final rules use the same factors the agencies used at proposal. These factors are discussed in detail in Section II.D.2 of this preamble and in Chapter 3 of the joint TSD, where we also discuss comments received on the proposal and our response to them. Details of the agencies' technology cost assumptions and how they were derived can be found in Chapter 3 of the joint TSD. We did not receive specific comments on our estimated technology direct manufacturing costs.

• *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 this were the case, the resulting sacrifice in the value of these attributes to consumers would represent an additional cost of achieving the required improvements, and thus of manufacturers' compliance with stricter standards. Currently the agencies assume that these vehicle attributes will not change as a result of these rules. Section II.C above and Chapter 2 of the joint TSD describe how the agencies 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 rules themselves will not result in such changes. Importantly, EPA and NHTSA have sought to include the cost of maintaining these attributes as part of the cost and effectiveness estimates for technologies that are included in the analysis for this final rule. For example, downsized engines are assumed to be turbocharged, so that they provide the same performance and utility even though they are smaller, and the costs of turbocharging and downsizing are included in the agencies' cost estimates.[263] The two instances where the rules might result in loss of vehicle utility, as described in Section III.D.3, III.H.1.b, and Section IV.G, involve cases where vehicles are converted to hybrid or full electric vehicles (EVs) and some buyers may experience a loss of welfare due to the reduced range of driving on a single charge compared to the range of an otherwise similar gasoline vehicle. However, in such cases, we believe that sufficient options would exist for consumers concerned about the possible loss of this utility (e.g., they could purchase the non-hybridized version of the vehicle or not buy an EV) that the agencies do not attribute a welfare loss for these vehicles resulting from the final rules. Though some comments raised concerns over consumer acceptance of EVs, other comments expressed optimism that consumer interest in EVs would be sufficient for the low levels of adoption projected in these rules to be used for compliance with the standards. The agencies maintain their assumption that purchasers of EVs will not incur welfare losses given that they will have sought out vehicles with these properties. Moreover, given the modest levels of EV penetration which the agencies project as a compliance strategy for manufacturers, the agencies likewise do not project any general loss of societal welfare since many other compliance alternatives remain available to manufacturers and thus to vehicle purchasers.

Consumer vehicle choice modeling is a method to understand and predict what vehicles consumers might buy. In principle these models can be used to estimate the effects of these rules on vehicle sales and fleet mix. In practice, though, past analyses using such models have not produced consistent estimates of how buyers might respond to improved fuel economy, and it is difficult to decide whether one data source, model specification, or estimation procedure is clearly preferable over another. Thus, for these final rules, the agencies continue to use forecasts of total industry sales, the share of total sales accounted for by passenger cars, and the market shares of individual models for all years between 2010 and 2025 that do not vary among regulatory alternatives.

The agencies requested 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. Some

[262] Technology direct manufacturing cost estimates for most technologies are fundamentally unchanged from those used by the agencies in the MYs 2012–2016 final rule, the heavy-duty truck rule (to the extent relevant), and TAR, although the agencies have revised costs for mass reduction, transmissions, and a few other technologies from those used in these earlier regulatory actions and analyses.

[263] The modeling work underlying the agencies' estimates of technology effectiveness build in the need to maintain vehicle performance (utility). See chapter 3.2 of the Joint TSD for details behind these effectiveness estimates. Our technology costs include all costs of implementing the technologies required to achieve these effectiveness values while maintaining performance and other utility. Thus, the costs of maintaining performance and other utility are an inherent element of the agencies' cost estimation process. The agencies consequently believe it reasonable to conclude that there will be no loss of vehicle utility as a direct result of these final rules. The agencies also 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 these additions may be affected by the presence of fuel-saving technology.

commenters considered vehicle choice models too uncertain for use in this rulemaking, while another requested that we conduct explicit consumer vehicle choice modeling (although without providing a justification as to which models to use or why any particular modeling approach is likely to generate superior estimates). Because the agencies have not yet developed sufficient confidence in their vehicle choice modeling efforts, we believe it is premature to use them in this rulemaking. The agencies have continued to explore the possible use of these models, as discussed in Sections III.H.1.a and IV.G.6, below.

• *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 CAFE and GHG standards (and which is mandated by statute for measuring compliance with CAFE passenger car standards)[264]. The modeling approach in this final rule is consistent with the proposal, and also follows the MYs 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 models that operate on liquid fuels will be 20 percent lower than their fuel economy ratings as measured for purposes of CAFE fuel economy testing. 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).[265] 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.[266] The U.S. Coalition for Advanced Diesel Cars suggested that the on-road gap used in the proposal was overly conservative at 20%, and that advanced technology vehicles may have on-road gaps that are larger than current vehicles. The agencies recognize the potential for future changes in driver behavior or vehicle technology to change the on-road gap to be either larger or smaller. The agencies continue to use the same estimates of the on-road gap as in the proposed rule for estimating fuel savings and other impacts, and will monitor the EPA fuel economy database as these future model year vehicles enter the fleet.

• *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 rule's estimated benefits. For these rules, the agencies are using the most recent fuel price projections from the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2012 Early Release reference case. The projections of fuel prices reported in EIA's AEO 2012 Early Release extend through 2035. Fuel prices beyond the time frame of AEO's forecast were estimated by applying the average growth rate for the years 2017–2035 for each year after 2035. This is the same general methodology used by the agencies in the analysis for the proposed rule, as well as in the MYs 2012–2016 rulemaking, in the heavy duty truck and engine rule (76 FR 57106), and in the Interim Joint TAR. For example, the AEO 2012 Early Release projections of gasoline fuel prices (in constant 2010$) are $3.63 per gallon in 2017, $3.76 in 2020, and $4.09 in 2035. Extrapolating as described above, retail gasoline prices are projected to reach $4.57 per gallon in 2050 (measured in constant 2010 dollars). Several commenters (Volkwagen, Consumer Federation of America, Environmental Defense Fund, Consumer's Union, National Resources Defense Council, Union of Concerned Scientists) stated that the EIA AEO 2011 future fuel price projections used in the proposal were similar to current prices, and thus were modest, or lower than expected. The agencies note that if a higher fuel prices projection were used, it would increase the value of the fuel savings from the rule, while a lower fuel price projection would decrease the value of the fuel savings from the rule. Another commenter noted the uncertainty projecting automotive fuel prices during this extended time period (National Auto Dealers' Association). As discussed in Chapter 4 of the Joint TSD, while the agencies believe that EIA's AEO reference case generally represents a reasonable forecast of future fuel prices for use in our analysis of the benefits of this rule, we recognize that there is a great deal of uncertainty in future fuel prices. However, given that no commenters offered alternative sources for fuel price projections, and the agencies have found no better source since the NPRM, in this final rulemaking the agencies continue to rely upon EIA projections of future gasoline and diesel prices.

• *Consumer cost of ownership and payback period*—The agencies provide, in Sections III.H.3 and IV.G.4, estimates of the impacts of these rules on the net costs of owning new vehicles, as well as the time period necessary for the fuel savings to outweigh the expected increase in prices for the new vehicles (i.e., the payback period). These analyses focus specifically on the buyers' perspectives, and therefore take into account the effect of the rule on insurance premiums, sales tax, and finance charges. From a social perspective, these are transfers of money from one group to another, rather than net gains or losses, and thus have no net effect on the net benefits of the rules. For instance, a sales tax is a cost to a vehicle buyer, but the money does not represent economic resources that are consumed; instead, it goes to finance state and local government activities, such as schools or roads. The role of finance charges is to spread payments over time, taking into account the opportunity cost of financing; this is just a reversal of the process of discounting, and thus does not affect the present value of the vehicle cost. Though the net benefits analysis is not affected by these payments, from the buyers' viewpoint, these are additional costs. In the NPRM, EPA included these factors in its payback period analysis and asked for comment on them; no comments were received. The agencies have updated these values for these final rules; the details of the estimation of these factors are found in TSD Chapter 4.2.13. Though the agencies use these common values for their respective cost of ownership and payback period analyses, each agency's estimates for the cost of ownership and the payback period differ due to somewhat different estimates for vehicle cost increases and fuel savings. Some comments encouraged our inclusion of maintenance and repair costs in these calculations and the agencies have responded by including maintenance costs in that analysis of the final rule.

[264] 49 U.S.C. 32904(c).

[265] 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. (Docket No. EPA–HQ–OAR–2010–0799–1125).

[266] See 71 FR 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, Docket No. EPA–HQ–OAR–2010–0799–1113) 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.

The potential effects of the rule on maintenance and repair costs are discussed in Sections III.H.2, IV.C.2, and Chapter 3.6 of the Joint TSD. When a new vehicle is destroyed in an accident, the higher costs of the replacement vehicle are already accounted for in the technology costs of new vehicles sold, since some of these are purchased to replace vehicles destroyed in accidents.[267]

• *Vehicle sales assumptions*—The first step in estimating lifetime fuel consumption by vehicles produced during a model year is to calculate the number of vehicles that are expected to be produced and sold. The agencies relied on the AEO 2011 and AEO 2012 Early Release Reference Cases 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 analysis for the proposed rule (and as in the MYs 2012–2016 final rule and Interim Joint TAR), we apply updated values of age-specific survival rates for cars and light trucks to the 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. Since the proposal, these values were updated using the same methodology with which the original estimates were developed, together with recent vehicle registration data obtained from R.L. Polk. No comments were received on the vehicle lifetime and survival rates in the proposal.

• *Vehicle miles traveled (VMT)*—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 2009 National Household Travel Survey (NHTS).[268] 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 meet the levels projected in the AEO 2012 Early Release Reference Case. The growth rate in average annual car and light truck use produced by this calculation is approximately 0.6 percent per year, and is applied in the agencies' modeling through 2050. We applied this growth rate to the mileage figures derived from the 2009 NHTS to estimate annual mileage by vehicle age during each year of the expected lifetimes of MY 2017–2025 vehicles. A generally similar approach to estimating future vehicle use was used in the MYs 2012–2016 final rules and Interim Joint TAR, but the future growth rates in average vehicle use have been revised for this rule. No substantive technical comments were received on this approach.

• *Accounting for the fuel economy rebound effect*—The fuel economy rebound effect refers to the increase in vehicle use (VMT) that results if an increase in fuel economy lowers the cost of driving. The agencies are continuing to use a 10 percent fuel economy rebound effect, consistent with the proposal, in their analyses of fuel savings and other benefits from more stringent standards. This value is also consistent with that used in the MYs 2012–2016 light-duty vehicle rulemaking and the Interim Joint TAR. That is, we assume that a 10 percent decrease in fuel cost per mile resulting from our standards would result in a 1 percent increase in the annual number of miles driven at each age over a vehicle's lifetime. We received comments recommending values both higher and lower than our proposed value of 10 percent for the fuel economy rebound effect, as well as comments maintaining that there were indirect rebound effects for which the agencies should account. The agencies discuss comments on this topic in more detail in sections III.H.4 and IV.C.3 of the preamble. The agencies do not regard any of these comments as providing new data or analysis that justify revising the 10 percent value. In Chapter 4 of the joint TSD, we provide a detailed explanation of the basis for our fuel economy rebound estimate, including a summary of new literature published since the MYs 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 RIA and Chapter 4 of EPA's RIA for sensitivity and uncertainty analyses of alternative fuel economy rebound assumptions.

• *Benefits from increased vehicle use*—The increase in vehicle use from the rebound effect results from vehicle buyers' decisions to 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 during that additional travel, plus the consumer surplus drivers receive from the improved accessibility their travel provides. No comments were received on this particular issue. As in the analysis for the proposed rule (and as in the MYs 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 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 fuel economy rebound effect also contributes to increased traffic congestion, motor vehicle accidents, and highway noise. Depending on how the additional travel is distributed over the day and where it takes place, additional vehicle use can contribute to traffic congestion and delays by increasing the number of vehicles using facilities that are already heavily traveled. These added delays impose higher costs on drivers and other vehicle occupants in the form of increased travel time and operating expenses. At the same time, this additional travel also increases costs associated with traffic accidents and vehicle noise. No comments were received on the specific economic assumptions employed in the proposal. The agencies are using the same methodology as used in the analysis for the proposed rule, relying on estimates of congestion, accident, and noise costs imposed by automobiles and light trucks developed by the Federal Highway Administration to estimate these increased external costs caused by added driving.[269] This method is also

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[267] The agencies do not have information to estimate the effect of the rule on repair costs for vehicles that are damaged but not destroyed. Some repairs, such as minor dents, may be unaffected by changes in vehicles; others may be more or less expensive. Insurance premiums in principle could provide insight into the costs of damages associated with more expensive vehicles, but, because insurance premiums include costs for destroyed vehicles, which are already implicitly covered in the sales estimates, it is not possible to separately estimate the costs for repairs from insurance data. See Joint TSD Chapter 3.6 for further discussion of this issue.

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

[269] These estimates were developed by FHWA for use in its 1997 *Federal Highway Cost Allocation Study; http://www.fhwa.dot.gov/policy/hcas/final/index.htm* (last accessed July 8, 2012).

consistent with the MYs 2012–2016 final rules.

• *Petroleum consumption and import externalities*—U.S. consumption of imported petroleum products imposes costs on the domestic economy that are not reflected in the market price for crude oil, or in the prices paid by consumers of petroleum products such as gasoline (often referred to as ''energy security'' costs). 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 (the ''monopsony effect''); (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. (often referred to as ''macroeconomic disruption and adjustment costs''); 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 (i.e., ''military/SPR costs'').[270] While the agencies received a number of comments regarding these energy security costs, particularly the treatment of military costs, we continue to use the same methodology from the proposal. Further discussion of these comments and the agencies' responses can be found in Sections III.H.8 and IV.3.

• *Monopsony Component*—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.[271,272] Although the reduction in the global price of crude oil and refined petroleum 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 sellers of crude petroleum and refined products from other countries. 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.

• *Macroeconomic Disruption Component:* In contrast to monopsony costs, 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 we include the estimated reduction in their expected value stemming from reduced U.S. petroleum imports in our energy security benefits estimated for this program.

• *Military and SPR Component:* We recognize that there may be significant (if unquantifiable) benefits in improving national security by reducing U.S. oil imports, and public comments supported the agencies inclusion of such benefits. Quantification of military security benefits is challenging because attribution to particular missions or activities is difficult and because it is difficult to anticipate the impact of reduced U.S. oil imports on military spending. The agencies do not have a robust way to calculate these benefits at this time, and thus exclude U.S. military costs from the analysis.

Similarly, since the size of the SPR, or other factors affecting the cost of maintaining the SPR, historically have not varied in response to changes in U.S. oil import levels, we exclude changes in the cost of maintaining the SPR from the estimates of the energy security benefits of the program. The agencies continue to examine appropriate methodologies for estimating the impacts on military and SPR costs as U.S. oil imports are reduced.

To summarize, the agencies have included *only* the macroeconomic disruption and adjustment costs portion of potential energy security benefits to estimate the monetary value of the total energy security benefits of this program. The energy security premium values in this final rule have been updated since the proposal to reflect the AEO2012 Early Release Reference Case projection of future world oil prices. Otherwise, the methodology for estimating the energy security benefits is consistent with that used in the proposal. Based on an update of an earlier peer-reviewed Oak Ridge National Laboratory study that was used in support of the both the MYs 2012–2016 light duty vehicle and the MYs 2014–2018 medium- and heavy-duty vehicle rulemakings, 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 $0.197 (2010$) in 2025. Each gallon of fuel saved as a consequence of higher standards is anticipated to reduce total U.S. imports of crude oil or refined fuel by 0.95 gallons.[273]

• *Air pollutant emissions*—

• *Impacts on criteria air pollutant emissions*—Criteria air pollutants emitted by vehicles, during fuel production and distribution, and during electricity generation 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 generation to power PHEVs and EVs will increase emissions. Thus the net effect of more stringent GHG and fuel economy 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 criteria pollutant emission rates for cars and light trucks produced during the model years affected by the 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 proposal and in the MYs 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, as well as new estimates of the emission rates from electricity generation. No comments were received on the use of the MOVES model. The agencies analyses of

[270] 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.

[271] Leiby, Paul. Oak Ridge National Laboratory. ''Approach to Estimating the Oil Import Security Premium for the MY 2017–2025 Light Duty Vehicle Rule'' 2012, EPA Docket EPA–HQ–OAR–2010–0799–41789.

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

[273] 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.

emissions from electric power plants are discussed in EPA RIA chapter 4, NHTSA RIA chapter VIII and NHTSA's EIS.

• *Economic value of reductions in criteria pollutant emissions*—To evaluate benefits from reducing emissions of criteria pollutants over the lifetimes of MY 2017–2025 vehicles, EPA and NHTSA estimate the economic value of the human health impacts associated with reducing population exposure to $PM_{2.5}$ using a ''dollar-per-ton'' method. These $PM_{2.5}$-related dollar-per-ton estimates provide the total monetized impacts to human health (the sum of changes in the incidence of premature mortality and morbidity) that result from eliminating or adding one ton of directly emitted $PM_{2.5}$, or one ton of $PM_{2.5}$ precursor (such as NO_X, SO_X, and VOCs, which are emitted as gases but form $PM_{2.5}$ as a result of atmospheric reactions), from a specified source. These unit values remain unchanged from the proposal. Note that the agencies' joint analysis of criteria air pollutant impacts over the model year lifetimes of 2017–2025 vehicles includes no estimates of the direct health or other impacts associated with emissions of criteria pollutants other than $PM_{2.5}$ (as distinguished from their indirect effects as precursors to $PM_{2.5}$). The agencies did receive comments arguing that the agencies should have included these impacts in their analyses, however, no ''dollar-per-ton'' method exists for ozone or toxic air pollutants due to complexity associated with atmospheric chemistry (for ozone and toxics) and a lack of economic valuation data and methods (for air toxics).

For the final rule, however, EPA and NHTSA also conducted full scale, photochemical air quality modeling to estimate the change in ambient concentrations of ozone, $PM_{2.5}$ and air toxics (i.e., hazardous air pollutants listed in section 112(b) of the Clean Air Act) for the year 2030, and used these results as the basis for estimating the human health impacts and their economic value of the rule in 2030. However, the agencies have not conducted such modeling over the complete life spans of the vehicle model years subject to this rulemaking, due to timing and resource limitations. Section III.H.7 below and Appendix E of NHTSA's Final EIS present these impact estimates.

• *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 these rules.[274] 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 changes in emissions of non-CO_2 GHGs that occur during fuel production, electricity use, and vehicle use due to their respective standards.[275] The agencies approach to estimating GHG emissions is consistent with the method used at proposal (and in the MYs 2012–2016 final rule and the Interim Joint TAR). No comments were received on the method for calculating impacts on greenhouse gas emissions, although several commenters discussed the emission factors used for electricity generation. These comments are discussed in section III.C and IV.X.

• *Economic value of reductions in CO_2 emissions*—EPA and NHTSA assigned a dollar value to reductions in CO_2 emissions, consistent with the proposal, using recent estimates of the ''social cost of carbon'' (SCC) developed by a federal interagency group that included representatives from both agencies and reported the results of its work in February 2010. 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.''[276] Published estimates of the SCC, as well as those developed by the interagency group, 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.[277] The SCC Technical Support Document (SCC TSD) provides a complete discussion of the methods used by the federal interagency group to develop its SCC estimates. Several commenters expressed support for using SCC to value reductions in CO_2 emissions and provided detailed recommendations directed at improving the estimates. One commenter disagreed with the use of SCC. However, as discussed in III.H.6 and IV.C.3 of the preamble, the SCC estimates were developed using a reasonable set of input assumptions that are supported by published literature. As noted in the SCC TSD, the U.S. government intends to revise these estimates over time, if appropriate, taking into account new research findings that were not available in 2010.

Several commenters also recommended presenting monetized estimates of the benefits of reductions in non-CO_2 GHG emissions (i.e., methane, nitrous oxides, and hydrofluorocarbons) expected to result from the final rule. Although the agencies are not basing their primary analyses on this suggested approach, they have conducted sensitivity analyses of the final rule's monetized non-CO_2 GHG impacts in preamble section III.H.6 and Chapter X of NHTSA's FRIA. Preamble sections III.H.6 and IV.C.3 also provide a more detailed discussion about the response to comments on SCC.

• *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 efficiency provides additional benefits to vehicle owners. The primary benefits from reducing the required frequency of refueling are the value of time saved by drivers and other vehicle occupants, as well as the value of the minor savings in fuel that would have been consumed during refueling trips that are no longer

[274] 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 10,180 grams per gallon.

[275] 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.

[276] SCC TSD, see page 2. Docket ID EPA–HQ–OAR–2010–0799–0737, *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.*

[277] SCC TSD, see pages 6–7.

required. Using recent data on vehicle owners' refueling patterns gathered from a survey conducted by the National Automotive Sampling System (NASS), NHTSA was able to more accurately estimate the characteristics of refueling trips. NASS data provided NHTSA with 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 during refueling trips, the average quantity of fuel purchased, and the distribution of reasons given by drivers for refueling. From these estimates, NHTSA constructed a revised set of assumptions to update those used in the MYs 2012–2016 FRM for calculating refueling-related benefits. The MYs 2012–2016 FRM discussed 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 benefits resulting from less frequent refueling, the framework of the analysis remains essentially the same as in the MYs 2012–2016 final rule. Note that this topic and associated benefits were not covered in the Interim Joint TAR. No comments were received on the refueling analysis presented in the NPRM. Detailed discussion and examples of the agencies' approaches are provided in Chapter VIII of NHTSA's FRIA and Chapter 7 of EPA's RIA.

• *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.[278] 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 proposal. One commenter (UCS) agreed with the agencies' use of 3 and 7 percent discount rates, while another (API) stated that the Energy Information Administration (EIA) uses a 15 percent ''consumer-relevant discount rate when evaluating the economic cost-effectiveness of new vehicle efficiency technology,'' which it noted would affect the agencies' assumptions of benefits if employed. The agencies have continued to employ the 3 and 7 percent discount rate values for the final rule analysis, as discussed further below in section IV.C.3 and in Chapter 4 of the Joint TSD.

For the reader's reference, Table II–19 and Table II–20 below summarize the values used by both agencies to calculate the impacts of the final standards. The values presented in these tables are summaries of the inputs used for the models; specific values used in the agencies' respective analyses may be aggregated, expanded, or have other relevant adjustments. See the Joint TSD, Chapter 4, and each agency's respective RIA for details.

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 Joint TSD. The agencies tested the sensitivity of their estimates of costs and benefits to a range of assumptions about each of these inputs, and found that the magnitude of these variations would not have changed the final standards. For example, NHTSA conducted separate sensitivity analyses for, among other things, discount rates, fuel prices, the social cost of carbon, the fuel economy rebound effect, consumers' valuation of fuel economy benefits, battery costs, mass reduction costs, energy security costs, and the indirect cost markup factor. This list is similar in scope to the list that was examined in the proposal, but includes post-warranty repair costs and transmission shift optimizer effectiveness as well. NHTSA's sensitivity analyses are contained in Chapter X of NHTSA's RIA.

Similarly, EPA conducted sensitivity analyses on discount rates, the social cost of carbon, 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, 4, and 7 of the EPA RIA. In addition, NHTSA performed 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 RIA.

TABLE II–19—ECONOMIC VALUES FOR BENEFITS COMPUTATIONS (2010$)

Rebound effect	10%
''Gap'' between test and on-road MPG for liquid-fueled vehicles	20%.
''Gap'' between test and on-road electricity consumption for electric and plug-in hybrid electric vehicles	30%.
Annual growth in average vehicle use	0.6.
Fuel Prices (2017–50 average, $/gallon)	
Retail gasoline price	$4.13.
Pre-tax gasoline price	3.78.
Economic Benefits from Reducing Oil Imports ($/gallon)	
''Monopsony'' Component	$ 0.0.0.
Macroeconomic Disruption Component	0.197 in 2025.
Military/SPR Component	0.00.
Total Economic Costs ($/gallon)	0.197 in 2025.
Emission Damage Costs (2020, $/short ton, 3% discount rate)	
Carbon monoxide	$ 0.

[278] 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 rule, and require discounting only for the purpose of expressing them as present values as of a common year (2012 for the Calendar Year analysis; the first year of production for each MY vehicle—2017 through 2025—for the Model Year analysis).

TABLE II–19—ECONOMIC VALUES FOR BENEFITS COMPUTATIONS (2010$)—Continued

Rebound effect	10%
Nitrogen oxides (NO_X)—vehicle use	5,600.
Nitrogen oxides (NO_X)—fuel production and distribution	5,400.
Particulate matter ($PM_{2.5}$)—vehicle use	310,000.
Particulate matter ($PM_{2.5}$)—fuel production and distribution	250,000.
Sulfur dioxide (SO_2)	33,000.
Annual CO_2 Damage Cost (per metric ton)	Variable, depending on discount rate and year (see Table II–20 for 2017 estimate).
External Costs from Additional Automobile Use ($/vehicle-mile)	
Congestion	$ 0.056.
Accidents	0.024.
Noise	0.001.
Total External Costs	$ 0.081.
External Costs from Additional Light Truck Use ($/vehicle-mile)	
Congestion	$0.050.
Accidents	0.027.
Noise	0.001.
Total External Costs	0.078.
Discount Rates Applied to Future Benefits	3%, 7%.

TABLE II–20—SOCIAL COST OF CO_2 ($/METRIC TON), 2017 (2010$)

Discount rate	5%	3%	2.5%	3%
Source of Estimate	Mean of Estimated Values			95th percentile estimate.
2017 Estimate	$6	$26	$41	$79.

F. CO_2 Credits and Fuel Consumption Improvement Values for Air Conditioning Efficiency, Off-Cycle Reductions, and Full-Size Pickup Trucks

For the MYs 2012–2016 rule, 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. EPA also provided another credit generating option for 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.’’ See 76 FR 74937, 74998, 75020.

EPA proposed to continue these credit mechanisms in the MYs 2017–2025 GHG program, and is finalizing these proposals in this notice. EPA also proposed that certain of the A/C credits and the off-cycle credits be included under the CAFE program. See *id.* and 76 FR 74995–998. For this rule, under EPA's EPCA authority, EPA is allowing manufacturers to generate fuel consumption improvement values for purposes of CAFE compliance based on the use of A/C efficiency and the other off-cycle technologies. These fuel consumption improvement values will not apply to compliance with the CAFE program for MYs 2012–2016. Also, reductions in direct A/C emissions resulting from leakage of HFCs from air conditioning systems, which are generally unrelated to fuel consumption reductions, will not apply to compliance with the CAFE program. Thus, as discussed below, credits for refrigerant leakage emission reductions will continue to apply only to the EPA GHG program.

The agencies expect that, because of the significant credits and fuel consumption improvement values available for improvements to the efficiency of A/C systems (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 0.000810 gal/mi for trucks), manufacturers will take technological steps to maximize these benefits. Since we project that all manufacturers will adopt these A/C improvements to their maximum extent, EPA has adjusted 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),[279] and NHTSA has also accounted for expected A/C efficiency improvements in determining the maximum feasible CAFE standards. The agencies discuss these CO_2 credits and fuel consumption improvement values below and in more detail in Chapter 5 of the Joint TSD. We also discuss below how other (non-A/C) off-cycle improvements in CO_2 and fuel consumption may be eligible to apply towards compliance with the GHG and CAFE standards; however, with two exceptions (for the two-cycle benefits of stop-start and active aerodynamic improvements—technologies which EPA expects manufacturers to adopt widely and whose benefits can be reliably quantified), these off-cycle improvements are not incorporated in the stringency of the standards Finally, EPA discusses in Section III.C below the

[279] Similarly, the MYs 2012–2016 GHG standards reflect direct and indirect A/C improvements. See 75 FR 25371, May 7, 2010.

GHG A/C leakage credits that are exclusive to the GHG standards.

EPA, in coordination with NHTSA, is also introducing for MYs 2017–2025 a new incentive for certain advanced technologies used in full-sized pickup trucks. Under its EPCA authority for CAFE and under its CAA authority for GHGs, EPA is establishing 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 from these full-sized pickup trucks.

We discuss each of these types of credits and incentives, in detail below and throughout Chapter 5 of the Joint TSD. We also discuss and respond to the key comments throughout this section.

1. Air Conditioning Efficiency Credits and Fuel Consumption Improvement Values

After detailed consideration of the comments and other available information, the agencies are finalizing a program of A/C efficiency credits and fuel consumption improvement values. Although the agencies are making some minor changes for the final rule, as described below, we are finalizing the program establishing efficiency credits and fuel consumption improvement values largely in its proposed form. Specifically, efficiency credits will continue to be calculated from a technology ''menu'' once manufacturers qualify for eligibility to generate A/C efficiency credits through specified A/C CO_2 emissions testing.

The efficiency credits and fuel consumption improvement values in this rule reflect an understanding of the relationships between A/C technologies and CO_2 emissions and fuel consumption that is improved from the MYs 2012–2016 rulemaking. Much of this understanding results from the use of a new vehicle simulation tool that EPA has developed and that the agencies used for the proposal and for this final rulemaking. 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, and no comments were received raising concerns about the model or its use in this rule. Chapter 2 of the EPA Regulatory Impact Analysis discusses the development of this model in more detail.

The agencies have identified several technologies related to improvements in A/C efficiency. 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 to align with cabin demand by using more sophisticated sensors and control strategies is one path to improving the overall efficiency of the A/C system. See generally section 5.1.3 of Joint TSD Chapter 5.

A broad range of stakeholders submitted general comments expressing support for the overall proposed program for A/C efficiency credits and fuel consumption improvement values as an appropriate method of encouraging efficiency-improving technologies. One commenter, Center for Biological Diversity, stated that ''[t]echnology that will be available during the rulemaking period and can be incorporated in an economically feasible manner should be built into the standard and not merely used as an 'incentive'.'' In fact, all of these A/C improvements (for both indirect and direct A/C improvements) are reflected in the standard stringency.[280] See section II.C.7.b above. Moreover, we have every expectation that manufacturers will use most if not all of these technologies—precisely because of their ready availability and relatively low cost.

Automaker and auto supplier commenters broadly supported the agencies' assessments of likely A/C efficiency-improving technologies and the credit values assigned to them. Several commenters suggested relatively minor changes in these assessments. One commenter, ICCT, suggested an approach that would attempt to vary A/C efficiency credits based on the degree to which other off-cycle improvements—specifically solar load reductions—may have independently reduced the demand for A/C cooling. ICCT's suggestion was to address what the commenter viewed as a potential for 'double-counting.' EPA agrees with the observation that A/C efficiency improvements and solar load improvements are related technically. However, we believe that the added complexity of scaling the established credit values for A/C technologies according to solar load improvements would not be warranted, given relatively small change in the overall credit values that would likely result. We are thus finalizing separate treatment of A/C efficiency and other off-cycle improvements, as proposed. (We summarize and discuss comments on A/C efficiency test procedures below.)

As described in Chapter 5.1.3.2 of the Joint TSD, EPA calculated the total eligible A/C efficiency credits from an analysis of the average impact of air conditioning on tailpipe CO_2 emissions. This methodology differs from the one used for the MYs 2012–2016 rule, though it does give similar values. In the MYs 2012–2016 rule, the total impact of A/C on tailpipe emissions was estimated to be 3.9% of total GHG emissions, or approximately 14.3 g/mi. Largely based on an SAE feasibility study,[281] EPA assumed that 40% of those emissions could be reduced through advanced technologies and controls. Thus, EPA calculated a maximum credit of 5.7 g/mi (for both cars and trucks) from efficiency improvements. EPA also assumed that there would be 85% penetration of these technologies when setting the standard, and consequently made the standard more stringent by 5.0 g/mi. For the MYs 2017–2025 proposal, EPA recalculated the A/C tailpipe impact using its vehicle simulation tool. Based on these simulations, it was determined that trucks should have a higher impact than cars, and the total emissions due to A/C was calculated to be 11.9g/mi for cars and 17.1 g/mi for trucks. In the proposal, the feasible level of control was increased slightly from the MYs 2012–2016 final rule to 42% (within the uncertainty bounds of the studies cited). Thus the maximum credit became 5.0 for cars and 7.2 for trucks, and the proposed stringency of the standards reflected these new levels as the penetrations increased from 85% in MY 2016 to 100% in MY 2017 (for car) and 2019 (for truck). Volkswagen commented that the change in split in the maximum car/truck efficiency credit from the previous rule changed the context for their compliance plans for cars. The agencies understand that a slightly lower maximum credit level could have a modest effect on compliance plans. We note that the level of stringency for cars due to A/C has not changed from the value we used

[280] As explained in section I.B above, one reason the CAFE and GHG standards are not the same in miles-per-gallon space is that direct leakage A/C improvements are reflected in the GHG standards.

[281] Society of Automotive Engineers, ''IMAC Team 2—Improved Efficiency, Final Report,'' April 2006 (EPA Docket # EPA–HQ–OAR–2010–0799).

for MY 2016, as this was assumed to be 5.0 g/mi in the previous rule as well as in the more recent proposal. We also believe that it is appropriate that the program evolve as our understanding of the inventory of in-use GHG emission inventories improves—as is the case in this instance. Having said this, the levels of the credits did not change significantly for cars and thus should not significantly affect A/C related GHG credit and fuel consumption improvement value calculations. We are therefore, finalizing the 5.0 and 7.2 g/mi maximum credits for cars and trucks respectively as proposed. This represents an improvement in current A/C related CO_2 and fuel consumption of 42% (again, as proposed) and the agencies are using this level of improvement to represent the maximum efficiency credit available to a manufacturer. This degree of improvement is reflected in the stringency of the final standards.

Specific components and control strategies that are available to manufacturers to reduce the air conditioning load on the engine are listed in Table II–21 below and are discussed in more detail in Chapter 5 of the joint TSD.

a. A/C Idle Test

Demonstrating the degree of efficiency improvement that a manufacturer's air conditioning systems achieve—thus quantifying the appropriate GHG credit and CAFE fuel consumption improvement value that the manufacturer is eligible for—would ideally involve a performance test. That is, manufacturers would use a test that would directly measure CO_2 (and thus allow calculation of fuel consumption) before and after the incorporation of the improved technologies. A performance test would be preferable to a predetermined menu value because it could—potentially—provide a more accurate assessment of the efficiency improvements of differently designed A/C systems. Progress toward such a test (or tests) 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'' test, does not require or simulate air conditioning usage through the test cycle. The existing SC03 test, which is used for developing the fuel economy and environment label values, is designed to identify any effect that the air conditioning system has on other emissions when it is operating under extreme temperature and solar conditions, but that test is not designed to measure the relatively small differences in tailpipe CO_2 due to different A/C efficiency technologies.

At the time of the final rule for the MYs 2012–2016 GHG program, EPA concluded that a practical, performance-based test procedure capable of quantifying efficiency credits was not yet available. Instead, EPA adopted a specialized new procedure for the more limited purpose of demonstrating that the design improvements for which a manufacturer was earning credits produced actual efficiency improvements. That is, passing the test was a precondition to generating A/C efficiency credits, but the test was not used in measuring the amount of those credits. See 76 FR 74938. EPA's test is fairly simple, performed while the vehicle is at idle, and thus named the A/C Idle Test, or just Idle Test. Beginning with the 2014 model year, manufacturers are required to achieve a certain CO_2 level on the Idle Test in order to then be able to use the technology-based lookup table (''menu'') and thus quantify the appropriate number of GHG efficiency credits that the vehicle can generate. See 75 FR 25427–31.

In meetings since the MYs 2012–2016 final rule was published and during the public comment period for this rule, several manufacturers provided data that raise questions about the ability of the Idle Test to completely fulfill its intended purpose. Especially for smaller, lower-powered vehicles, the data show that it can be difficult to achieve a degree of test-to-test repeatability that manufacturers believe is necessary in order to comply with the Idle Test requirement and generate credits. Similarly, manufacturers and others have stated that the Idle Test does not accurately or sufficiently capture the improvements from many of the technologies listed in the menu. While two commenters (Hyundai and Kia) supported retaining the Idle Test for the purpose of generating A/C credits, most commenters strongly opposed any use of the Idle Test. In some cases, although they recommended that EPA abandon the Idle Test, several manufacturers suggested changes to the test if it is to remain as a part of the program. Specifically, these manufacturers supported the EPA proposals to scale the Idle Test results by engine size and to broaden the ambient temperature and humidity specifications for the Idle Test.

EPA noted many of these concerns in the preamble to the proposed rule, and proposed certain changes to the A/C Idle Test as a result. See 76 FR 74938. EPA also notes that the Idle Test was never meant to directly quantify the credits generated and we acknowledge that it is inadequate to that task. The Idle Test was meant simply to set a threshold in order to access the menu to generate credits (and in some cases to adjust the menu values for partial credit). EPA also discussed that it had developed a more rigorous (albeit more complicated and expensive to perform) test—the AC17 test—which includes the SC03 driving cycle, the fuel economy highway cycle, a preconditioning cycle, and a solar peak period. EPA proposed that the AC17 test would be mandatory in MYs 2017 and following model years, but that the AC Idle Test would continue to be used in MYs 2014–2016 (with the AC17 test used as a report-only alternative in those earlier model years).[282] Under the proposal, the AC17 test (unlike the AC Idle Test) would be used in fixing the amount of available credit. Specifically, if the AC17 test result, compared to a baseline AC17 test of a previous model year vehicle without the improved technology, equaled or surpassed the amount of menu credit, the manufacturer would receive the full menu credit amount. If the AC17 test result was less than the menu value, the manufacturer would receive the amount of credit corresponding to the AC17 test result.[283]

Since proposal, EPA has continued to carefully evaluate the concerns and suggestions relating to the Idle Test. The agency recognizes that there are technical shortcomings as well as advantages to this relatively simple and inexpensive test. EPA has concluded that, given that a more sophisticated A/C is now available, the most appropriate course is to maintain the availability of the AC Idle Test through MY 2016, but to also allow manufacturers the option of using the AC17 test to demonstrate that A/C components are indeed functioning effectively. This use of the AC17 test as an alternative to the Idle Test will be allowed, commencing with MY 2014. Thus, for MYs 2014, 2015, and 2016, manufacturers will be able to generate A/C efficiency credits from the technology menu by performing and reporting results from the AC17 test in lieu of passing the Idle Test. During these model years, the level of credit and fuel consumption improvement value manufacturers can generate from the menu will be based on the design of the A/C system. In MYs 2017–2019, eligibility for AC efficiency credits will be determined solely by performing and reporting AC17 test results. During this time, the process for determining the

[282] 76 FR 74940.

[283] 76 FR 74940.

level of credit and fuel consumption improvement value will be the same as during MYs 2014, 2015, and 2016. Finally, starting in MY 2020, AC17 test results will be used both to determine eligibility for AC efficiency credits and to play a role in determining the amount of the credit, as proposed. In order to determine the amount of credit or fuel consumption improvement value after MY 2020, an A to B comparison will be required. The credit and fuel consumption improvement menu will continue to be used. Because of the general technical support for the AC17 test, and in light of several important clarifications and changes that EPA is implementing to minimize the AC17 testing burden on manufacturers, EPA believes that most if not all manufacturers wishing to generate efficiency credits will choose to perform the AC17 test. Specifically, EPA is modifying the proposed AC17 test procedure to reduce the number of vehicles requiring testing, so that many fewer vehicles will need to be tested on the AC17 than on the Idle Test. Further discussion of the AC17 test appears below in this section of the preamble and in Chapter 5.1.3.6 of the Joint TSD.

However, EPA is continuing to allow the Idle Test as a testing option through MY 2016. In addition, EPA is finalizing the modifications that we proposed to the Idle Test, making the threshold for access to the menu a function of engine displacement an option instead of the flat threshold, as well as adjusting the temperature and humidity specifications in the AC Idle Test. We are also finalizing the proposed modification that would allow a partial credit if the Idle Test performance is better than typical performance, based on historic EPA results from Idle Testing. Chapter 5.1.3.5 of the Joint TSD further describes the adjustments that EPA is making to the Idle Test for MYs 2014–2016.

b. AC17 Test

As mentioned above, EPA, working in a joint collaboration with manufacturers (through USCAR) and CARB, has made significant progress in developing a more robust A/C-related emissions test. As noted above, the AC17 test is a four-part performance test, which combines the existing SC03 driving cycle, the fuel economy highway cycle, as well as a pre-conditioning cycle and a solar soak period. As proposed, and as discussed below, EPA will allow manufacturers choosing to generate efficiency credits to report the results of the AC17 test in lieu of the Idle Test requirements for MYs 2014–2016, and will require them to use the AC17 test after MY 2016. Until MY 2019, as for MYs 2014–2016, manufacturers will need to report the results from AC17 testing, but not to achieve a specific CO_2 emissions reduction in order to access the menu. However, beginning with MY 2020, they will need to compare the test results to those of a baseline vehicle to demonstrate a measureable improvement in A/C CO_2 emissions and fuel consumption as a precondition to generating AC efficiency credits from the A/C credit and fuel consumption improvement menu; in the event that the improvement is less than the menu value, the amount of credit would be determined by the AC17 test result.

EPA is making several technical and programmatic changes to the proposed AC17 test to minimize the number of vehicles that manufacturers will need to test, and to further streamline each test in order to minimize the testing burden. Since the appropriateness of the AC17 test for actually quantifying absolute A/C efficiency improvements (as opposed to demonstrating a relative improvement) is still being evaluated, manufacturers wishing to generate A/C efficiency credits will continue to use the technology menu to quantify the amount of CO_2 credits and fuel consumption improvement values for compliance with the GHG and CAFE programs. A number of commenters, including the Alliance, Ford, The Global Automakers, and others suggested that further work with the industry on the test should occur before implementing its use. However, we believe that the general robustness of the test, combined with the technical and programmatic improvements that EPA is incorporating in this final rule (as discussed below), and the de facto phase-in of the test in MYs 2014–2016 as well as MYs 2017–2019, support our decision to implement the test.

i. AC17 Technical Issues

Commenters universally agreed that in most technical respects the AC17 test represents an improvement over the Idle Test. A few commenters suggested specific technical changes, which EPA has considered. Several auto industry commenters suggested that the proposed temperature and humidity tolerances of the test cell conditions may result in voided tests, due to the difficulty they see in maintaining these conditions throughout a 4-hour test interval. However, as discussed in more detail in Chapter 5 of the joint TSD, we are allowing manufacturers to utilize a 30-second moving average for the test chamber temperature; we have concluded that these tolerances are achievable with this revision, and that widening these tolerances would negatively affect the accuracy and repeatability of the test. As a result, we are finalizing the tolerances as originally proposed. Also, one commenter (Enhanced Protective Glass Automotive Association or EPGAA) suggested that for manual A/C systems, the A/C temperature control settings for the test be based on actual cabin temperatures rather than on the duration of lapsed time of the test, as proposed. EPA does not disagree in theory with the purpose of such a change—to attempt to better align the control requirements for a manual A/C system with those for an automatic system. However, the effect on test results of the slightly different control requirements is not large, and we believe that it would be impractical for the technician/driver to monitor cabin temperature and adjust the system accordingly during the test. We are therefore finalizing the automatic and manual A/C system control requirements as proposed.

In several cases, commenters suggested other technical changes to the AC17 test that EPA agrees will make performance of the test more efficient, with no appreciable effect on test accuracy. The relatively minor technical changes that we are finalizing include provisions relating to: the points during the test when cell solar lamps are turned on; establishing a specification for test cell wind speed; and a simplification of the placement requirements for ambient temperature sensors in the passenger cabin. See joint TSD section 5.1.3.5 explaining these changes more fully.

Overall, EPA has concluded that the AC17 test as proposed, with the improvements described above, is a technically robust method for demonstrating differences in A/C system efficiency as manufacturers progressively apply new efficiency-improving technologies.

ii. AC17 Program Issues

Beyond technical issues related to the AC17 test itself, many commenters expressed concerns about several related program issues—i.e., how the agency proposed to use the test as a part of determining eligibility for A/C efficiency credits. First, many manufacturers and their trade associations stated that some characteristics of the AC17 test unnecessarily add to the burden on manufacturers of performing each individual test. For example, the roughly 4-hour duration of the AC17 test limits the number of tests that can be performed in a given facility over a period of time. Also, the test requires the use of relatively costly SC03 test chambers, and manufacturers say that they have, or have access to, only a limited number of these chambers.

Most of these concerns, however, are direct results of necessary design characteristics of the test. Specifically, the impacts on vehicle efficiency of improved A/C technologies are relatively small compared to total vehicle CO_2 emissions and fuel consumption. Similarly, the relative contributions of various A/C-related components, systems, and controls can be difficult to isolate from one another. For these reasons, the joint government and industry collaborators designed the test to accurately and repeatably measure small differences in the efficiency of the entire vehicle related to A/C operation. The result has been that the AC17 test takes a fairly long time to perform (about 4 hours) and requires the special climate-controlled capability of an SC03 chamber, as well as relatively tight test parameters.

As discussed above, EPA believes that the AC17 represents a major step toward the eventual goal of performance-based testing that could be used to directly quantify the very significant A/C efficiency credits and fuel consumption improvement values that are available to eligible manufacturers under this program. In this context, EPA believes that the characteristics of the AC17 test identified by the manufacturers in their comments generally tend to be inherent aspects needed for a robust test, and in most respects we are finalizing the requirements for the use of the AC17 as proposed.

In addition to concerns about the effort required to perform each AC17 test, manufacturers also commented on what they understood as a requirement to run an unreasonable number of tests in order to qualify for efficiency credits and improvement values. On the other hand, ICCT commented that they believe that given the frequent changes in A/C technology, one or two tests per year for a manufacturer is too few, and that ''each significantly changed model should be tested.'' In response to these concerns, EPA has taken several steps in this final rule to clarify how a manufacturer will be able to use the AC17 to demonstrate the effectiveness of its different A/C systems and technologies while minimizing the number of tests that it will need to perform. In general, EPA believes that it is appropriate to limit the number of vehicles a manufacturer must test in any given model year to no more than one vehicle from each platform that generates credits (and CAFE improvement values) during each model year. For the purpose of the AC17 test and generating efficiency credits, EPA will use a definition for ''platform'' that allows a manufacturer to include several generally similar vehicle models in a single ''platform'' and to generate credits (or improvement values) for all of the vehicles with that platform based on a limited number of AC17 tests, as described below. This definition is slightly modified from the proposed definition, primarily by making clear that manufacturers need not necessarily associate vehicles that have different powertrains with different platforms for A/C credit purposes. The modified definition follows:

''Platform'' means a segment of an automobile manufacturer's vehicle fleet in which the vehicles have a degree of commonality in construction (primarily in terms of body and chassis design). Platform does not consider the model name, brand, marketing division, or level of decor or opulence, and is not generally distinguished by such characteristics as powertrain, roof line, or number of doors, seats, or windows. A platform may include vehicles from various fuel economy classes, including both light-duty vehicles and light-duty trucks/medium-duty passenger vehicles.

At the same time, EPA believes that if only a limited number of vehicles in a platform are to be tested on the AC17 in any given model year, it is important that vehicles in that platform with substantially different air conditioning designs be included in that testing over time. Thus, manufacturers with vehicles in a platform that are generating credits will need to choose a different vehicle model each year for AC17 testing. Testing will begin with the model that is expected to have highest sales. In the following model year, the manufacturer will choose the model in that platform representing the next-highest expected sales not already tested, and so on. This process will continue either until all vehicles in that platform that are generating credits have been tested (in which case the previous test data can be carried over) or until the platform experiences a major redesign (at which point the AC17 testing process will start over.) We believe that by clarifying the definition of ''platform'' and more clearly limiting testing to one test per platform per year, we have addressed the manufacturers' concerns about unreasonable test burdens.

Finally, in order to further minimize the number of tests that will be required for A/C efficiency credit purposes, instead of requiring replicate testing in all cases, EPA will allow a manufacturer to submit data from as few as one AC17 test for each instance in which testing is required. A manufacturer concerned about the variability of its testing program may at its option choose to perform additional replicate tests and use of the AC17 test in MYs 2014–2016 is for reporting only) because the data from these initial years will form the basis on which future credits are measured as described below, and a more robust confirmation of test-to-test consistency may be in their interest.

As mentioned above, for MYs 2019 and earlier (including optional AC17 testing prior to MY 2017), AC17 testing will only require reporting of results (and system characteristics) for manufacturers to be eligible to generate credits and improvement values from the technology menu. Beginning in MY 2020, manufacturers will also need to use AC17 testing to demonstrate that the A/C efficiency-improving technologies or systems on which the desired credits are based are indeed reducing CO_2 emissions and fuel consumption. EPA proposed to have the manufacturer identify an appropriate comparison ''baseline'' vehicle that did not incorporate the new technology, and generate CO_2 emissions data on both vehicles. The manufacturer would be eligible for credits and fuel consumption improvement values to the extent that the test results showed an improvement over the earlier version of the vehicle without the improved technology. 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.

In their comments, auto manufacturers raised concerns about the potential difficulty of identifying and testing an acceptable baseline vehicle. EPA has considered these comments, and continues to believe that identifying and testing a baseline vehicle will not be overly burdensome in most cases. However, we agree that establishing an appropriate baseline vehicle can be difficult in some cases, including when the manufacturer has made major technological improvements to the vehicle, beyond the A/C technology improvements in question. Some manufacturers recommended that because of this difficulty and the other issues discussed above, the AC17 test should only be used in a ''research'' role to validate credit values on the credit menu, rather than in a regulatory compliance role. However, EPA believes that with the adjustments in its use described below, the AC17 can appropriately serve as a part of the GHG and CAFE compliance programs. One such adjustment is to allow the manufacturer to compare vehicles from different ''generations'' of design (i.e., from earlier major design cycles), which expands the universe of potentially appropriate comparative baseline vehicles. Further, if cases arise where no appropriate baseline comparison vehicles are available, manufacturers will instead be able to submit an engineering analysis that describes why a comparison to a baseline vehicle is neither available nor appropriate, and also justifies the generating of credits and improvement values, in lieu of a baseline vehicle test result. EPA would evaluate these submissions as part of the vehicle certification process. EPA discusses such an engineering analysis in Chapter 5 (Section 5.5.2.8) of the Joint TSD. Other than these adjustments, this final rule adopts the AC17 testing of certification vehicles and comparative baseline vehicles beginning in MY 2020, as proposed. Thus, starting in MY 2020, the AC17 test will be used not only to establish eligibility for generating credits, but will also play a role in determining the amount of the credit.

EPA discusses the revised AC17 test in more detail in Chapter 5 (section 5.1.3.8) of the joint TSD, including a graphical flow-chart designed to illustrate how the AC17 test will be used at various points during the implementation of the GHG (and from MY 2017 on, CAFE) programs.

c. Technology ''Menu'' for Quantifying A/C Efficiency Credits and Fuel Consumption Improvement Values

EPA believes that more testing and development will be necessary before the AC17 test could be used to measure absolute CO_2 and fuel consumption performance with sufficient accuracy to completely replace the technology menu as the method for quantifying efficiency credits and fuel consumption improvement values. As EPA did in the MYs 2012–2016 rule, the agencies have used a design-based ''menu'' approach for the actual quantification of efficiency credits (upon which fuel consumption improvement values are also based) for this final rule. The menu established today is very similar to that of the earlier rule, both in terms of the technologies included in the lookup table and the effectiveness values assigned to each technology. As in the earlier rule, the agencies assign an appropriate amount of CO_2 credit to each efficiency-improving air conditioning technology that the manufacturer incorporates into a vehicle model. The sum of these values for all of the technologies used on a vehicle will be the amount of CO_2 credit generated by that vehicle, up to a maximum of 5.0 g/mi for cars and 7.2 g/mi for trucks. As stated above, these maximum values are equivalent to fuel consumption improvement values of 0.000563 gallons/mi for cars and 0.000810 gallons/mi for trucks. (If amendments to the menu values are made in the future, EPA will consult with NHTSA on the amount of fuel consumption improvement value manufacturers may factor into their CAFE calculations.)

Several comments addressed the technology menu and its use. The Alliance of Automobile Manufacturers said that they believe that projected A/C CO_2 emissions—and thus the maximum potential reductions against which credits can be generated—are actually higher than EPA had projected. We have reassessed this issue since the MYs 2012–2017 rulemaking, including the question of how much time vehicles spend in a ''compressor on'' mode, and on balance we continue to believe that our projected A/C CO_2 emissions values—and thus the potential credits from the technology menu—are appropriate. We discuss the development of the maximum efficiency credit values in more detail in Chapter 5 (section 5.5.2.1) of the Joint TSD.

Honeywell recognized that a performance-based test procedure for quantifying credits is not yet available, but asked EPA to be open to using such a test if one is developed. EPA agrees, and we are making clear that the off-cycle technology provisions discussed in the next section can be applied to A/C technologies if all criteria are met. We will also continue to monitor the quality of A/C efficiency testing procedures as they develop and consider specific revisions to the AC17 as appropriate. Finally, ICCT proposed accounting for any efficiency impact of alternative refrigerants in quantifying efficiency credits. However, because the effect on efficiency of the most likely future alternative refrigerant, HFO–1234yf, is only minimal when the A/C system design is optimized for its use, we are finalizing the technology menu with no adjustments for the use of alternative refrigerants. Here too, however, EPA will monitor the development and use of alternative refrigerants and any data on their impact on A/C efficiency, and consider adjustments in the future as appropriate.

Table II–21 presents the A/C efficiency credits and estimated CAFE fuel consumption improvement values being finalized in this rule for each of the efficiency-improving air conditioning technologies. We provide more detail on the agencies' development of the A/C efficiency credits and CAFE fuel consumption improvement values in Chapter 5 of the Joint TSD. In addition, that Chapter 5 presents very specific definitions of each of the technologies in the table below, definitions intended to ensure that the A/C technologies used by manufacturers correspond with the technologies we used to derive the credits and fuel consumption improvement values.

TABLE II–21—A/C EFFICIENCY CREDITS AND FUEL CONSUMPTION IMPROVEMENT VALUES

Technology description	Estimated reduction in A/C CO_2 emissions and fuel consumption (percent)	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

TABLE II–21—A/C EFFICIENCY CREDITS AND FUEL CONSUMPTION IMPROVEMENT VALUES—Continued

Technology description	Estimated reduction in A/C CO_2 emissions and fuel consumption (percent)	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)
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 controls that limit wasted electrical energy (e.g. pulse width 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	0.5	0.7	0.000056	0.000079

For the CAFE program, EPA will determine fleet average fuel consumption improvement values in a manner consistent with the way fleet average CO_2 credits will be determined. EPA will convert the metric tons of CO_2 credits for air conditioning (as well as for other off-cycle technologies and for full size pick-up trucks) into fleet-wide fuel consumption improvement values, consistent with the way EPA would convert the improvements in CO_2 performance to metric tons of credits. Section III.C discusses this methodology in more detail. There will be separate improvement values for each type of credit, calculated separately for cars and for trucks. These improvement values are 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.

2. Off-Cycle CO_2 Credits

Although EPA employs a five-cycle test methodology to evaluate fuel economy for fuel economy labeling purposes, EPA uses the established two-cycle (city, highway or correspondingly FTP, HFET) test methodology for GHG and CAFE compliance.[284] EPA recognizes that there are technologies that provide real-world GHG benefits to consumers, but that the benefit of some of these technologies is not represented on the two-cycle test. 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 if, after application to EPA, EPA determined that the credits were technically appropriate.

During meetings with vehicle manufacturers prior to the proposal of the MY 2017–2025 standards, manufacturers raised concerns that the approval process in the MYs 2012–2016 rule 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 efficiency improvements. These same manufacturers believed that such a process could stifle innovation and fuel efficient technologies from penetrating into the vehicle fleet.

In the MYs 2017–2025 proposal, EPA, in coordination with NHTSA, proposed to extend the off-cycle credit program to MY 2017 and later, and to apply the off-cycle credits and equivalent fuel consumption improvement values to both the CAFE and GHG programs.[285] The proposal to extend the off-cycle credits program to CAFE was a change from the MYs 2012–2016 final rule where EPA provided the off-cycle credits only for the GHG program. In addition, in response to the concerns noted above, EPA proposed to substantially streamline the off-cycle credit program process by establishing means of obtaining credits without having to prove case-by-case that such credits are justified. Specifically, EPA proposed a menu with a number of technologies that the agency believed would show real-world CO_2 and fuel consumption benefits not measured, or not fully measured, by the two-cycle test procedures, which benefits could be reasonably quantified by the agencies at this time. For each of the preapproved technologies in the menu, EPA proposed a quantified default value that would be available without additional testing. Manufacturers would thus have to demonstrate that they were in fact using the menu technology but would not have to do testing to quantify the technology's effects unless they wished to receive a credit larger than the default value. This list is conceptually similar to the menu-driven approach just described for A/C efficiency credits.

The proposed default values for these off-cycle credits were largely determined from research, analysis, and simulations, rather than from full vehicle testing, which would have been both cost and time prohibitive. EPA believed that these predefined estimates were somewhat conservative to avoid the potential for windfall credits.[286] If

[284] As noted earlier, use of the two-cycle test is mandated by statute for passenger car CAFE standards.

[285] 76 FR 74941–944.

[286] While many of the assumptions made for the analysis were ''conservative'', others were ''central''. For example, in some cases an average vehicle was selected on which the analysis was conducted. In this case, a smaller vehicle may presumably be deserving of fewer credits whereas

manufacturers believe their specific off-cycle technology achieves larger improvement, they could apply for greater credits and fuel consumption improvement values with supporting data using the case-by-case demonstration approach. For technologies not listed on the menu, EPA proposed to continue the case-by-case demonstration approach from the MYs 2012–2016 rule but with important modifications to streamline the decision-making process. Comments to the proposal (addressed at the end of this preamble section) were largely supportive. In the final rule, EPA is continuing the off-cycle credit program established in the MYs 2012–2016 rule (but with some significant procedural changes), as proposed. EPA is also finalizing a list of pre-approved technologies and credit values. The pre-defined list, with credit values and CAFE fuel consumption improvement values, is shown in Table II–21 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 for use in EPA's GHG program, as proposed.

In the NPRM, EPA proposed capping the amount of credits a manufacturer may generate using the defined technology list to 10 g/mile per year on a combined car and truck fleet-wide average basis. EPA also proposed 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 significant adoption by MY 2017 and later. Based on comments and consideration on the amount of data that are available, we are finalizing the cap of 10 g/mile per year on a combined car and truck fleet-wide average basis. The fleetwide cap is being finalized because the default credit values are based on limited data, and also because 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. However, we are not finalizing the minimum penetration rates applicable to certain technologies, primarily based the agencies' agreement with commenters stating that penetration caps might stifle the introduction of fuel economy and GHG improving technologies particularly in cases where manufacturers would normally introduce the technologies because manufacturing capacities are limited or low initial volume reduces risk if consumer acceptance is uncertain. Allowing credits for lower production volumes may encourage manufacturers to introduce more off-cycle technologies and then over several years increase production volumes thereby bringing more of these technologies into the mainstream. These program details are discussed in further in Section III.C.5.b.i.

For the final rule analysis, the agencies have developed estimates for the cost and effectiveness of two off-cycle technologies, active aerodynamics and stop-start. The agencies assumed that these two technologies are available to manufacturers for compliance with the standards, similar to all of the other fuel economy improving technologies that the analysis assumes are available. EPA and NHTSA's modeling and other final rule analyses use the 2-cycle effectiveness values for these technologies and include the additional off-cycle adjustment that reflects the real world effectiveness of the technologies. Therefore, NHTSA has included the assessment of these two off-cycle technologies in the assessment of maximum feasible standards for this final rulemaking. Including these technologies that are on the pre-defined menu recognizes that these technologies have a higher degree of effectiveness in the real-world than reflected in 2-cycle testing. EPA likewise considered the 2-cycle benefits of these technologies in determining the stringency of the final standards. The agencies note that they did not consider the availability of other off-cycle technologies in their modeling analyses for the proposal or for the final rule. There are two reasons for this. First, the agencies have virtually no data on the cost, development time necessary, manufacturability, etc. of these other technologies. The agencies thus cannot project the degree of emissions reduction and fuel economy improvements properly attributable to these technologies within the MYs 2017–2025 timeframe. Second, the agencies have no data on what the penetration rates for these technologies would be during the rule timeframe, even assuming their feasibility. See 76 FR 74944 (agencies need information on ''effectiveness, cost, and availability'' before considering inclusion of off-cycle technology benefits in determining the standards).

This section provides an overview of the pre-defined technology list being finalized and the key comments the agencies received regarding the technologies on the list and the proposed credit values. Provisions regarding how the pre-defined list fits into the overall off-cycle credit program are discussed in section III.C.5, including the MY 2014 start date for using the list, the 10 g/mile credit cap for the list, and the proposed penetration thresholds for listed technologies. In addition, a detailed discussion of the comments the agencies received regarding the technical details of individual technologies and how the credit values were derived is provided in Chapter 5 of the joint TSD.

In the proposal, the agencies requested comments on all aspects of the off-cycle credit menu technologies and derivations. EPA and NHTSA received many comments and, in addition, several stakeholders including Denso, Enhanced Protective Glass Automotive Association (EPGAA), ICCT and Honda, requested meetings and met with the agencies. Overall, there was general support for the menu based approach and the technologies included in the proposed list, but there were also suggestions to re-evaluate the definition of some of the technologies included in the menu, the calculation and/or test methods for determining the credits values, and recommendations to periodically re-evaluate the menu as technologies emerge or become pervasive.

For most of the listed technologies, the agencies proposed single fixed credit values and for other technologies a step-function (e.g., x amount of credit for y amount of reduction or savings).[287] The agencies received comments requesting a scalable calculation method for some technologies rather than the proposed fixed value or step-function approach. Some commenters requested that the credits for active aerodynamics, high efficiency exterior lighting, waste heat recovery (proposed as ''engine heat recovery'' but revised based on comments to the proposal) and solar panels (proposed as ''solar roof panels'' but also revised based on comments) be scalable (variable based on system capability) rather than an ''all-or-

a larger vehicle may be deserving of more. Where the estimates are central, it would obviously be inappropriate for the Agencies to grant greater credit for the larger vehicles since this value is already balanced by the smaller vehicles in the fleet. The agency will take these matters into consideration when applications are submitted to modify credits on the menu.

[287] In the Proposal (76 FR 74943/1), we described the engine heat recovery and solar roof panel credits as 'scalable', however this was an error. The engine heat recovery did allow 0.7g/mi credit per 100W generated step-function, however the solar panels were not scalable. In actuality, glazing was the only continuously scalable credit on the proposed off-cycle menu.

nothing'' single value approach proposed.[288] The agencies agree with the commenters and are allowing scaling of these credits. In some cases, this created issues with the simplified methodology for determining the default values used for the proposal. Therefore, the proposed methodology required revision in order to calculate the default values for the technologies with scalable credits. The revised calculation methodology for each scalable technology is discussed in detail in Chapter 5 of the TSD. Notably, the calculation method for the solar panel credit has been changed, to provide scalability of the credit and a better estimate the benefits of solar panels for HEVs, PHEVs, and EVs.

Although we are allowing scaling of the credits, we are not accepting a request or granting credit for any level of credit less than 0.05 g/mi CO_2. We are requiring reporting CO_2 values to the nearest tenth and, therefore, anything below 0.05 g/mi of CO_2 would be rounded down to zero. Therefore, for any credit requested as part of the off-cycle credit program (e.g., scalable or fixed; via the pre-defined technology list or alternate method approval process), only credit values equal to 0.05 g/mi or greater will be accepted and approved.

In addition to supporting the off-cycle credit program in the MYs 2017–2025 program, comments received from the National Resources Defense Council (NRDC) and ICCT urged the agencies to ensure that off-cycle credits are verifiable via actual testing or reflect real-world in-use data from a statistically representative fleet. These comments also expressed concern that some of the proposed menu technologies would not achieve appreciably greater reductions than measured over the 2-cycle tests, that the off-cycle credit process had not fully assured that there would be component and/or system durability and had not accounted for in-use degradation. These commenters' ultimate concern is that the off-cycle credit flexibility could create windfall credits or avoid cost-effective 2-cycle improvements.

The agencies believe that the off-cycle credit program, as proposed and finalized, legitimately accounts for real-world emission reductions and fuel consumption improvements not measured, or not fully measured, under the two-cycle test methodologies. The off-cycle technologies on the defined list have been assessed by the agencies using the best available data and information at the time of this action to appropriately assign default credit values. The agencies conducted extensive reviews of the proposed credit values and technologies and, based on comments (such as those from ICCT) and analysis, did adjust some credit values and technology descriptions. In addition, the comments from the Alliance of Automobile Manufacturers provided data that aligned with and supported some of the estimated credit default values (discussed in greater detail in Chapter 5 of the joint TSD). As with the proposal and further refinement in these final rules, the agencies have structured the off-cycle credit program extension for MYs 2017–2025 to employ conservative calculation methodologies and estimates for the credit values on the defined technology list. In addition, the agencies will continue, as proposed, to apply a 10 g/mi cap to the total amount of available off-cycle credits to help address issues of uncertainty and potential windfalls. Based on review of the technologies and credits provided for those technologies, the cap balances the goal of providing a streamlined pathway for the introduction of off-cycle technologies while controlling potential environmental risk from the uncertainty inherent with the estimated level of credits being provided. Manufacturers would need to use several listed technologies across a very large portion of their fleet before they would reach the cap. Based on manufacturer comments regarding the proposed sales thresholds, discussed below, the agencies are not anticipating widespread adoption of these technologies, at least not in the early years of the program. Also, the cap is not an absolute limitation because manufacturers have the option of submitting data and applying for credits which would not be subject to the 10 g/mile credit limit as discussed in III.C.5. Therefore, we are confident in the underlying analysis and default values for the identified off-cycle credit technologies, and are finalizing the defined list of off-cycle credit technologies, and associated default values, with minimal changes in this final rule as discussed below.

For off-cycle technologies not on the pre-defined technology list, or to obtain a credit greater than the default value for a menu pre-defined technology, a manufacturer would be required to demonstrate the benefits of the technology via 5-cycle testing or via an alternate methodology that would be subject to a public review and comment process. Further, a manufacturer must certify the in-use durability of the technology for the full useful life of the vehicle for any technologies submitted for off-cycle credit application to ensure enforceability of the credits granted.

The agencies proposed an additive approach where manufacturers could add the credit values for all of the listed technologies employed on a vehicle model (up to the 10 g/mile cap, as discussed in III.C.5). The agencies received comments from ICCT recommending a multiplicative approach where the credit values for each technology on the list is determined by taking the total amount of available credits for off-cycle technologies and distributing it based on each technology's percent contribution to the overall off-cycle benefit (e.g., percent benefit of technology A, B, * * * n × total available credit equals the off-cycle credit for technology A, B, * * * n).

EPA understands ICCT's recommendation, as this is similar how to the calculation methods employed in the EPA Lumped Parameter Model combine the effectiveness of some technologies when the interaction of differing technologies does not yield the combined absolute fuel consumption improvement for each technology, but rather the actual effectiveness is a fractional value of each technology's effectiveness (often described as ''synergies''). The agencies carefully evaluated these comments and, as stated previously, held a meeting with ICCT at their request to discuss the comments fully.[289] Overall, the agencies believe the recommended multiplicative approach is inherently difficult since the fractional contribution of each technology to the overall off-cycle benefit must be determined, and then the combined synergistic effectiveness would also require accurate and robust determination. This would require extensive iterative testing to determine the synergistic affects for every possible combination of off-cycle technology included on each vehicle. In addition, this would be highly dependent on the base design of the vehicle and, therefore, would need to be determined for each unique vehicle content combination.

The agencies agree there may be synergistic (or non-synergistic) affects, but believe the combination of employing conservative credit value estimates and a 10 g/mi cap to the total amount of available off-cycle credits

[288] For example, in the proposal, a manufacturer had to install high efficiency lighting on all systems in order to get the 1.1 g/mi credit.

[289] The ICCT also submitted a number of additional detailed comments on the credit magnitude of certain off-cycle technologies which are discussed in Chapter 5 of the Joint TSD.

will achieve nearly the same overall effect of limiting the additive effect of multiple off-cycle technologies to a vehicle. Therefore, we are finalizing the calculation approach as defined in this final rule.

As discussed above, the agencies are allowing scaling of the credit values in lieu of fixed values based on the comments received for the following technologies on the menu: high efficiency exterior lighting, waste heat recovery, solar panels and active aerodynamics. In the case of waste heat recovery and active aerodynamics, this did not change the numerical credit values we proposed. For waste heat recovery, 0.7 g/mi CO_2 per 100 watts serves as the basis for scaling the credit. For active aerodynamics, we used the value of 0.6 g/mi for cars and 1.0 g/mi for trucks based on a 3% aerodynamic drag improvement from the table of values in the NPRM TSD. The comments simply asked to use this entire range of values rather than just using the credit values corresponding to 3% aerodynamic drag improvement. These scaling factors were calculated using both the Ricardo simulation results (described in Chapter 3 of the TSD) and the EPA full vehicle simulation tool (described in Chapter 2 of the EPA's RIA).

In contrast, for high efficiency exterior lighting and solar panels, this required a revision in the methodology to allow for proper scaling. For high efficiency exterior lighting, the comments also requested credit allowance for high efficiency lighting on individual lighting elements rather than on all lighting elements. In the NPRM, our methodology assumed a package approach where each lighting element was weighted based on contribution to the overall electrical load savings, and then this was scaled by our base load reduction estimate for 5-cycle testing (e.g., 3.2 g/mile per 100 watts saved; see TSD 5.2.2). Using this package approach, it is difficult to de-couple the grams per mile CO_2 contribution of individual lighting elements. Therefore, we revised our approach by accounting for the gram per mile CO_2 credit for each individual high efficiency lighting element separately.

The agencies are finalizing the pre-defined technology list for off-cycle credits fundamentally as proposed with the exception of six technologies, primarily in response to the comments received: engine idle start-stop, electric heater circulation pump, high efficiency exterior lighting, solar panels, and active transmission and active engine warm-up.

First, the pre-defined credit values for engine idle start-stop are revised in response to comments questioning some vehicle operation and VMT assumptions and some methods for calculating the pre-defined credit values. More details on these changes can be found in Chapter 5 of the Joint TSD.

Second, the proposed stand-alone credit for an electric heater circulation pump is incorporated into the pre-defined credit for engine stop-start, thus aligning with the integrated nature of these two technologies. As the agencies re-evaluated the pre-defined credit values for engine idle start-stop, we recognized that a substantive amount of the off-cycle benefit attributed to engine stop-start would not be achievable in cold temperature conditions (e.g., temperatures below 40 deg F) without a technology that performs a similar function to the electric heater circulation pump as defined in the NPRM. The agencies believe that a mechanism allowing heat transfer to continue, even after the engine has shut-off, is necessary in order to maintain basic comfort in the cabin especially in colder ambient temperatures. This could occur, for example, when a vehicle is stopped at a multiple lane intersection controlling high traffic volumes. This technology can be an electric heater circulation pump, or some other cabin heat exchanger. Without this technology, the engine would need to continue operating and, therefore, circulating warm engine coolant through the HVAC system to continue providing heat to the cabin. Therefore, two credit values are being finalized for stop-start systems: a higher value (similar to the credits proposed) for systems with an electric heater circulation pump and a lesser value for stop-start systems without a pump or heat transfer mechanism.

Third, the agencies have revised the proposed pre-defined credit values for high-efficiency exterior lighting after evaluation of the numerous industry data provided via comments. The fundamental impetus for the revisions resulted from the research study cited as a basis for many pre-defined values as described in Chapter 5 of the TSD. When reviewing the additional data, the agencies concluded the initially referenced research study (Schoettle, et al.[290]) provided current draw values for high-efficiency low beam lighting that were too high when compared to traditional incandescent lighting, resulting in a reduced projected benefit. Data from the automakers showed a much lower power demand for high-efficiency low beam lighting and, consequently, a much larger benefit than projected in the draft TSD.[291] Therefore, the agencies increased the overall amount of credit for high-efficiency exterior lighting on the menu to reflect the additional analysis based on the data received via comment.

Fourth, as discussed above, the need for scaling the credit value resulted in a new methodology for solar panels, and, consequently, adjusted credit values. For the NPRM, we assumed a fixed solar panel power output and scaled this according to our base load estimate (e.g., 3.2 g/mile per 100 watts saved; see TSD 5.2.2). However, the rated solar panel power output depends on several factors including the size and efficiency of the panel, and the energy that the panel is able to capture and convert to useful power. Therefore, these factors need to be considered when scaling, and our new methodology takes these factors into account. The agencies also accounted for the possibility of combining solar panels for both energy storage and active ventilation in the scaling algorithm.

Finally, we discuss active transmission and active engine warm-up together (although they are listed separately) since the methodology for them is the same. Chrysler commented that there should be separate car and truck credits for active transmission and active engine warm-up, as formulated for other advanced load reduction technologies (e.g., engine idle start-stop, electric heater circulation pump). In the NPRM, we used the credit value corresponding to a mid-size car to arrive at 1.8 g/mi. After considering these comments, we re-analyzed (using the Ricardo data) the credit values for active transmission and active engine warm-up using expanded vehicle classes on a sales-weighted basis. As a result, there was a clear disparity between the credit values for active transmission and active engine warm-up on cars and trucks. Accordingly, we now have separate car (1.5 g/mi) and truck (3.2 g/mi) active transmission and active engine warm-up credits.

There were no other changes to the off-cycle credit defined technology list other than the expansion or clarification of definitions for certain technologies as discussed in Chapter 5 of the TSD. Many commenters advocated for the inclusion of additional technologies on the off-cycle credit defined technology

[290] Schoettle, B., et al., ''LEDS and Power Consumption of Exterior Automotive Lighting: Implications for Gasoline and Electric Vehicles,'' University of Michigan Transportation Research Institute, October, 2008.

[291] Alliance, Docket No. NHTSA–2010–0131–0262, page 27 of 93; Appendix 2, page 2 of 19.

list. Some commenters suggested that technologies should be added such as high efficiency alternators (Alliance, Denso, VW, Porsche, Ford), electric cooling fans (Bosch), HVAC eco-modes, transmission cooler bypass valves (Ford), navigation systems (Garmin), separate credits for congestion mitigation/crash avoidance systems (Daimler), engine block heaters (Honda), and an ''integral'' approach utilizing a combination of technologies (Global Automakers).

Some commenters were opposed to adding any technologies to the menu (CBD) and others suggested some of the proposed values should be re-evaluated (ICCT) or that the values should be based on real test data, not simulation modeling (NRDC).

After reviewing and considering the comments, in general, we did not see evidence at this time to add any of these technologies to the pre-defined technology list. In many cases, there are no consistent, established methods or supporting data to determine the appropriate level of credit. Consequently, there is no reasonable basis or verifiable method for the agencies to substantiate or refute the performance claims used to support a request for pre-assigned, default credit values for such technologies, particularly for systems requiring driver intervention or action.

Therefore, we are not adding any of these technologies we were asked to consider to the pre-defined technology list. In the case of crash avoidance technologies, we are prohibiting off-cycle credits for these technologies under any circumstances. In the case of the other technologies for consideration, we are allowing manufacturers to use the alternate demonstration methods for technologies not on the pre-defined technology list menu as discussed in Section III.C. (see ''Demonstration not based on 5-cycle testing'') to request credit. We respond below to the comments urging the agencies to add further technologies to the pre-defined list. Additional responses are found in TSD Chapter 5 and Section 7 of EPA's Response to Comment Document.

In addition, there were substantial comments regarding allowing credits for glazing. Specifically, the comments expressed concerns about incentivizing the use of metallic glazing which may impact signals emanating from within the passenger compartment and the desire for a separate credit for polycarbonate (PC) glazing. This is discussed below as well.

a. High Efficiency Alternators

Several commenters from the automobile industry associations, individual manufacturers, and suppliers urged the agencies to include high efficiency alternators on the off-cycle defined technology list.

The Alliance of Automobile Manufacturers stated that the test cycles are performed with the accessories off but that ''actual real world driving has average higher loads due to accessory use.'' They cited GM testing comparing three different alternators on four vehicles with efficiencies ranging from 61% to 70% using the Verband der Automobilindustrie (VDA; the trade association representing German automobile manufacturers) test procedure that demonstrated a savings of 1.0 grams per mile CO_2 on average for an alternator with an efficiency of 68% VDA. Volkswagen and Porsche supported the comments from the Alliance of Automobile Manufacturers, however Porsche felt that a default credit of 1.6 grams per mile CO_2 was possible based on their independent analysis. The Global Automakers echoed the comments above regarding real-world versus test cycle accessory usage but did not supply supporting data.

Two suppliers, Bosch and Denso, also supported adding high efficiency alternators to the defined technology list. Bosch cited testing on a General Motors 2.4 liter 4 cylinder gasoline engine with an increased alternator efficiency from 65%, the level of efficiency assumed in the NPRM, to 75% showed the potential for an increase of 0.7% in fuel economy by increasing alternator efficiency by 10%. Bosch also stated that increases in efficiency up to 82% are possible using existing and new technologies. Denso used performed a similar analysis by simulating an increase in alternator efficiency of 10% (65% to 75%). Using our NPRM values for CO_2 emissions reductions of 3.0 grams per mile CO_2 on the 2-cycle and 3.7 grams per mile CO_2 on the 5-cycle tests, they calculated a potential credit of 2.8 grams per mile CO_2.

In response, we agree that high efficiency alternators have the potential to reduce electrical load, resulting in lower fuel consumption and CO_2 emissions. However, the problem with including this technology on the defined technology list is assigning an appropriate default credit value due to the lack of supporting data across a range of vehicle categories and range of implementation strategies.

First, we appreciate commenters submitting data but we would need to have similar data from the range of available vehicle categories. With the exception of the data from the Alliance of Automobile Manufacturers that included a Cadillac SRX with, most recently, a 3.6 liter V6 engine, most of the data is from smaller displacement vehicles. Therefore, the range of data would need to be expanded to the mid-size and large car, and large truck to even begin to develop a default credit value.

Second, similar to high efficiency exterior lighting, the type of and number of electrical accessories on the vehicle may cause significant variability in the base electrical load and, consequently, the level of reduction and associated benefit of high efficiency alternator technology. However, unlike high efficiency exterior lighting with a limited amount of components, the vehicle components and accessories that affect high efficiency alternator load are seemingly unlimited. As the information from Denso suggests, there are some typical standard components but the list of standard versus optional components changes depending on manufacturer, nameplate and trim level (e.g., optional accessories on a lower trim level vehicle may be standard on a upper/luxury trim level vehicle). This makes it difficult to develop a default value given this level of variability.

Third, high efficiency alternators present the opportunity for manufacturers to add vehicle content that does not contribute to reducing fuel consumption or CO_2 emissions. Due to the extra electrical capacity resulting from using the high efficiency alternator, other content (e.g., seat heaters/coolers, cup holder cooler/warmers, higher amplification sound system) can be added that may increase consumer value, however, that consumer value is unrelated to reducing fuel consumption or CO_2 emissions. This potential for electrical load ''backsliding'' can counteract the benefits of a high efficiency alternator, and can also potentially affect mass reduction depending on the mass of the added content.

A good example of a beneficial use of additional electrical load is the synergy between solar panels and active cabin ventilation. The solar panel can be used to power active cabin ventilation system motors but the amount of power produced by the panel may exceed the motor power requirements. Moreover, the active cabin ventilation system is only effective for the hot/sunny summer portion of the year. Rather than directing this excess power to other non-fuel consumption related content (or wasting it), we are incentivizing manufacturers to use this excess power for battery charging to drive the wheels, and thus displace fuel and CO_2 emissions.

However, unlike a solar panel, the high efficiency alternator supplies power to many vehicle features, and the EPA does not wish to directly regulate the electrical usage on vehicles in order to prevent ''load backsliding''. This load backsliding could convert a fuel efficient technology into one that is detrimental to CO_2 emissions reductions and fuel economy improvements. Because of this uncertainty the agencies are not adding high efficiency alternators to the defined technology list. However, manufacturers may request credits for high-efficiency alternators using the case-by-case procedures for technologies not on the defined technology list. There are two general issues, at a minimum, which a manufacturer would need to consider and address in such a request. First, the manufacturer would need to consider the level of alternator efficiency improvement. As stated by the Alliance of Automobile Manufacturers, current alternator efficiencies are in the range of ''60% to 64%, with high efficiency models having ratings above 68% VDA.'' Therefore, any request for high efficiency alternator credit should significantly exceed current alternator technology efficiency. The 68% VDA number stated by the Alliance of Automobile Manufacturers seems to be an appropriate starting point given current technology although EPA would make a specific determination as to the amount of needed improvement when evaluating a specific off-cycle credit application, and so is not making any final determination here. Second, manufacturers should ensure proper accounting of vehicle components and accessories and associated loads. A good example of this is Table 1 in the comments from Denso that identifies the content loads and their occurrence on the 2-cycle test versus real world. The manufacturer may need to perform this type of comparison on an annual basis so that there is a clear assessment of load content adjustments over time to minimize electrical load ''backsliding'' (i.e., adding more content due to the availability of additional load capacity) as discussed above.

b. Transmission Oil Cooler Bypass Valve

The transmission oil cooler is used on vehicles to cool the transmission fluid under heavy loads, especially by large trucks during towing or large payload operations. As stated by the Alliance, one of the drawbacks is that this system operates continuously even under conditions where faster warm-up, such as cold conditions, would be beneficial. Therefore, the Alliance comments suggested that we add bypass valves for transmission oil coolers to the pre-defined technology list since ''a bypass valve for the transmission oil cooler allows the oil flow to be controlled to provide maximum fuel economy under a wide variety of operating conditions.'' They suggested a credit of 0.3 g/mi CO_2 based on General Motors (GM) engineering development and that this credit could be additive with active transmission warm up strategy.

The reason we are not including this technology on the pre-defined technology list is lack of available data and multiple methodologies for implementation that make determining an appropriate credit value difficult. As stated by the Alliance, ''bypass valves are not currently commonly used with transmission oil coolers.'' As a result, there is very limited data on the performance of such systems other than the engineering data cited by the Alliance. Also, the bypass valve could be implemented passively (e.g., viscosity based), actively (e.g., valve controllers based on temperature or viscosity), or by some other smart design. Consequently, depending on the implementation method, the credit value may not correspond effectively to the level of performance.

However, this technology can be demonstrated using 5-cycle or alternate demonstration methods. Therefore, we recommend that manufacturers seeking credit for this technology separately or in conjunction with active transmission warm-up credits explore this approach.

c. Electronic Thermostat

Porsche stated in their comments that there is ''potential GHG benefit for electronic thermostat * * * in configurations which do not include an electric water pump.'' In lieu of a traditional mechanical water pump, an electric water pump facilitates engine coolant flow without the penalty of using an energy-sapping belt driven system. However, for systems that use a mechanical water pump, an electronic thermostat could be used in lieu of an electric water pump to optimally control the flow of coolant (e.g., close off coolant flow to the radiator when the engine is cold). Porsche requested that the agencies allow credit for this technology irrespective of the other cooling system specifics (e.g., mechanical or electric water pump).

This technology is not on the pre-defined technology list, nor does this appear to be the intent of Porsche's comments. As such, the electronic thermostat can be demonstrated using 5-cycle or alternate demonstration methods. Therefore, we agree with Porsche and, if a benefit for the electronic thermostat regardless of the type of water pump used can be demonstrated, the electronic thermostat would be eligible under the procedures for evaluating technologies not on the pre-defined technology list.

d. Other Vehicle Relays

Honda requested that we consider allowing credit for other electrical relays on the vehicle such as those used for power windows, wiper motors, power tailgate, defroster, and seat heaters. However, Honda states that they are unsure of how to measure the impact suggesting that lifetime usage data might be a basis to support the credit granted.

In response, we feel that granting credits for other vehicle relays is best considered using the demonstration methods for evaluating technologies not on the predefined technology list.

The confounding issue, as Honda points out in their comments, is how to quantify the benefit and, further, how to directly relate this benefit to fuel consumption savings. The complexity of identifying single and multiple relay impact is a daunting task and must be considered when pursuing this path. Further, the use of lifetime usage data only captures activity but does not couple this activity with a gram-per-mile CO_2 benefit, thus falling short of demonstrating direct savings. Therefore, although the granting of credit is possible, these issues, and any others, would need to be addressed before credit is granted for other vehicle relays.

e. Brushless Motor Technology for Engine Cooling Fans

The comments from Bosch advocated for adding brushless motor technology for engine cooling fans to the pre-defined technology list. In their comments, Bosch stated that the current baseline technology is series-parallel brushed motors requiring 149 watts to operate. By switching to a brushless engine cooling fan motor, the wattage requirement is reduced to 68 watts for a savings of 87 watts, according to Bosch. Bosch reduced this number further to 81.2 watts since they considered a range of series-parallel brushed motors with varying wattage values. Based on this savings and Bosch's assumption that reducing electrical load by 30 watts saves 0.1 mile per gallon, Bosch projected a fuel savings of 0.27 miles per gallon. Using our load reduction assumption of reducing 100 watts saves 0.7 gram per mile of CO_2, this equates to a credit of 0.56 gram per mile of CO_2.

After consideration of Bosch's comments and the data provided showing potential benefits, it is not clear from the data provided if this would be the actual benefit once this technology is implemented. Absent real-world vehicle data, it is difficult to determine what the baseline and, consequently, the resulting benefit would be. In addition, it is likely that some or all of the benefit of brushless motor technology for engine cooling fans is captured on the 2-cycle test procedures.

Consequently, we are not adding brushless motor technology for engine cooling fans to the pre-defined technology list due to insufficient data on real-world, power requirements, activity profiles, and test data demonstrating the 2-cycle versus 5-cycle benefits. These factors prevent us from determining a default credit value necessary for addition to the off-cycle technology menu. A manufacturer that believes its engine cooling fan brushless motor merits credit can request it using the demonstration methods for technologies not on the predefined technology list.

f. Integral Fuel Saving Technologies and Advanced Combustion Concepts

The Global Automakers and Ford Motor Company encouraged the agencies to consider granting credit for integral fuel saving technologies and advanced combustion concepts (e.g., camless engines, variable compression ratio engines, micro air/hydraulic launch assist devices, advanced transmissions) using demonstration methods for technologies that are not on the predefined technology list. Both parties took issue with our statements in the NPRM Preamble (see 76 FR 75024): ''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. 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.''

These commenters urged EPA to allow demonstration of benefits using some alternative testing or analytical method, or to provide an opportunity to perform some type of demonstration, for integral fuel saving technologies and advance combustion concepts.

In response, since these methods are integral to basic vehicle design, there are fundamental issues as to whether they would ever warrant off-cycle credits. Being integral, there is no need to provide an incentive for their use, and (more important), these technologies would be incorporated regardless. Granting credits would be a windfall. As we stated in the NPRM Preamble (see 76 FR 75024), these technologies are included in the base vehicle design to meet the standard and it is consequently inappropriate for these types of technologies to receive off-cycle credits. EPA (in coordination with NHTSA) will continue to track the progress of these technologies and attempt to collect data on their effectiveness and use.

g. Congestion Avoidance Devices, Other Interactive, Driver-Based Technologies and Driver-Selectable Features

As mentioned above, many commenters advocated for the inclusion of additional technologies on the off-cycle credit defined technology list such as congestion avoidance, interactive/driver-based technologies, which provide information to the driver that the driver may use to alter his/her driving route or technique, and driver-selectable technologies, which cause the vehicle to operate in a different manner.

Daimler commented that the agencies should provide ''congestion mitigation credits based on crash avoidance technologies,'' because crash avoidance technologies can potentially reduce traffic congestion associated with motor vehicle collisions and thus, ''similar to off-cycle technologies,'' provide ''significant CO_2 and fuel consumption benefits.'' [292] Daimler argued that doing so was within both agencies' authority, referring to the authority under which the agencies had proposed off-cycle credits.[293] Daimler provided a menu of suggested congestion reduction credit values of 1.0 g/CO_2 per mile for its ''Primary Longitudinal Assistance Package'' (comprised of forward collision warning plus adaptive brake assist) and an additional 0.5 g/CO_2 per mile for its ''Advanced Longitudinal Assistance Package'' (the primary package plus autonomous emergency braking and adaptive cruise control), based on calculations using figures from its own analysis of the effectiveness of these technologies and from a German insurance institute,[294] along with values for other congestion mitigation technologies such as driver attention monitoring and adaptive forward lighting.[295]

In addition to requesting that the agencies create a new category of credits, the comment further addressed means of evaluating and approving applications for such credits. Daimler suggested that NHTSA require manufacturers to submit data ''specific to [their] product offerings showing that [their] technology is effective in reducing vehicle collisions,'' and that ''NHTSA may approve the application and determine the amount of the credit'' and determine whether the technology is ''robust and effective in terms of crash avoidance and the consequent fuel savings.'' [296] Daimler suggested that NHTSA's review process for such information could be considerably less stringent than that for ''regulation to mandate new technology and/or to link technology directly to fatalities or injuries,'' because fatalities and injuries would not be at issue for congestion mitigation credits.[297] Instead, Daimler stated that ''technologies [should be] appropriate if they can reasonably be shown to avoid accidents, and thereby reduce congestion and its associated fuel consumption and CO_2 emissions.'' [298]

The agencies agree that there is a clear nexus between congestion mitigation and fuel/CO_2 savings for the entire on-road fleet. It is less clear, however, whether there is a calculable relationship between congestion mitigation and fuel/CO_2 savings directly attributable to individual vehicles produced by a manufacturer, or even to a manufacturer's fleet of vehicles. Daimler argued that emissions of 6.0 gCO_2/mi could be averted if all accidents were avoided. However, even assuming such a result were achievable, Daimler agreed that attributing those fuel consumption/CO_2 benefits from reduced traffic congestion to specific individual technologies on specific vehicles would be difficult.

NHTSA has extensive familiarity with the safety technologies usually associated with crash avoidance, having required some (most notably, electronic stability control) as standard equipment on all newly manufactured light vehicles, and being deeply engaged in research on others, including the

[292] Daimler, EPA Docket # EPA–HQ–OAR–2010–0799–9483, at 10.

[293] *Id.* at 11, 17.

[294] *Id.* at 13–14.

[295] *Id.* at 14–16.

[296] *Id.* at 15.

[297] *Id.*

[298] *Id.*

braking technologies mentioned in Daimler's comment. When NHTSA's research indicates sufficient maturity of a crash avoidance technology, the agency may either promote its use through its New Car Assessment Program (NCAP) or mandate its use by issuing a Federal Motor Vehicle Safety Standard (FMVSS) requiring the technology on all or some categories of new vehicles.

Under the NCAP program, NHTSA tests new vehicles to determine how well they protect drivers and passengers during a crash, and how well they resist rollovers. These vehicles are then rated using a 5-star safety rating system. Five stars indicate the highest safety rating; one star, the lowest. In addition, NHTSA began in model year 2011 identifying on its Web site, *www.SaferCar.gov*, new vehicles equipped with any of three recommended advanced crash avoidance technologies that meet the agency's established requirements. These technologies, Electronic Stability Control, Forward Collision Warning, and Lane Departure Warning, can help drivers avoid crashes.

Additional technologies may be added to the NCAP list of crash avoidance technologies when there is sufficient information and analysis to confirm their safety value. NHTSA, for example, is carefully analyzing advanced braking systems of the type discussed in Daimler's comments and could decide in the near future that they are ripe for inclusion in NCAP. Alternatively, NHTSA may conclude that such technologies are sufficiently developed, their safety benefits sufficiently clear, and relevant test procedures sufficiently defined that they should be the subject of a mandatory safety standard. NHTSA could not render a determination on such a request without thoroughly testing the technology as applied in that specific model and developing a specialized benefits analysis. The agency's higher priority would clearly have to be analyzing the technologies it found to offer great safety promise on a broader basis and developing standardized tests for those technologies. Therefore the agencies believe that evaluation of crash avoidance technologies is better addressed under NHTSA's vehicle safety authority than under a case-by-case off-cycle credit process.

Furthermore, the A/C efficiency, off-cycle, and pickup truck credit provisions being finalized by the agencies are premised on the installation of specific technologies that directly reduce the fuel consumption and CO_2 emissions of the specific vehicles in which they are installed. For all of these credits, the amount of GHG emission reduction and fuel economy improvement attributable to the technology being credited can be reliably determined, and those improvements can be directly attributed to the improved fuel economy performance of the vehicle on which the technology is installed. Thus, for a technology to be ''counted'' under the credit provisions, it must make direct improvements to the performance of the specific vehicle to which it is applied. The agencies have never considered indirect improvements [299] for the fleet as a whole, and did not discuss that possibility in the proposal. The agencies believe that there is a very significant distinction between technologies providing direct and reliably quantifiable improvements to fuel economy and GHG emission reductions, and technologies which provide those improvements by indirect means, where the improvement is not reliably quantifiable, and may be speculative (or in many instances, non-existent), or may provide benefit to other vehicles on the road more than for themselves. As the agencies have reiterated, and many commenters have likewise maintained, credits should be available only for technologies providing real-world improvements, the improvements must be verifiable, and the process by which credits are granted and implemented must be transparent.

None of these factors would be satisfied for credits for these types of indirect technologies used for crash avoidance systems, safety-critical systems, or other technologies that may reduce the frequency of vehicle crashes. The agencies are consequently not providing off-cycle credits potentially attributable to crash avoidance systems, safety-critical systems, or technologies that may reduce the frequency of vehicle crashes. . Therefore, the agencies are not providing off-cycle credits for technologies and systems including, but not limited to, Electronic Stability Control, Tire Pressure Monitoring System, Forward Collision Warning, Lane Departure Warning and/or Intervention, Collision Imminent Braking, Dynamic Brake Support, Adaptive Lighting, Blind Spot Detection, Adaptive Cruise Control, Curve Speed Warning, Fatigue Warning, systems that reduce driver distraction, and any other technologies that may reduce the likelihood of crashes.

Thus, manufacturers will not receive credits or fuel economy improvement adjustments for installing these technologies. If a manufacturer has an off-cycle technology that is not included on this list and brings it to the agencies for assessment, NHTSA will determine whether it is ineligible for a credit or adjustment by reason of the agency's judgment that it is related to crash avoidance systems, is related to motor vehicle safety within the meaning of the National Traffic and Motor Vehicle Safety act, as amended, or may otherwise reduce the possibility and or frequency of vehicle crashes.

The agencies believe that the advancement of crash avoidance systems specifically is best left to NHTSA's exercise of its vehicle safety authority. NHTSA looks forward to working with manufacturers and other interested parties on creating opportunities to encourage the general introduction of these technologies in the context of the NCAP program and possible safety standards. To that end, the agency would welcome relevant data and analysis from interested parties.

The agencies also received comments related to other technologies that may reduce CO_2 emissions and fuel consumption by reducing traffic congestion or that provide information to the driver with which the driver may change his or her driving technique or the route driven (more direct route or traffic avoidance [300]). All commenters addressing these issues acknowledged the difficulty of quantifying benefits associated with congestion mitigation and driver-selectable technologies.[301] Commenters generally noted that the off-cycle credit provisions in the MYs 2012–2016 GHG rule, and the off-cycle credit provisions proposed in this rulemaking did not appear to cover technologies such as in-dash GPS navigation systems, driver coaching and feedback systems (such as ''eco modes''), vehicle maintenance alerts and reminders, and ''other automatic and driver-initiated location content-

[299] i.e. improvements that improve the fuel economy or GHG emissions of other vehicles on the road.

[300] Agencies distinguish between congestion mitigation and congestion avoidance. Congestion mitigation affects the fuel economy and GHG emissions mainly of other vehicles on the road, whereas congestion avoidance affects the fuel economy mainly of the single vehicle with the technology.

[301] Alliance, Docket No. NHTSA–2010–0131–0262, at 11 (stating that it did not seem like there is sufficient information at this time to define specific credit opportunities); Ford, Docket No. NHTSA–2010–0131–0235, at 16 (stating that ''quantifying the benefit is an acknowledged challenge''); MEMA, Docket No. NHTSA–2010–0131-[fill in], at 9 (stating that the benefits from these technologies ''cannot be quantified literally* * *'').

based technologies that have been shown to reduce fuel consumption.'' [302] These commenters requested the opportunity to work with the agencies at developing such procedures.[303] With regard to EPA's request for comment on whether the regulatory text should clarify how EPA treats driver-selectable modes,[304] the Alliance stated that it believed there was no need to clarify regulatory text, but that EPA should simply update or refine informal guidance as necessary to address issues as they develop.[305] MEMA stated that there was ''precedent for providing CAFE credits based on a projected usage factor of a fuel saving device,'' citing EPA letters regarding the impact of a shift indicator light on fuel economy.[306]

At proposal, EPA addressed the possibility of evaluating applications for off-cycle credits for technologies involving driver interaction, indicating that ''driver interactive technologies face the highest demonstration hurdle because manufacturers would need to provide actual real-world usage data on driver response rates.'' 76 FR 75025. The agencies still believe it to be highly unlikely that off-cycle credits could be justified for these non-safety technologies. This issue is addressed in detail in section III.C.5.ii below. These technologies do not improve the fuel efficiency of the vehicle under any given operating condition, but rather provide information the driver may use to change the driving cycle over which the vehicle overrates which, in turn, *may* improve the real-world fuel economy (miles driven per gallon consumed)/CO_2 emissions (per mile driven) compared to what the fuel economy and CO_2 emissions per mile would have been had the driver not used the information or if the technology was not on the vehicle. The agencies believe, for example, there would be a number of specific challenges to quantifying the effect on fuel economy and CO_2 emissions per mile driven of GPS/real time traffic navigation systems. First, given that the systems available today are available through subscription services, the manufacturer would need to prove that the vehicle operators will pay for such a service for the useful life of the vehicle or the manufacturer would have to provide the service at no cost to vehicle operators over the useful life of the vehicle. Second, there would need to be an extensive data collection program to show that drivers were using the system and that they were taking alternate routes that actually improved fuel economy. It would be necessary to determine the level of fuel economy improvement as well as to show evidence that this level of improvement would be expected to be achieved by vehicle operators over the useful life of the vehicle. In addition, it would be necessary to show the sampling is representative, the effects are statistically significant, and the results are reproducible. Third, the real time traffic information must be proven to be accurate and assurances provided that the level of accuracy would be maintained over the useful life of the vehicle. Inaccurate information might lead to poorer fuel economy. Fourth, anecdotal information indicates that navigations systems are most often used to direct the driver using the shortest temporal path. The agencies believe that only rarely would a driver choose the route that achieves the highest fuel economy over one that takes the least time—especially if the time savings would be significant. In addition, other factors may need to be demonstrated, such as the effect of these technologies in differing geographical regions with various road and traffic patterns and the effect of these technologies during different parts of the day (e.g., rush hour vs. mid-day). It is for these reasons that the agencies believe that meeting the burden of proof for these class of technologies will be extremely difficult. Other ''driver interactive'' off-cycle technologies will present similar challenges. These may include, but are not limited to, in-dash GPS navigation systems, driver coaching and feedback systems such as ''eco modes,'' fuel economy performance displays and indicators, or haptic devices such as, for example, throttle pedal feedback systems, vehicle maintenance alerts and reminders, and other automatic or driver-initiated location content-based technologies that may improve fuel economy.

Finally, the agencies requested comments on the treatment of driver selectable technologies as stated in 76 FR 75089: ''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.'' If we did not receive comments to the contrary, we also stated that ''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.''

The current EPA policy on select-shift transmissions (SSTs) and multimode transmissions (MMT), and shift indicator lights (SILs) is under Manufacturer Guidance Letter CISD–09–19 (December 3, 2009) and supersedes several previous letters on both of these topics. For, SSTs and MMTs, the manufacturer must determine the predominant mode (e.g., 75% of the drivers will have at least 90% of vehicle shift operation performed in one mode, and, on average, 75% of vehicle shift operation is performed in that mode), using default criteria in the guidance letter or a driver survey. If the worst-case mode is determined to be the predominant mode, the manufacturer must test in this mode and use the results with no benefit from the driver-selectable technology reflected in the fuel economy values. If the best-case mode is determined to be the predominant mode, the manufacturer may test in this mode and use the results with the full benefit of the driver-selectable technology reflected in the fuel economy values. If the predominant mode is not discernible, the manufacturer must test in all modes and harmonically average the results (Note: in most cases, there are only two modes so this becomes a 50/50 average between best- and worst-case modes). Based on the EPA decision process under CISD–09–19, both the label and CAFE/GHG could reflect 0, 50, or 100% of the benefit of a driver-selectable device. However, when calculating CAFE, only the 2-cycle test results (e.g., Federal Test Procedure (FTP) and Highway Fuel Economy test (HWFET)) are used. Thus, the higher fuel economy results would only affect the 2-cycle testing values for CAFE purposes. For SILs, the manufacturer must perform an instrumented vehicle survey on a prototype vehicle to determine the appropriate shift schedule to optimize fuel economy. Previous guidance for SILs contained the option for A–B testing with and without the SIL. This has been eliminated in the latest guidance, allowing only an instrumented vehicle survey as the basis for determining SIL related fuel economy improvements. However, for purposes of determining CAFE compliance reporting values, the 2-cycle test results (e.g., Federal Test Procedure

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[302] *See, e.g.,* MEMA at 9; Ford at 16; Garmin, Docket No. NHTSA–2010–0131–0245, at 2–3 (requesting an alternate way for manufacturers to prove the real-world fuel economy and CO_2 benefits of in-dash GPS navigation systems (with or without traffic avoidance) to the agencies besides the ways laid out in the off-cycle credit approval provisions at 40 CFR 86.1866–12(d)(2) and (d)(3)).

[303] Alliance at 11, Ford at 16, MEMA at 9.

[304] See 76 FR 75025.

[305] *Id.* at 90.

[306] MEMA at 9.

(FTP) and Highway Fuel Economy test (HWFET)) are used to align statutory provisions allowing for these two test cycles when determining program compliance. Therefore, only fuel economy improvement values identified on during the FTP and HWFET test cycles would be applicable to the CAFE program.

In response to EPA's request for comment on whether the regulatory text should clarify how EPA treats driver-selectable modes, the Alliance stated that it believed there was no need to clarify regulatory text, but that EPA should simply update or refine informal guidance as necessary to address issues as they develop.[307] MEMA stated that there was ''precedent for providing CAFE credits based on a projected usage factor of a fuel saving device,'' citing EPA letters regarding the impact of a shift indicator light on fuel economy.[308] Finally, the Alliance provided data from General Motors on their HVAC Eco-Mode button based on On-Star data from in-use vehicles (n=3,500; 50.3% of the drivers use the system 90% of the time or greater, 57.4% use it 50% of the time or greater, and 34% never use it). Based on the data supplied, they anticipate a benefit of 1.8 g/mi and, with 50% of the people using the HVAC Eco-Mode, a credit of 0.9 g/mi is warranted (i.e., 1.8×0.5).

On the comments from the Alliance that there is no need to clarify regulatory text and the informal guidance should be updated or refined as necessary, we agree that the current regulations and the latest guidance letter, CISD–09–19, appropriately supersedes previous guidance letters and addresses select-shift transmissions (SSTs) and multimode transmissions, and shift indicator lights (SILs). Therefore, we will not attempt to clarify the regulatory text and we will continue to update our guidance as necessary.

Regarding the comment from MEMA that there is ''precedent for providing CAFE credits based on a projected usage factor of a fuel saving device,'' citing EPA letters regarding the impact of a shift indicator light on fuel economy, the manufacturer guidance letters referenced by MEMA (CD–82–10 (LD) and CD–83–10(LD)) have been superseded by CISD–09–19. Thus, the procedures in CISD–09–19 would be the applicable guidance for comparison. As previously mentioned, CISD–09–19 requires the manufacturer to 1) determine the potential benefit of a driver selectable feature and 2) discern the predominant mode in-use. This process is very similar and consistent with the process we proposed for demonstrating technologies not on the defined technology list. Therefore, we agree with MEMA that there is a precedent within our current policy to consider the influence of driver-selectable features on test cycle results.

For the comments from the Alliance on the HVAC Eco-Mode [309], as discussed above, the existing policy in CISD–09–19 requires using instrumented vehicle survey data to determine the predominant mode and test the vehicle in this mode to determine the fuel economy benefits. This is very similar to the process we are using for alternate method demonstrations under the off-cycle credit program. Therefore, this further supports our previous assertion for addressing driver-selectable technologies under our alternate method demonstration process.

However, we want to emphasize that although we acknowledge the similarities between the procedures under the existing policy in CISD–09–19 and the procedures used in the off-cycle program, our discussion of driver-selectable devices is completely limited to their potential impact on off-cycle credits. The procedures used to conduct FTP and HFET testing for the purpose of determining CAFE and GHG values for a model type are not at issue here. Following our request for comments on how we handle these devices when testing on the FTP and HFET, comments suggested no changes to existing guidance are needed. We agree and will continue to handle these devices on a case-by-case basis consistent with the existing policy in CISD–09–19. In addition, the existing guidance and FTP/HFET testing policy in CISD–09–19 is not applicable in the context of the off-cycle program since driver-selectable technologies will always require the need for estimates of real-world customer usage to receive off-cycle credit. Therefore, in summary we believe that there is a precedent set by the existing policy in CISD–09–19 to determine a usage in-use but that the existing policy in CISD–09–19 has no bearing on the credit determinations in the off-cycle program, and the converse (i.e., the off-cycle credit program affecting existing policy in CISD–09–19). Specifically, the section entitled ''Alternative Methods for Determination of Usage Rates'' in CISD–09–19 that allows an instrumented vehicle survey or on-board data collection are most consistent with the procedures for the off-cycle program as discussed in III.C.5.iii. and 40 CFR § 86.1869–12(c).

In the context of the off-cycle program, the test values applicable to a vehicle's fuel economy label value are mostly independent from those generated for the CAFE compliance; where the 2-cycle results for compliance and the combination of all 5-cycle test results are used for the fuel economy label. However, as indicated with other technologies included in the finalized pre-defined technology menu, fuel economy improvements are reflected in the 2-cycle test result values used for CAFE compliance revealing the need to account for the improved 2-cycle test results when considering off-cycle credits for driver-selectable technologies. Therefore, if a manufacturer is requesting off-cycle credit but has previously used the improved fuel economy test results under the existing policy in CISD–09–19 for a driver-selectable technology, the manufacturer must use the 2-cycle results determined under CISD–09–19 for both the A and B values of the FTP and HWFET A–B tests to determine the potential benefit of the driver selectable technology when requesting off-cycle credit. This approach effectively negates the 2-cycle results and benefits, and which is consistent with the treatment for the other off-cycle technologies where credit is not granted for improvements reflected on current 2-cycle test procedures.

Accordingly, we are allowing driver-selectable technologies to be eligible for credit in the off-cycle credit program using procedures and processes demonstrating technologies not on the defined technology list using alternative methods and the public process. Under these provisions, the manufacturer must determine the benefit of the driver-selectable technology using approved methodologies and a usage factor for the technology using an instrumented vehicle survey, and applying this factor to the measured benefit to estimate and request credit. As discussed above, if a manufacturer has previously received some fuel economy improvement as a result of the decision process under CISD–09–19, the manufacturer must use the 2-cycle results from that decision process as the A and B values for the 2-cycle A–B tests to estimate the off-cycle credit. Consequently, if a manufacturer uses 5-cycle testing to demonstrate the benefit of a driver selectable technology, the manufacturer must use the previously determined 2-cycle test values for the FTP and HWFET A–B tests, which effectively only captures the benefit from the remaining three cycles of 5-cycle testing (i.e., US06,

[307] *Id.* at 90.

[308] MEMA at 9.

[309] Alliance, Docket No. NHTSA–2010–0131–0262, page 38 of 93; Appendix 2, page 13 of 19.

SC03, Cold FTP). The usage factor would then be applied to these 5-cycle results (or any other approved methodology for non-5-cycle test methodologies). For driver-selectable technologies, the manufacturers must adhere to all criteria and requirements as discussed below in III.C.5.iii. and 40 CFR § 86.1869–12(b) and (c).

While we are allowing credit for driver-selectable and driver interactive technologies (including congestion avoidance), the agencies believe that applicants would face formidable burdens of showing that improvements over baseline are legitimate, reliably quantifiable, certain, and transparently demonstrable as described above. As identified in CISD–09–19, there will need to be an extensive data collection program to show that drivers are using the technology and to generate a reliable usage factor, if this has not previously been established. In addition, the usage factor applied to the benefit from the driver-selectable technology will tend to lower the amount of credit unless a manufacturer can demonstrate 100% usage of a driver-selectable technology. Therefore, depending on the level of benefit, the amount of resulting credit could be minimal compared the effort to generate the necessary, supporting data, and manufacturers should consider this before undertaking this process.

In summary, the agencies are not adding driver-selectable or driver-interactive features to the defined technology list. However, driver-selectable and driver-interactive features are eligible for off-cycle credits using procedures and processes for demonstrating technologies not on the defined technology list under the off-cycle program as discussed above.

h. Credit for Glass and Glazing Technologies: Concerns With Metallic Glazing and Request for Separate Polycarbonate Glazing Credit

Multiple comments were received with concerns regarding the use of metallic glazing from the Crime Victims Unit of California (CVUC), California State Sheriffs, Garmin, Honda and TechAmerica. Many commenters raised concerns the credit for glazing may unintentionally create incentives to use metallic films or small metallic particles to achieve reduced vehicle solar heat loading and access the off-cycle credit. The commenters indicated this type of metallic glazing can potentially interfere with signals for global positioning systems (GPS), cell phones, cellular signal based prisoner tracking systems, emergency and/or electronic 911 (E911) calls or other signals emanating from within or being transmitted to a vehicle's passenger compartment/cabin. In addition, some commenters cited this concern as the reason that the California Air Resources Board (CARB) removed their mandate for metallic glazing from the ''Cool Cars'' Regulation in California.

To address these concerns, the agencies met with the Enhanced Protective Glass Automotive Association (EPGAA), which represents automotive glass manufacturers and suppliers. The meeting included representatives from the automotive glass suppliers Pittsburgh Glass Works LLC (PGW), Guardian Industries, and Asahi Glass Company (AGC) to discuss the potential concerns with metallic glazing, signal interference and/or radio frequency (RF) attenuation (details of this meeting are available in EPA docket # EPA–HQ–OAR–2010–0799–41752 and docket NHTSA–2010–0131). At this meeting, EPGAA provided data to the agencies that showed: In general, any glazing material can create signal interference and RF attenuation, and depending on the situation, RF attenuation and signal interference can occur without the presence of metallic glazing material; there was no statistically-significant increase in signal interference and RF attenuation when metallic glazing was used. Furthermore, many vehicles in production today are designed with metallic solar control deletion areas or zones around the window edges and/or defined areas in either the front windshield of rear backlight to minimize signal interference and RF attenuation. Following the meeting, EPGAA representatives provided a list of vehicles currently utilizing metallic glazing demonstrating to the agencies that this technology is currently in-use without significant signal interference/RF attenuation issues being raised. EPGAA representatives indicated the technology is especially prevalent in Europe and with no significant consumer complaints.

In addition, the agencies received comments from the California Air Resources Board (CARB) in response to the specific comments submitted to the proposal regarding the California Cool Cars Regulation indicating the program was withdrawn as a result of the metallic solar glazing concerns (see EPA docket #EPA–HQ–OAR–2010–0799). CARB stated the mandate for metallic glazing in the Cool Cars Regulation was withdrawn was primarily related to the timing of when the concerns regarding metallic glazing were raised in relation to the proposed mandate's targeted finalization than to substantive concerns. CARB also clarified that they were not requiring a specific type of glazing and that a performance-based approach ultimately adopted in the Advanced Clean Cars Regulation accomplished the same objectives as proposed under the Cool Cars Regulation without the need for a mandate. In addition, CARB performed testing of signal interference and RF attenuation by CARB (see test results in EPA docket # EPA–HQ–OAR–2010–0799–41752) echoing the findings of the automotive glass industry that there is ''[n]o effect of reflective glazing observed on monitoring ankle bracelets or cell phones'' and that any ''[e]ffects on GPS navigation devices [are] completely mitigated by use of [the] deletion window'' placing either the device or the external antennae in this area''. CARB urged EPA to finalize the proposed credit values for glass and glazing as proposed. Finally, CARB issued a formal memorandum [310] confirming the timing related reasons for withdrawing the Cool Cars mandate and its test results regarding signal interference and RF attenuation, and urging the agencies to finalize the proposed credit values for glass and glazing as proposed.

Based on this information, the agencies are finalizing the proposed credit values and calculation procedures for solar control glazing. EPA and NHTSA note further the off-cycle credit is performance-based and not a mandate for vehicle manufacturers. Manufacturers have options to choose from a variety of glazing technologies that meet their desired performance for rejecting vehicle cabin solar loading. We reiterate that the rule is technology neutral and that none of these potential glazing technologies are foreclosed. Second, we did not see evidence contravening the information that the automotive glass industry and CARB presented showing that there would not be significant adverse effects on signal interference and RF attenuation by any of the recognized glazing technologies. However, to address the concerns of other commenters, we will emphasize to manufacturers that they should evaluate the potential for signal interference and RF attenuation when requesting the solar control glazing credit to ensure that their designs do not cause any interference.

i. Summary of Off-Cycle Credit Values

As proposed, EPA is finalizing that a CAFE improvement value for off-cycle improvements be determined at the fleet

[310] CARB memorandum available at EPA docket #EPA–HQ–OAR–2010–0799 and NHTSA docket NHTSA–2010–0131.

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 regulations at 40 CFR 600.510–12. Note that although 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.

Finally, the agencies proposed that the pre-approved menu list of off-cycle technologies and default credit values would be predicated on a certain minimum percentage of technology penetration in a manufacturer's domestic fleet. 76 FR 75381. Commenters persuasively argued that such a requirement would discourage introduction and utilization of beneficial off-cycle technologies. They pointed out that new technologies are often introduced on limited model lines or platforms both to gauge consumer acceptance and to gain additional experience with the technology before more widespread introduction. Requiring levels of technology penetration such as the 10 percent proposed for many of the menu technologies could thus create a negative rather than positive incentive to deploy off-cycle technologies. The agencies agree, and note further that having an aggressive penetration rate requirement also raises issues of sufficiency of lead time in the early years of the program. The agencies are therefore not adopting minimum penetration requirements as a prerequisite to claim default credits from the preapproved technology menu.

Table II–22 shows the list of off-cycle technologies and credits and equivalent fuel consumption improvement values for cars and trucks that the agencies are finalizing in today's action. The credits and fuel consumption improvement values for active aerodynamics, high-efficiency exterior lighting, waste heat recovery and solar roof panels are scalable, depending on the amount of respective improvement these systems can generate for the vehicle. The Solar/Thermal control technologies are varied and are limited to a total of 3.0 and 4.3 g/mi (car and truck respectively) The various pre-defined solar/thermal control technologies eligible for off-cycle credit are shown in Table II–22 below.

TABLE II–22—OFF-CYCLE TECHNOLOGIES AND CREDITS AND EQUIVALENT FUEL CONSUMPTION IMPROVEMENT VALUES FOR CARS AND LIGHT TRUCKS

Technology	Adjustments for cars		Adjustments for trucks	
	g/mi	gallons/mi	g/mi	gallons/mi
+ High Efficiency Exterior Lights* (at 100 watt savings)	1.0	0.000113	1.0	0.000113
+ Waste Heat Recovery (at 100W)	0.7	0.000079	0.7	0.000079
+ Solar Panels (based on a 75 watt solar panel)**;				
Battery Charging Only	3.3	0.000372	3.3	0.000372
Active Cabin Ventilation and Battery Charging	2.5	0.000282	2.5	0.000282
+ Active Aerodynamic Improvements (for a 3% aerodynamic drag or Cd reduction)	0.6	0.000068	1.0	0.000113
Engine Idle Start-Stop;				
w/ heater circulation system #	2.5	0.000282	4.4	0.000496
w/o heater circulation system	1.5	0.000169	2.9	0.000327
Active Transmission Warm-Up	1.5	0.000169	3.2	0.000361
Active Engine Warm-up	1.5	0.000169	3.2	0.000361
Solar/Thermal Control	Up to 3.0	0.000338	Up to 4.3	0.000484

* High efficiency exterior lighting credit is scalable based on lighting components selected from high efficiency exterior lighting list (see Joint TSD Section 5.2.3, Table 5–21).

** Solar Panel credit is scalable based on solar panel rated power, (see Joint TSD Section 5.2.4). This credit can be combined with active cabin ventilation credits.

\# In order to receive the maximum engine idle start stop, the heater circulation system must be calibrated to keep the engine off for 1 minute or more when the external ambient temperature is 30 deg F and when cabin heat is demanded (see Joint TSD Section 5.2.8.1).

+ This credit is scalable; however, only a minimum credit of 0.05 g/mi CO_2 can be granted.

TABLE II–23—OFF-CYCLE TECHNOLOGIES AND CREDITS FOR SOLAR/THERMAL CONTROL TECHNOLOGIES FOR CARS AND LIGHT TRUCKS

Thermal control technology	Credit (g CO_2/mi)	
	Car	Truck
Glass or Glazing	Up to 2.9	Up to 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

* Active cabin ventilation has potential synergies with solar panels as described in Chapter 5.2 of the joint TSD.

j. Vehicle Simulation Tool

Chapter 2 of EPA's RIA provides a detailed description of the vehicle simulation tool that EPA had developed and has used for the final rule. This tool is capable of simulating a wide range of conventional and advanced engine, transmission, 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 MYs 2017 to 2025 GHG rule, this simulation tool was used to assist estimating the amount of GHG credits for improved A/C systems and off-cycle technologies. EPA sought public comment on this approach of using the tool for generating some of the credits. The agency received no specific comment on the model itself or on the documentation of the model. However, based on the comments described in the previous section (particularly on allowing scalable credits on off-cycle technologies), EPA modified and fine-tuned the vehicle simulation tool in order to properly capture the amount of scalable GHG reductions provided by off-cycle technologies. More specifically, based on the comments from the Auto Alliance, EPA used the simulation tool to generate scalable credits for the active aerodynamic technology. For this final rule, EPA utilized the simulation tool in order to quantify the (scalable) credits for Active Aerodynamics, High Efficiency Exterior Lights, Solar Panel, and Waste Heat Recovery [311] more accurately. The details of this analysis are presented in Chapter 5.2 of the Joint TSD.

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. EPA utilized the simulation tool to estimate the default credit values for the engine start-stop technology. Details of the analysis are provided in the chapter 5.2.8.1 of Joint TSD. However, 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 cannot provide full benefits of these technologies on the GHG reductions. For this reason, the agency did not use the simulation tool to generate the default GHG credits for these technologies, though future versions of the model may be more capable of quantifying the efficacy of these off-cycle technologies as well. As described in Chapter 5 of the Joint TSD, the Active Engine/Transmission Warm-up credits were estimated using the results from the Ricardo vehicle simulation results.

In summary, for the MYs 2017 to 2025 GHG final rule, EPA used the simulation tool to quantify the amount of GHG emissions reduced by improvements in A/C systems and to determine the default credit values for some of the off-cycle technologies such as active aerodynamics, electrical load reduction, and engine start-stop. Details of the analysis and values of these scalable credits are described in Chapter 5 of Joint TSD. This simulation tool will not be officially used for credit compliance purposes (as proposed) because EPA has already made several of the credits scalable for the purposes of this final rule. However, EPA may use the tool as part of the case-by-case of off-cycle credit determination process. EPA encourages manufacturers to use this simulation tool in order to estimate the credits values of their off-cycle technologies.

3. Advanced Technology Incentives for Full-Size Pickup Trucks

The agencies recognize that the standards for MYs 2017–2025 will be challenging for large vehicles, including full-size pickup trucks that are often used for commercial purposes and have generally higher payload and towing capabilities than other light-duty vehicles. Section II.C and Chapter 2 of the joint TSD describe the adjustments made to the slope of the truck curve compared to the MYs 2012–2016 rule, reflecting these considerations. Sections III.B and IV.E describe the progression of the stringency of the truck standards. Large pick-up trucks represent are a significant portion of the overall light-duty vehicle fleet and generally have higher levels of fuel consumption and GHG emissions than most other light-duty vehicles. Improvements in the fuel economy and GHG emissions of these vehicles can have significant impact on overall light-duty fleet fuel use and GHG emissions. The agencies believe that offering incentives in the earlier years of this program that encourage the deployment of technologies that can significantly improve the efficiency of these vehicles and that also will foster production of those technologies at levels that will help achieve economies of scale, will promote greater fuel savings overall and make these technologies more cost effective and available in the later model years of this rulemaking to assist in compliance with the standards.

The agencies are therefore finalizing the proposed approach to encourage penetration of these technologies both through the standards themselves, but also through various provisions providing regulatory incentives for advanced technology use in full-size pick-up trucks. The agencies' goal is to incentivize the penetration into the marketplace of ''game changing'' technologies for these pickups, including the marketing of hybrids. For that reason, EPA, in coordination with NHTSA, proposed and is adopting provisions for credits and corresponding equivalent fuel consumption improvement values for manufacturers that hybridize a significant number of their full-size pickup trucks, or use other technologies that significantly reduce CO_2 emissions and fuel consumption.[312]

Most of the commenters on this issue supported the large truck credit concept. Some OEM commenters argued that it should be extended to other vehicles such as SUVs and minivans. ICCT, Volkswagen, and CBD opposed adopting the proposed incentive, arguing that this vehicle segment is not especially challenged by the proposed standards, that hybrid systems would readily transfer to it from other vehicle classes, and that the credit essentially amounts to an economic advantage for manufacturers of large trucks. CBD also commented that this credit should be eliminated, since they believe hybrid technology should be forced by aggressive standards rather than encouraged through regulatory incentives. Other environmental group commenters also expressed concern about the real-world impacts of offering this credit, and suggested various ways to tailor it to ensure that fuel savings and emissions reductions associated with it are genuine.

We believe that extending the large truck credit to other light-duty trucks such as SUVs and minivans would greatly expand, and therefore dilute, the intended credit focus. The agencies do not believe that providing such incentives for hybridization in these additional categories is necessary, or that the performance levels required of

[311] This technology was termed 'engine heat recovery' at proposal.

[312] Note that EPA's 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 program. Instead, EPA will 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 here to show the relationship between CO_2 and fuel consumption improvements.

non-hybrid technologies eligible for credits are of such stringency that extending credits to all or most light-duty trucks would amount to anything more than a de facto lowering of overall program stringency. Although commenters rightly pointed out that some of these non-truck vehicles do have substantial towing capacity, most are not used as towing vehicles, in contrast to full-size pickup trucks that often serve as work vehicles. Moreover, the smaller footprint trucks fall on the lower part of the truck curve, which have a higher rate of improvement (in stringency) than the larger trucks, thus making them more comparable to cars in terms of technology access and effectiveness (as well as not having access to these credits).

Arguments made by commenters for not adopting the large truck technology credit are not convincing. Although there may not be inherent reasons for a lack of hybrid technology migration to large trucks, it is clear that this migration has nevertheless been slow to materialize for practical/economic reasons, including in-use duty cycles and customer expectations. These issues still need to be addressed by the designers of large pickups to successfully introduce these technologies in these trucks, and we believe that assistance in the form of a focused, well-defined incentive program is warranted. See section III.D.6 and 7 for further discussion of EPA's justification for this credit program in the context of the stringency of the truck standards.

Volkswagen commented that any HEV or performance-based credits generated by large trucks should not be transferable to other vehicle segments, arguing that if compliance for the large truck segment is really as challenging as predicted, there should be no excess of credits to transfer anyway. This may be the case, but we do not agree that it argues for restricting the use of large pickup truck credits. We think the sizeable technology hurdle involved and the limited model years in which credits are available preclude the potential for credit windfalls. Furthermore, neither the size of the large truck market nor the size of the per-vehicle credit are so substantial that they could lead to a large pool of credits capable of skewing the competition in the lighter vehicle market. As described in Section III.D of this preamble, EPA will continue to monitor the net level of credit transfers from cars to trucks and vice versa in the MYs 2017–2025 timeframe.

As proposed, the agencies are defining a full-size pickup truck based on minimum bed size and hauling capability, as detailed in 86.1866–12(e) of the regulations being adopted. This definition is meant to ensure that the larger pickup trucks, which provide significant utility with respect to bed access and payload and towing capacities, are captured by the definition, while smaller pickup trucks with more limited capacities are not covered. A full-size pickup truck is defined as meeting requirements (1) and (2) below, as well as either requirement (3) or (4) below. A more detailed discussion can be found in section III.C.3.

(1) Bed Width—The vehicle must have an open cargo box with a minimum width between the wheelhouses of 48 inches. And—

(2) Bed Length—The length of the open cargo box must be at least 60 inches. And—

(3) Towing Capability—the gross combined weight rating (GCWR) minus the gross vehicle weight rating (GVWR) must be at least 5,000 pounds. Or—

(4) Payload Capability—the GVWR minus the curb weight (as defined in 40 CFR 86.1803) must be at least 1,700 pounds.

EPA sought comment on extending these credits to smaller pickup trucks, specifically to those with narrower beds, down to 42 inches, but still with towing capability comparable to large trucks. This request for comment produced mixed reactions among truck manufacturers, and some argued that EPA should go further and drop the bed size limit entirely. ICCT and CBD strongly opposed any extension of credits, arguing that adopting the 42″ bed width criterion would allow virtually all pickup trucks to qualify, thereby distorting technology requirements and reducing the benefits of the rule. None of the commenters argued convincingly in favor of the extension and so we are adopting the 48″ minimum requirement as proposed. Chrysler commented that the proposed payload and towing capability minimums are too restrictive, making a sizeable number of Ram 1500 configurations ineligible to earn credits. However, the company provided no sales information to enable the agencies to reassess this issue. Moreover, the agencies did not premise the proposed incentive on every full-size truck configuration being eligible. Manufacturers typically offer a variety of truck options to suit varied customer needs in the work and recreational truck markets, and the fact that one manufacturer (or more) markets to applications lacking the towing and payload demands of the core group of vehicles in this segment does not, in the agencies' view, justify a revision of the hauling requirements that were a fundamental consideration in establishing the credit.

The agencies also sought comment on the definitions of mild and strong hybrids based on energy capture on braking (brake regeneration). Minor modifications to these definitions were made based on these comments as well as new testing performed by the EPA. Due to the detailed nature of these comments, these responses and the description of the testing are included in section 5.3.3 of the Joint TSD.

The program requirements and incentive amounts differ somewhat for mild and strong HEV pickup trucks. As proposed, mild HEVs will be eligible for a per-vehicle credit of 10 g/mi (equivalent to 0.0011 gallon/mile for a gasoline-fueled truck) during MYs 2017–2021. Eligibility also requires that the technology be used on a minimum percentage of a company's full size pickups, beginning with at least 20% of a company's full-size pickup production in 2017 and ramping up to at least 80% in MY 2021. These minimum percentages are lower in MYs 2017 and 2018 than proposed (20% and 30%, respectively, compared to the proposed 30% and 40%), based on our assessment of the comments arguing reasonably that the proposed percentages were too demanding, especially in the initial model years when there is the least lead time. Strong HEV pickup trucks will be eligible for a 20 g/mi CO_2 credit (0.0023 gallon/mile) during MYs 2017–2025 if the technology is used on at least 10% of the company's full-size pickups. The technology penetration thresholds and their basis, as well as comments received on our proposal for them, are discussed in more detail in section III.C below. Because of their importance in assigning credit amounts, EPA is adopting explicit regulatory definitions for mild and strong HEVs. These definitions and the relevant comments we received are discussed in section III.C.3 and in section 5.3.3 of the Joint TSD.

Because there are other, non-HEV, advanced technologies that can provide significant reductions in pickup truck GHG emissions and fuel consumption (e.g., hydraulic hybrid), EPA is also adopting the proposed, more generalized, credit provisions for full-size pickup trucks that achieve emissions levels significantly below their applicable CO_2 targets. This performance-based credit will be 10 g/mi CO_2 (equivalent to 0.0011 gal/mi for the CAFE program) or 20 g/mi CO_2 (0.0023 gal/mi) for full-size pickups achieving 15 or 20%, respectively, better CO_2 than their footprint-based targets in a given model year. The basis for our choice of the 15 and 20% over-compliance targets is explained in Section 5.3.4 of the Joint TSD.

These performance-based credits have no specific technology or design requirements; automakers can use any technology or set of technologies as long as the vehicle's CO_2 performance is at least 15 or 20% below its footprint-based target. However, a vehicle cannot receive both HEV and performance-based credits. 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 will also include any A/C-related credits generated by the vehicles.

The 10 g/mi performance-based credit will be available for MYs 2017 to 2021. In recognition of the nature of automotive redesign sequence, a vehicle model meeting the requirements in a model year will receive the credit in subsequent model years through MY 2021, unless its CO_2 level increases or its production drops below the penetration threshold described below, even if the year-by-year reduction in standards levels causes the vehicle to fall short of the 15% over-compliance threshold. The 10 g/mi credit is not available after MY 2021 because the post-2021 standards quickly overtake designs that were originally 15% over-compliant, making the awarding of credits to them inappropriate. The 20 g/mi CO_2 performance-based credit will be available for a maximum of five consecutive model years within the 2017 to 2025 model year period, provided the vehicle model's CO_2 level does not increase from the level determined in its first qualifying model year, and subject to the penetration requirement described below. A qualifying vehicle model that subsequently undergoes a major redesign can requalify for the credit for an additional period starting in the redesign model year, not to exceed five model years and not to extend beyond MY 2025.

As with the HEV incentives, eligibility for 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 CO_2 credit (0.0011 gal/mi) is 15% in MY 2017, with a ramp up to 40% in MY 2021. The minimum percentage for the 20 g/mi credit (0.0023 gal/mi) is 10% in each year over the model years 2017–2025. The technology penetration thresholds and their basis, as well as comments received on our proposal for them, are discussed in more detail in section III.C.

ICCT opposed allowing vehicle models that earn performance-based credits in one year to continue receiving them in subsequent years as the increasingly more stringent standards progressively diminish the vehicle's performance margin compared to the standard. We view the incentive over the longer term, as a multi-year package, intending it to encourage investment in lasting technology shifts. The fact that it is somewhat easier to exceed performance by 15 or 20% in the earlier years, when the bar is set lower, and, once earned, to retain that benefit for a fixed number of years (provided sales remain strong), works to focus the credit as intended—on incentivizing the introduction of new technology as early in the program as possible.

G. Safety Considerations in Establishing CAFE/GHG Standards

1. Why do the Agencies consider safety?

The primary goals of 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.[313] As a safety agency, NHTSA has long considered the potential for adverse safety consequences when establishing CAFE standards,[314] and under the CAA, EPA considers factors related to public health and human welfare, including safety, in regulating emissions of air pollutants from mobile sources.[315] Safety trade-offs associated with fuel economy increases have occurred in the past, particularly before NHTSA CAFE standards were attribute-based,[316] 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, partly in response to CAFE standards, to build smaller and lighter vehicles, rather than adding more expensive fuel-saving technologies while 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 the more stringent 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 standards, and the agencies have incorporated this expectation into our modeling analysis supporting the 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 agencies are encouraged by comments to the NPRM from the Alliance of Automotive Manufacturers reflecting a commitment to safety stating that, while improving the fuel efficiency of the vehicles, the vehicle manufacturers are ''mindful that such improvements must be implemented in a manner that does not compromise the rate of safety improvement that has been achieved to date.'' 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-

[313] 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.

[314] This practice is recognized approvingly in case law. As the United States Court of Appeals for the D.C. 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 (D.C. Cir. 1990).

[315] As noted in Section I.D above, EPA has considered the safety of vehicular pollution control technologies from the inception of its Title II regulatory programs. See also *NRDC* v. *EPA,* 655 F. 2d 318, 332 n. 31 (D.C. Cir. 1981). (EPA may consider safety in developing standards under section 202(a) and did so appropriately in the given instance).

[316] National Research Council, ''Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards,'' National Academy Press, Washington, DC (2002), Finding 2, p. 3, *Available at http://www.nap.edu/openbook.php?isbn=0309076013* (last accessed Aug. 2, 2012).

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.[317] 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 minimize incentive to downsize vehicles does not mean that some manufacturers will not downsize if doing so makes it easier for them to meet the overall CAFE/GHG standard in a cost-efficient manner, as for example if the smaller vehicles are so much lighter (or de-contented) 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).[318] 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 final rule, and do not expect manufacturers to reduce vehicle footprint in response to the final rule, the agencies must attempt to predict the safety effects, if any, of the final rule 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. This was reinforced by comments to the proposal from Volvo which stated ''Everything else being equal, several of the studies presented indicate a significant increase, up to a factor ten, in the fatality risk for the occupants in the lighter vehicle for a two-to-one weight ratio between the colliding vehicles in a head-on crash.''[319]

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. 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 lighter yet stiffer 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 for analyzing these CAFE and GHG standards, 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. 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 functionality such as durability, drivability, 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. Comments to the proposal from the Alliance of Automakers supported NHTSA's approach of using both engineering and statistical analyses to assess the effects of the standards on safety, stating ''The Alliance supports NHTSA's intention to examine safety from the perspective of both the historical field crash data and the engineering analysis of potential future Advanced Materials Concept vehicles. NHTSA's planned analysis rightly looks backward and forward.'' [320] DRI furnished alternative statistical analyses in which the significant fatality increase seen for mass reduction in cars weighing less than 3,106 pounds in Kahane's analysis tapers off to a non-significant or near-zero level. Other commenters (including ICCT, Center for Biological Diversity (CBD), Consumers Union, NRDC, and the Aluminum Association), in contrast, stated that

[317] 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 Joint TSD for more information on the agencies' choice of ''cut-off'' points for the footprint-based target curves.

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

[319] Docket No. NHTSA–2010–0131–0243; Section: Safety Consideration.

[320] Alliance comments, Docket No. NHTSA–2010–0131, at *pg* 5.

mass reduction can be implemented safely and there should be no safety impacts associated with the CAFE/GHG standards. Some commenters argued that safety of future vehicles will be solely a function of vehicle design and not of weight or size, while others argued that better material usage, better design, and stronger materials will improve vehicle safety if vehicle size is maintained. More specifically, comments from ICCT stated that reducing vehicle weight through the use of strong lightweight materials, while maintaining size can reduce intrusion, as the redesigned vehicle can reduce crash forces with equivalent crush space. ICCT further stated that ''this also supports that size-based standards that encourage the use of lightweight materials should reduce intrusion and, hence, fatalities.''[321] The American Iron and Steel Institute indicated that steel structures are particularly effective in absorbing energy during a collision over the engineered crush space (or crumple zone), and further indicated that new advanced high-strength steel technology has already demonstrated its ability to reduce mass and maintain or improve test crashworthiness performance all within the same vehicle footprint, although acknowledging that these comments did not necessarily reflect crash performance with vehicles of different sizes and masses.

The agencies have looked closely at these issues, and we believe that our approach of using both statistical analyses of historical data to assess societal safety effects, and design studies to assess the ability of individual designs to comply with the FMVSS and perform well on NCAP and IIHS tests responds to these concerns.

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

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 recommendations on whether the existing methods or other methods should be used for future statistical analysis of historical data. This study would 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).[322]

Second, NHTSA and EPA, in consultation with DOE, would update the MY 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: 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 U.S. 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, and an updated database was created and employed for assessing safety effects in this final rule. The agencies also believe, as UMTRI also found, that different statistical analyses may have produced different results because they each used slightly different datasets for their analyses. In order to try to mitigate this issue 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 made the preliminary version of the new database, which was the basis for NHTSA's 2011 report, available to the public in May 2011, and an updated version in April 2012,[323] enabling other researchers to analyze the same data and hopefully minimizing discrepancies in the results that would have been due to inconsistencies across databases.[324] The agencies recognize, however, that the updated database may not represent the future fleet, because vehicles have continued and will

[321] ICCT comments, Docket No. EPA–HQ–OAR–2010–0799, Document ID: 9512, at *pg* 13.

[322] All three of the peer reviews are available in Docket No. 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.''

[323] The new databases are available at *ftp://ftp.nhtsa.dot.gov/CAFE/*.

[324] 75 FR 25324 (May 7, 2010); the discussion of planned statistical analyses is on pp. 25395–25396.

continue to change. NHTSA published a preliminary report with the NPRM in November 2011, which has subsequently been revised based on peer review comments. The final report is being published concurrently with this rulemaking.[325]

The agencies are aware that several studies have been initiated using the 2011 version or the 2012 version of NHTSA's newly established safety database. In addition to new Kahane studies, which are discussed in section II.G.3.d, 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 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 considers 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. Both LBNL studies were peer reviewed and subsequently revised and updated. DRI used models that separate the effect of mass reduction on two components of fatality risk, crash avoidance and crashworthiness. The LBNL and DRI studies are available in the docket for this final rule.[326] The database is available for download to the public from NHTSA's Web site.

Finally, EPA and NHTSA with DOT's Volpe Center, part of DOT's Research and Innovative Technology Administration, 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.'' This study is also available in the docket for this final rule.[327]

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 in the midterm review and future rulemakings, 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.[328] 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 mass reduction for this final 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 regarding 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 recent historical 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. This study was updated and finalized in March of 2012.[329] He showed that the trends in risk for various classes of vehicles—e.g., non-sports car passenger cars, vans, SUVs,

[325] The final report can be found in Docket No. NHTSA–2010–0131.

[326] Wenzel, T. (2011a). *Assessment of NHTSA's Report ''Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs—Draft Final Report.''* (Docket No. NHTSA–2010–0152–0026). Berkeley, CA: Lawrence Berkeley National Laboratory; Wenzel, T. (2011b). *An Analysis of the Relationship between Casualty Risk Per Crash and Vehicle Mass and Footprint for Model Year 2000–2007 Light-Duty Vehicles—Draft Final Report.''* (Docket No. NHTSA–2010–0152–0028). Berkeley, CA: Lawrence Berkeley National Laboratory; Wenzel, T. (2012a). *Assessment of NHTSA's Report ''Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs—Final Report.''* (To appear in Docket No. NHTSA–2010–0152). Berkeley, CA: Lawrence Berkeley National Laboratory; Wenzel, T. (2012b). *An Analysis of the Relationship between Casualty Risk Per Crash and Vehicle Mass and Footprint for Model Year 2000–2007 Light-Duty Vehicles—Final Report.''* (To appear in Docket No. NHTSA–2010–0152). Berkeley, CA: Lawrence Berkeley National Laboratory; Van Auken, R.M., and Zellner, J. W. (2012a). *Updated Analysis of the Effects of Passenger Vehicle Size and Weight on Safety, Phase I.* Report No. DRI–TR–11–01. (Docket No. NHTSA–2010–0152–0030). Torrance, CA: Dynamic Research, Inc.; Van Auken, R.M., and Zellner, J. W. (2012b). *Updated Analysis of the Effects of Passenger Vehicle Size and Weight on Safety, Phase II; Preliminary Analysis Based on 2002 to 2008 Calendar Year Data for 2000 to 2007 Model Year Light Passenger Vehicles to Induced-Exposure and Vehicle Size Variables.* Report No. DRI–TR–12–01, Vols. 1–3. (Docket No. NHTSA–2010–0152–0032). Torrance, CA: Dynamic Research, Inc.; Van Auken, R.M., and Zellner, J. W. (2012c). *Updated Analysis of the Effects of Passenger Vehicle Size and Weight on Safety, Phase II; Preliminary Analysis Based on 2002 to 2008 Calendar Year Data for 2000 to 2007 Model Year Light Passenger Vehicles to Induced-Exposure and Vehicle Size Variables.* Report No. DRI–TR–12–01, Vols. 4–5. (Docket No. NHTSA–2010–0152–0033). Torrance, CA: Dynamic Research, Inc.; Van Auken, R.M., and Zellner, J. W. (2012d). *Updated Analysis of the Effects of Passenger Vehicle Size and Weight on Safety; Sensitivity of the Estimates for 2002 to 2008 Calendar Year Data for 2000 to 2007 Model Year Light Passenger Vehicles to Induced-Exposure and Vehicle Size Variables.* Report No. DRI–TR–12–03. (Docket No. NHTSA–2010–0152–0034). Torrance, CA: Dynamic Research, Inc.

[327] Brewer, John. *An Assessment of the Implications of ''Smart Design'' on Motor Vehicle Safety.* 2011. Docket No. NHTSA–2010–0131.

[328] 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.'')

[329] Wenzel, T.P. (2012). *Analysis of Casualty Risk per Police-Reported Crash for Model Year 2000 to 2004 Vehicles, Using Crash Data from Five States,* March 2012, LBNL–4897E, available at: *http://energy.lbl.gov/ea/teepa/pdf/lbnl-4897e.pdf* (last accessed Jun. 18, 2012).

crossover utility vehicles (CUV), 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 that societal risk tends to decrease as car or CUV size increases, while societal risk tends to increase as pickup or SUV size increases.

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 18 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, all else being equal, 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 also predicted that ''the sky will not fall'' as the fleet downsizes, insofar as 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 disagreement on what value of Variance Inflation Factor (VIF, a measure of multicollinearity) that would call results into question, and suggested that a 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 whether smaller, lighter vehicles maneuver better, and thus avoid more crashes, than larger, heavier vehicles. German noted that lighter vehicles should have improved handling and braking characteristics and ''may be more likely to avoid collisions.'' Lund presented 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 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[330] 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 than that of its lighter crash partner, 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 absolute mass reduction (say, 100 pounds) 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 regression model distorts the estimates, resulting in high variance inflation factors with wrong signs and magnitudes in the results. Her results consistently showed that the ratio between the masses of two vehicles involved in a two-vehicle crash was a more important parameter than variables 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[331] of a set of

[330] 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*.

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

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 database 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 [332] 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 the various statistical analyses 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 reduce 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 2012 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 modification, are not exposure-based risk models and inferences drawn from these models tend 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 societal fatality risk in two-vehicle crashes 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 fuel economy is used as a surrogate for curb weight.

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. Two Reports by Dr. Charles Kahane, NHTSA titled ''Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs'': Preliminary Report, November 2011 and Final Report, August 2012

The relationship between a vehicle's mass, size, and fatality risk is complex, and 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

[332] Kahane, C. J. (2003). *Vehicle Weight, Fatality Risk and Crash Compatibility of Model Year 1991–99 Passenger Cars and Light Trucks,* NHTSA Technical Report. DOT HS 809 662. Washington, DC: National Highway Traffic Safety Administration, *http://www-nrd.nhtsa.dot.gov/Pubs/809662.PDF*.

MYs 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.[333] 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 MYs 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.[334]

In April 2010, NHTSA, working closely with EPA and the Department of Energy (DOE), commenced 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 MYs 1991–1999 vehicles in CYs 1995–2000 crashes had become outdated as new safety technologies, vehicle designs and materials were introduced. The new databases are comprised of MYs 2000–2007 vehicles in CY 2002–2008 crashes with the most up-to-date possible data, given the processing lead time for crash data and the need for enough crash cases to permit statistically meaningful analyses. NHTSA made the first version of the new databases available to the public in May 2011 and an updated version in April 2012,[335] enabling other researchers to analyze the same data and hopefully minimizing discrepancies in the results due to inconsistencies across the data used.[336]

One way to estimate these effects is the use of statistical analyses of societal fatality 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 2011–2012 NHTSA reports 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 2011–2012 reports[337] analyze MYs 2000–2007 cars and LTVs in CYs 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 MYs 2000–2007 vehicles from MYs 1991–1999 has been the increase in crossover utility vehicles (CUV), which are SUVs of unibody construction, sometimes built upon a platform shared with passenger cars. CUVs have blurred the distinction between cars and trucks. The new analyses treat 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. 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 more accurate VMT estimates than NHTSA's earlier databases, derived from a file of odometer readings by make, model, and model year recently developed by R.L. Polk and purchased by NHTSA.[338] For the 2011–2012 reports, 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 reducing 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[339] 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 light-duty vehicles manufactured on or after September 1, 2011 are required to be equipped with ESC.[340]

For the 2011–2012 reports, 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

[333] Kahane (2010).

[334] 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).2012a). *Updated Analysis of the Effects of Passenger Vehicle Size and Weight on Safety, Phase I.* Report No. DRI–TR–11–01. (Docket No. NHTSA–2010–0152–0030). Torrance, CA: Dynamic Research, Inc.

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

[336] 75 FR 25324 (May 7, 2010); the discussion of planned statistical analyses is on pp. 25395–25396.

[337] Kahane, C. J. (2011). "Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs—Preliminary Report," is available in the NHTSA docket, NHTSA–2010–0152 as item no. 0023. Kahane, C. J. (2012). "Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000–2007 Passenger Cars and LTVs—Final Report," is also in that docket. 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."

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

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

[340] 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.

are also split in half by median weight of the model year 2000–2007 vehicles. Table II–24 presents the *2011 preliminary report's* 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–24—RESULTS OF 2011 NHTSA *Preliminary 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

Charles Farmer, Paul E. Green, and Anders Lie, who reviewed NHTSA's 2010 report, again peer-reviewed the 2011 preliminary report.[341] In preparing its 2012 final report, NHTSA also took into account Wenzel's assessment of the preliminary report and its peer reviews, DRI's analyses published early in 2012, and public comments such as those by ICCT.[342] These comments prompted supplementary analyses, especially sensitivity tests, discussed below. However, the basic analysis of the 2012 final report is almost unchanged from the 2011 preliminary report, differing only in the addition of some crash data that became available in the interim and a minor change in the formula for estimating annual VMT. Table II–25 presents the 2012 final report's 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–25—RESULTS OF 2012 NHTSA FINAL 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	1.56	+.39 to +2.73
Cars ≥ 3,106 pounds	.51	−.59 to +1.60
CUVs and minivans	−.37	−1.55 to +.81
Truck-based LTVs < 4,594 pounds	.52	−.45 to +1.48
Truck-based LTVs ≥ 4,594 pounds	−.34	−.97 to +.30

Only the 1.56 percent risk increase in the lighter-than-average cars is statistically significant. There are nonsignificant increases in the heavier-than-average cars and the lighter-than-average truck-based LTVs, and non-significant societal benefits for mass reduction in CUVs, minivans, and the heavier-than-average truck-based LTVs. The report concludes that judicious combinations of mass reductions that maintain footprint and are proportionately higher in the heavier vehicles are likely to be safety-neutral—i.e., they are unlikely to have a societal effect large enough to be detected by statistical analyses of crash data. 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 amounts within this range. There are several reasons for these increases: During this time, 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–26—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

[341] Items 0035 (Lie), 0036 (Farmer) and 0037 (Green) in Docket No. NHTSA–2010–0152.

[342] Item 0258 in Docket No. NHTSA–2010–0131.

TABLE II–26—2010 REPORT: MY 1991–1999, CY 1995–2000 FATALITY INCREASE (%) PER 100-POUND MASS REDUCTION WHILE HOLDING FOOTPRINT CONSTANT—Continued

	Actual regression result scenario	Upper-estimate scenario	Lower-estimate scenario
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–27—FATALITY INCREASE (%) PER 100-POUND MASS REDUCTION WHILE HOLDING FOOTPRINT CONSTANT

	NHTSA (2010) (percent)	NHTSA (2012) (percent)
Lighter cars	2.21	1.56
Heavier cars	0.90	0.51
Lighter LTVs	0.17*	0.52
Heavier LTVs	−1.90*	−0.34
CUV/minivan		−0.37

* Includes CUV/minivan

The new results are directionally similar to the 2010 results: Fatality increase in the lighter cars, safety benefit in the heavier LTVs. But the effects may have become weaker at both ends. (NHTSA does 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 1.56 percent while the societal fatality-reduction benefit of mass reduction in the heaviest LTVs diminished from 1.90 percent to 0.34 percent and is no longer statistically significant.

The agencies believe that the changes may be due to a combination of 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 MYs 2000–2007. Also, the tendency of light, small vehicles to be driven in a manner that results in high crash rates is not as strong as it used to be.[343] 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 depending on whether the crash partner is another car or LTV (34 percent of fatalities occurred in crashes involving two light-duty vehicles, and another 6 percent occurred in crashes involving a light-duty vehicle and a heavy-duty vehicle) 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 higher, 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 (which, combined, accounted for 23 percent of fatalities), mass reduction is usually not harmful and often beneficial, because the lighter vehicles respond more quickly to braking and steering. Offsetting this beneficial, 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.[344]

The estimates in Table II–25 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 MYs 2017–2025 timeframe will be different from the MYs 2000–2007 fleet analyzed for this study. Nevertheless, one consideration provides some basis for confidence in applying the regression results to estimate the effects of mass reductions larger than 100 pounds or over longer time periods. This is NHTSA's fourth evaluation of the effects of mass reduction and/or downsizing, comprising databases ranging from MYs 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.[345] 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.

NHTSA's 2011 preliminary report acknowledged another source of uncertainty, namely that the baseline statistical model can be varied by choosing different control variables or redefining the vehicle classes or crash types, for example. Alternative models produce different point estimates.

[343] Kahane (2012), pp. 30–36.

[344] *Ibid.*, pp. 27–30.

[345] 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%).

NHTSA believed it was premature to address that in the preliminary report. ''The potential for variation will perhaps be better understood after the public and other agencies have had an opportunity to work with the new database.'' [346] Indeed, the principal comments on the 2011 preliminary report were suggestions or demonstrations of other ways to analyze NHTSA's database, especially by Farmer and Green in their peer reviews, Van Auken (DRI) in his most recent analyses, and Wenzel in his assessment of NHTSA's report. The analyses and findings of Wenzel's and Van Auken's reports are summarized in Sections II.G.3.e, II.G.3.f, and II.G.3.g, below. These reports, among other analyses, define and run specific alternative regression models to analyze NHTSA's 2011 or 2012 databases.[347]

From these suggestions and demonstrations, NHTSA garnered 11 more or less plausible alternative techniques that could be construed as sensitivity tests of the baseline model.[348] The models use NHTSA's databases and regression-analysis approach, but differ from the baseline model in one or more terms or assumptions. All of them try to control for fundamentally the same driver, vehicle, and crash factors, but differ in how they define these factors or how much detail or emphasis they provide for some of them. NHTSA applied the 11 techniques to the latest databases to generate alternative estimates of the societal effect of 100-pound mass reductions in the five classes of vehicles. The range of estimates produced by the sensitivity tests gives an idea of the uncertainty inherent in the formulation of the models, subject to the caveat that these 11 tests are, of course, not an exhaustive list of conceivable alternatives. Below are the baseline and alternative results, ordered from the lowest to the highest estimated increase in societal risk for cars weighing less than 3,106 pounds:

TABLE II–28—SOCIETAL FATALITY INCREASE (%) PER 100-POUND MASS REDUCTION WHILE HOLDING FOOTPRINT * CONSTANT

	Cars < 3,106	Cars ≥ 3,106	CUVs & minivans	LTVs † < 4,594	LTVs † ≥ 4,594
Baseline estimate	1.56	.51	− .37	.52	− .34
95% confidence bounds (sampling error):					
Lower	.39	− .59	− 1.55	− .45	− .97
Upper	2.73	1.60	.81	1.48	.30
11 Alternative Models					
1. Track width/wheelbase w. stopped veh data	.25	− .89	− .13	− .09	− .97
2. With stopped − vehicle State data	.97	− .62	− .33	.35	− .80
3. By track width & wheelbase	.97	.24	− .24	− .07	− .58
4. W/O CY control variables	1.53	.43	.04	1.20	.30
5. CUVs/minivans weighted by 2010 sales	1.56	.51	.53	.52	− .35
6. W/O non − significant control variables	1.64	.68	− .46	.35	− .54
7. Incl. muscle/police/AWD cars/big vans	1.81	.49	− .37	.49	− .76
8. Control for vehicle manufacturer	1.91	.75	1.64	.68	− .13
9. Control for veh manufacturer/nameplate	2.07	1.82	1.31	.66	− .13
10. Limited to drivers with BAC=0	2.32	1.06	− .19	.86	− .58
11. Limited to good drivers ‡	3.00	1.62	−.00	1.09	− .30

* While holding track width and wheelbase constant in alternative model nos. 1 and 3.
† Excluding CUVs and minivans.
‡ Blood alcohol content = 0, no drugs, valid license, at most 1 crash and 1 violation during the past 3 years.

For example, in cars weighing less than 3,106 pounds, the baseline estimate associates 100minus;pound mass reduction, while holding footprint constant, with a 1.56 percent increase in societal fatality risk. The corresponding estimates for the 11 sensitivity tests range from a 0.25 to a 3.00 percent increase. The sensitivity tests illustrate both the fragility and the robustness of the baseline estimate. On the one hand, the variation among the alternative estimates is quite large relative to the baseline estimate: In the preceding example of cars < 3,106 pounds, from almost zero to almost double the baseline. In fact, the difference in estimates is a reflection of the small statistical effect that mass reduction has on societal risk, relative to other factors. Thus, sensitivity tests which vary vehicle, driver, and crash factors can appreciably change the estimate of the effect of mass reduction on societal risk in relative terms.

On the other hand, the variations are not all that large in absolute terms. The ranges of the alternative estimates, at least these alternatives, are about as wide as the sampling-error confidence bounds for the baseline estimates. As a general rule, in the alternative models, as in the baseline models, mass reduction tends to be relatively more harmful in the lighter vehicles, and more beneficial in the heavier vehicles. Thus, in all models, the estimated effect of mass reduction is a societal fatality increase (not necessarily a statistically significant increase) for cars < 3,106 pounds, and in all models except one, a societal fatality reduction for LTVs ≥ 4,594 pounds. None of these models suggest mass reduction in small cars would be beneficial. All suggest mass reduction in heavy LTVs would be beneficial or, at least, close to neutral. In general, any judicious combination of mass reductions that maintain footprint and are proportionately higher in the heavier vehicles is unlikely to have a societal effect large enough to be detected by statistical analyses of crash data. NHTSA has conducted a sensitivity analysis to estimate the fatality impact of the alternative models using the coefficients for these 11 test

[346] Kahane (2011), p. 81.

[347] Wenzel (2012a), Van Auken and Zellner (2012b, 2012c, 2012d).

[348] See Kahane (2012), pp. 14–16 and 109–128 for a further discussion of the alternative models and the rationales behind them.

cases. The results for these sensitivity runs can be found in Table IX–6 of NHTSA's FRIA.

Four additional comments on NHTSA's 2011 report are addressed in the 2012 report. ICCT noted that DRI's latest analyses are two-stage analyses that subdivide the effect of mass reduction into a fatalities-per-crash component (called ''effect on crashworthiness'') and a crashes-per-VMT component (called ''effect on crash avoidance''). ICCT believes it counterintuitive that DRI's two-stage analysis using the same independent variables as NHTSA's basic model shows mass reduction harms ''crash avoidance''; thus, ICCT prefers DRI's alternative models (using different independent variables) that do not show mass reduction harming crash avoidance. NHTSA's response is that DRI's estimates of separate fatalities-per-crash and crashes-per-VMT components appear to be valid, but, in NHTSA's opinion, these components do not necessarily correspond to the intuitive concepts of ''crashworthiness'' and ''crash avoidance.'' Specifically, the fatalities-per-crash component is affected not only by the crashworthiness of the vehicles, but also by how severe their crashes are: a crash-avoidance issue. Farmer recommended that, in the analyses of crashes between two light vehicles, NHTSA estimate the effect of mass reduction in the case vehicle separately for the occupants of that vehicle and for the occupants of the other vehicle. The analysis shows that mass reduction consistently and substantially increases risk for the vehicle's own occupants and substantially lowers it for the occupants of the partner vehicle. Several commenters suggested that NHTSA consider logistic ridge regression as a tool for addressing multicollinearity; NHTSA was unable to acquire software for logistic ridge regression now, but will attempt to acquire it for future analyses. Lie requested—and NHTSA added—a comparison of the estimated safety effects of mass reduction to the effects of safety technologies and the differences in risk between vehicles with good and poor test ratings.

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 (LBNL Phase 1 report), 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 (LBNL Phase 2 report). Both reports have been reviewed by NHTSA, EPA, and DOE staff, as well as by a panel of reviewers.[349] The final versions of the reports reflect responses to comments made in the formal review process, as well as changes made to the VMT weights developed by NHTSA for the final rule, and inclusion of 2008 data for six states that were not available for the analyses in the draft final versions included in the NPRM docket.

The LBNL Phase 1 report replicates Kahane's analysis for NHTSA, using the same data and methods, and in many cases using the same SAS programs, in order to confirm NHTSA's results. The LBNL report confirms NHTSA's 2012 finding that mass reduction is associated with a statistically significant 1.55% increase in fatality risk per vehicle miles travelled (VMT) for cars weighing less than 3,106 pounds; for other vehicle types, mass reduction is associated with a smaller increase, or even a small decrease, in risk. Wenzel tested the sensitivity of these estimates to changes in the measure of risk and the control variables and data used in the regression models. Wenzel also concluded that there is a wide range in fatality risk by vehicle model for models that have comparable mass or footprint, 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 Phase 1 report notes that many of the control variables NHTSA includes in its logistic regressions are statistically significant, and have a much larger estimated effect on fatality risk than vehicle mass. For example, installing torso side airbags, electronic stability control, or an automated braking system in a car is estimated to reduce fatality risk by about 10%; cars driven by men are estimated to have a 40% higher fatality risk than cars driven by women; and cars driven at night, on rural roads, or on roads with a speed limit higher than 55 mph are estimated to have a fatality risk over 100 times higher than cars driven during the daytime on low-speed non-rural roads. While the estimated effect of mass reduction may result in a statistically-significant increase in risk in certain cases, the increase is small and is overwhelmed by other known vehicle, driver, and crash factors.

NHTSA notes these findings are additional evidence that estimating the effect of mass reduction is a complex *statistical* problem, given the presence of other factors that have large effects. The findings do not propose future technologies that could neutralize the potentially deleterious effects of mass reduction. Indeed, the preceding examples are limited to technologies emerging in the 2002–2008 timeframe of the crash database but that will be in all model year 2017–2025 vehicles (side airbags, electronic stability control) or factors that are simply unchangeable circumstances in the crash environment outside the control of CAFE or other vehicle regulations (for example, that about half of the drivers are males and that much driving is at night or on rural roads).

Sensitivity tests: LBNL tested the sensitivity of the NHTSA estimates of the relationship between vehicle weight and risk using 19 different regression analyses that changed the measure of risk, the control variables used, or the data used in the regression models.

TABLE II–29—SOCIETAL FATALITY INCREASE (%) PER 100-POUND MASS REDUCTION WHILE HOLDING FOOTPRINT * CONSTANT FROM WENZEL STUDY

	Cars < 3,106	Cars ≥ 3,106	CUVS & minivans	LTVS† < 4,594	LTVS† ≥ 4,594
Baseline estimate	1.55	0.51	−0.38	0.52	−0.34

[349] EPA sponsored the peer review of the LBNL Phase 1 and 2 Reports.

TABLE II–29—SOCIETAL FATALITY INCREASE (%) PER 100-POUND MASS REDUCTION WHILE HOLDING FOOTPRINT * CONSTANT FROM WENZEL STUDY—Continued

	Cars < 3,106	Cars ≥ 3,106	CUVS & minivans	LTVS† < 4,594	LTVS† ≥ 4,594
19 Alternative Models					
1. Weighted by current distribution of fatalities	1.27	0.37	−0.70	0.42	−0.36
2. Single regression model for all crash types	1.26	0.35	−0.74	0.41	−0.42
3. Excluding footprint (allowing footprint to vary with mass)	2.74	1.95	0.60	0.47	−0.39
4. Fatal crashes per VMT	1.95	0.89	−0.47	0.54	−0.42
5. Fatalities per induced exposure crash	−0.22	−1.45	−0.84	−1.13	−0.76
6. Fatalities per registered vehicle-year	0.93	2.40	−0.40	−0.09	−0.76
7. Accounting for vehicle manufacturer	1.90	0.75	1.62	0.59	−0.11
8. Accounting for vehicle manufacturer plus five luxury brands	2.04	1.80	1.28	0.57	−0.11
9. Accounting for initial vehicle purchase price	1.42	0.84	−0.92	0.45	−0.52
10. Excluding CY variables	1.52	0.43	0.03	1.20	0.30
11. Excluding crashes with alcohol/drugs	1.88	0.88	−0.16	0.78	−0.35
12. Excluding crashes with alcohol/drugs or bad drivers	2.32	1.19	−0.01	1.01	−0.11
13. Accounting for median household income	1.20	0.16	−0.44	0.68	−0.30
14. Including sports, squad, AWD cars and fullsize vans	1.79	0.49	−0.38	0.49	−0.77
15. Stopped instead of non-culpable vehicles for induced exposure	0.97	−0.63	−0.33	0.35	−0.80
16. Including track width and wheelbase instead of footprint	0.95	0.24	−0.25	−0.07	−0.58
17. Using stopped vehicles and track width/wheelbase	0.26	−0.90	−0.14	−0.10	−0.97
18. Reweighting CUVs and minivans by 2010 sales	1.55	0.51	0.55	0.52	−0.34
19. Excluding non-significant control variables	1.63	0.69	−0.46	0.35	−0.54

* While holding track width and wheelbase constant in alternative model nos. 1 and 3.
† Excluding CUVs and minivans.

For all five vehicle types, the range in estimates from the nineteen alternative models spanned zero, with the individual estimated effects of a 100-pound mass reduction in Table II–28 ranging from a 1.45 percent fatality reduction (cars ≥ 3,106 pounds, alternative 5) up to an increase in risk of 2.74 percent (cars < 3,106 pounds, alternative 3). Nevertheless, for cars weighing less than 3,106 pounds, only one of the 19 alternative regressions estimated a reduction rather than an increase in U.S. fatality risk: Alternative 5, where risk was defined as fatalities per induced exposure crash (rather than fatalities per VMT). Whereas for LTVs ≥ 4,594 pounds, only one of the 19 alternatives estimated an increase in fatality risk, namely the model without CY variables (alternative 10).

NHTSA notes that all of these models suggest mass reduction in small cars would be harmful or, at best, close to neutral; all suggest mass reduction in heavy LTVs would be beneficial or, at worst, close to neutral. The range on these 19 sensitivity tests is similar to the range in the 11 tests included in the Kahane write-up.

Multicollinearity issues (from LBNL study): 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. The Pearson correlation coefficient r between vehicle mass and footprint ranges from 0.90 for four-door sedans and SUVs, to just under 0.50 for minivans. The variance inflation factor (VIF) is a more formal measure of multicollinearity of variables included in a regression model. Allison [350] ''begins to get concerned'' with VIF values greater than 2.5, while Menard [351] suggests that a VIF greater than 5 is a ''cause for concern'', while a VIF greater than 10 ''almost certainly indicates a serious collinearity problem''; however, O'Brien [352] suggests that ''values of VIF of 10, 20, 40 or even higher do not, by themselves, discount the results of regression analyses.'' When both weight and footprint are included in the regression models, the VIF associated with weight exceeds 5 for four-door cars, small pickups, SUVs, and CUVs, and exceeds 2.5 for two-door cars and large pickups; the VIF associated with weight is only 2.1 for minivans. NHTSA included several analyses to address possible effects of the near-multicollinearity between mass and footprint.

First, NHTSA ran a sensitivity case 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.[353] If the multicollinearity was so great that including both variables in the same model gave misleading results, removing footprint from the model would give much different results than keeping it in the model. NHTSA's sensitivity test estimates that when footprint is allowed to vary with mass, the effect of mass reduction on risk increases from 1.55% to 2.74% for cars weighing less than 3,106 pounds, from a non-significant 0.51% to a statistically-significant 1.95% for cars weighing more than 3,106 pounds, and from a non-significant 0.38% decrease to a statistically-significant 0.60% increase in risk for CUVs and minivans; however, the effect of mass reduction on light trucks is unchanged.

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

[350] Allison, P.D.. *Logistic Regression Using SAS, Theory and Application.* SAS Institute Inc., Cary NC, 1999.

[351] Menard, S. *Applied Logistic Regression Analysis, Second Edition.* Sage Publications, Thousand Oaks, CA 2002.

[352] O'Brien, R.M. ''A Caution Regarding Rules of Thumb for Variance Inflation Factors,'' Quality and Quantity, (41) 673–690, 2007.

[353] Kahane (2012), pp. 93–94.

10 deciles equals 270 regressions).[354] This analysis estimates the effect of mass reduction on risk separately for vehicles with similar footprint. The analysis indicates that reducing vehicle mass does not consistently increase risk across all footprint deciles for any combination of vehicle type and crash type. Risk increases with decreasing mass in a majority of footprint deciles for 12 of the 27 crash and vehicle combinations, but few of these increases are statistically significant. On the other hand, risk *decreases* with decreasing mass in a majority of footprint deciles for 5 of the 27 crash and vehicle combinations; in some cases these risk reductions are large and statistically significant.[355] 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 control variables except vehicle mass and footprint, risk does decrease as mass increases; however, risk and mass are not strongly correlated, with the R^2 ranging from 0.32 for CUVs to less than 0.13 for all other vehicle types (as shown in Figure II–2). 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 full-size (i.e. ¾- and 1-ton) pickups, societal risk *increases* as mass increases, with an R^2 of 0.45; this is consistent with NHTSA's basic regression results for light trucks weighing more than 4,594 pounds, with societal risk decreasing as mass decreases. LBNL also examined the relationship between vehicle mass and residual risk, that is, the remaining unexplained risk after accounting for all other vehicle, driver and crash variables, 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.)

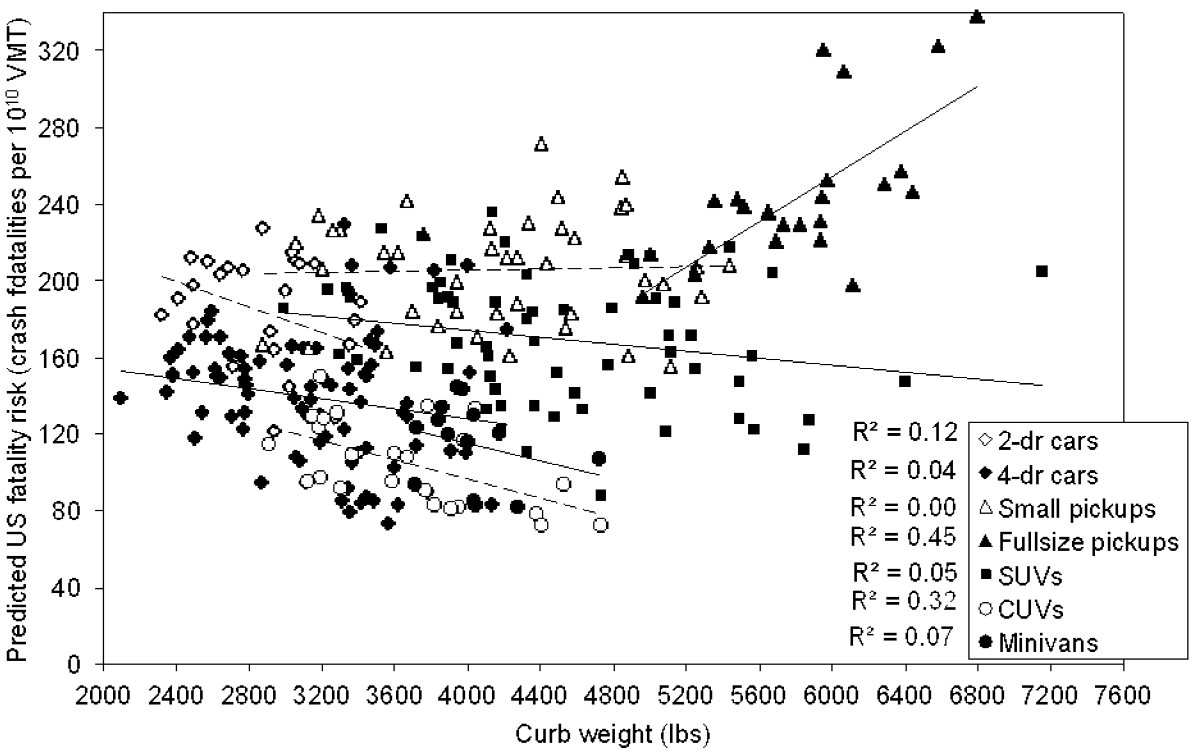
Figure II–2 indicates that some vehicles on the road today have the same, or lower, fatality risk than models that weigh substantially more, and are substantially larger in terms of footprint. After accounting for differences in driver age and gender, safety features installed, and crash times and locations,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

The figure shows that when the data are aggregated at the make-model level, the combination of differences in vehicle design, vehicle selection, and statistical variations has more influence than mass on fatality rates. The figure perhaps also suggests that, to the extent these variations in fatality rates are due to differences in vehicle design rather than vehicle selection or statistical variations, there is potential for lowering fatality rates through improved vehicle design. 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.

[354] *Ibid.,* pp. 73–78.

[355] And in 10 of the 27 crash and vehicle combinations, risk increased in 5 deciles and decreased in 5 deciles with decreasing vehicle mass.

Figure II-2 _Predicted US fatality risk per VMT vs. curb weight by vehicle type, after accounting for all driver, crash, and vehicle variables except mass and footprint



f. Report by Tom Wenzel, LBNL, ''An Analysis of the Relationship Between Casualty Risk per Crash and Vehicle Mass and Footprint for Model Year 2000–2007 Light-Duty Vehicles'', 2012 (LBNL Phase 2 Report)

LBNL compared the logistic regression results of NHTSA's analysis of U.S. fatality risk per VMT, replicated in the LBNL Phase 1 report, with an independent analysis of 13-state fatality risk and casualty risk per crash (LBNL Phase 2 report). The LBNL Phase 2 analysis differs from the NHTSA analysis in two respects: first, it analyzes risk per crash, using data on all police-reported crashes from thirteen states, rather than risk per estimated VMT; and second, it analyzes casualty (fatality plus serious injury) risk, as opposed to just fatality risk. There are several good reasons to investigate the effect of mass and footprint reduction on casualty risk per crash. First, risk per VMT includes two components that influence whether a person is killed or seriously injured in a crash: how well a vehicle can be (based on its handling, acceleration, and braking capabilities), or actually is, driven to avoid being involved in a serious crash (crash avoidance), and, once a serious crash has occurred, how well a vehicle protects its occupants from fatality or serious injury (crashworthiness) as well as the occupants of any crash partner (compatibility). By encompassing both of these aspects of vehicle design, risk per VMT gives a complete picture of how vehicle design can promote, or reduce, road user safety. On the other hand, risk per crash isolates the second of these two safety effects, crashworthiness/compatibility, by examining the relationship between mass or footprint and how well a vehicle protects its occupants and others once a crash occurs.

Second, estimating risk on a per crash basis only requires using data on police-reported crashes from states, and does not require combining them with data from other sources, such as vehicle registration data and VMT information, as in NHTSA's 2012 analysis. Only 16 states currently record the vehicle identification number of vehicles involved in police-reported crashes, which is necessary to determine vehicle characteristics, and only 13 states also report the posted speed limit of the roadway on which the crash occurred. Given the limited number of fatality cases in 13 States, extending the analysis to casualties (fatalities plus serious/incapacitating injuries; i.e., level ''K'' and ''A'' injuries in police reports, a substantially larger number of cases than fatalities alone) reduces the statistical uncertainty of the results. Finally, a serious incapacitating injury can be just as traumatic to the victim and his or her family, and costly from an economic perspective, as a fatality. Limiting the analysis to the risk of fatality, which is a relatively rare event, ignores the effect vehicle design may have on reducing the large number of incapacitating injuries that occur each year on the nation's roadways. All risks in the report are societal risk, including fatalities and serious injuries in the case vehicle and any crash partners, and include not only driver but passenger casualties as well as non-occupant casualties such as pedestrians.

NHTSA notes that casualty severity is identified by public safety officers at the crash scene prior to examination by medical professionals, and therefore reported casualty severity will inherently have a degree of subjectivity.[356]

[356] NHTSA notes that police-reported ''A'' injuries do not necessarily correspond to life-threatening or seriously disabling injuries as defined by medical professionals. In 2000–2008

Continued

The LBNL Phase 2 report estimates that mass reduction increases crash frequency (columns B and E) in all five vehicle types, with larger estimated increases in lighter-than-average cars and light-duty trucks. As a result, mass reduction is estimated to have a more beneficial effect on casualty risk per crash (column F) than on casualty risk per VMT (column G), and on fatality risk per crash (column C) than on fatality risk per VMT (column D). Mass reduction is associated with decreases in casualty risk per crash (column F) in all vehicles except cars weighing less than 3,106 pounds; in two of the four cases these estimated reductions are statistically significant, albeit small. For cars and light trucks, lower mass is associated with a more beneficial effect on fatality risk per crash (column C) than on casualty risk per crash (column F); for CUVs/minivans we estimate the opposite: lower mass is associated with a more beneficial effect on casualty risk than fatality risk per crash.

TABLE II–30—ESTIMATED EFFECT OF MASS OR FOOTPRINT REDUCTION ON TWO COMPONENTS OF 13-STATE FATALITY AND CASUALTY RISK PER VMT: CRASH FREQUENCY (CRASHES PER VMT) AND CRASHWORTHINESS/COMPATIBILITY (RISK PER CRASH)

Variable	Case vehicle type	A. NHTSA U.S. fatalities per VMT (percent)	B. 13-state crashes per VMT (percent)	C. 13-state fatalities per crash (percent)	D. 13-state fatalities per VMT (percent)	E. 13-state crashes per VMT (percent)	F. 13-state casualties per crash (percent)	G. 13-state casualties per VMT (percent)
Mass Reduction	Cars < 3106 lbs	*1.55* *	*2.00*	−0.54	*1.42*	*2.00*	0.09	*1.86*
	Cars > 3106 lbs	0.51	*1.50*	*−2.39*	−1.07	*1.50*	*−0.77*	*0.73*
	LTs < 4594 lbs	*0.52*	*1.44*	*−1.61*	−0.13	*1.44*	−0.11	*1.55*
	LTs > 4594 lbs	*−0.34*	*0.94*	*−1.25*	−0.34	*0.94*	*−0.62*	−0.04
	CUV/minivan	−0.38	*0.95*	0.98	*1.60*	*0.95*	−0.16	0.10
Footprint Reduction	Cars	*1.87*	*0.64*	0.92	*2.11*	*0.64*	0.23	*1.54*
	LTs	−0.07	*1.04*	0.48	*1.64*	*1.04*	*−0.25*	*0.94*
	CUV/minivan	*1.72*	*−0.55*	−1.67	−1.24	*−0.55*	0.56	*1.54*

* Based on NHTSA's estimation of uncertainty using a jack-knife method, only mass reduction in cars less than 3,106 pounds has a statistically significant effect on U.S. fatality risk.

Estimates that are statistically significant at the 95% level are shown in *italics*.

It is unclear why lower vehicle mass is associated with higher crash frequency, but lower risk per crash, in the regression models. It is possible that including variables that more accurately account for important differences among vehicles and driver behavior would reverse this relationship. For example, adding vehicle purchase price as a control variable reduces the estimated increase in crash frequency as vehicle mass decreases, for all five vehicle types; in the case of cars weighing more than 3,106 pounds, controlling for purchase price even reverses the sign of the relationship: mass reduction is estimated to slightly decrease crash frequency.[357] It also appears that, in model year 2000–2007 vehicles, the effect of mass reduction on casualties per crash is simply very small, if any (estimated effects in Table II–30, column F are under 1% per 100-pound reduction in all five vehicle groups).

The association of mass reduction with 13-state casualty risk per VMT (column G) is quite consistent with that NHTSA estimated for U.S. fatality risk per VMT in its 2012 report (column A), although LBNL estimated the effects on casualty risk to be more detrimental than the effects on fatality risk, for all vehicle types. In contrast with NHTSA's estimates of U.S. fatality risk per VMT (column A), mass reduction is estimated to *reduce* casualty risk per crash (column F) for four of the five vehicle types, with two of these four reductions estimated to be statistically significant. Mass reduction is associated with a small but insignificant increase in casualty risk per crash for cars weighing less than 3,106 pounds.

As in the LBNL Phase 1 study, replicating NHTSA methodology, many of the control variables included in the logistic regressions are statistically significant, and have a large effect on fatality or casualty risk per crash, in some cases one to two orders of magnitude larger than those estimated for mass or footprint reduction. However, the estimated effect of these variables on risk per crash is not as large as their estimated effect on fatality risk per VMT. LBNL concludes that the estimated effect of mass reduction on casualty risk per crash is small and is overwhelmed by other known vehicle, driver, and crash factors.

NHTSA notes that to estimate the effect of mass reduction on safety requires careful examination of how to model the covariant effects of vehicle, driver, and crash factors.

LBNL states that regarding the control variables, there are several results that, at first glance, would not be expected: side airbags in light trucks and CUVs/minivans are estimated to reduce crash frequency; ESC and ABS, crash avoidance technologies, are estimated to reduce risk once a crash has occurred; and AWD and brand new vehicles are estimated to increase risk once a crash has occurred. In addition, male drivers are estimated to have essentially no effect on crash frequency, but are associated with a statistically significant increase in fatality risk once a crash occurs. And driving at night, on high-speed or rural roads, are associated with higher increases in risk per crash than on crash frequency. A possible explanation for these unexpected results is that important control variables are not being included in the regression models. For example, crashes involving male drivers, in vehicles equipped with AWD, or that occur at night on rural or high-speed roads, may not be more frequent but rather more severe than other crashes, and thus lead to greater fatality or casualty risk. And drivers who select vehicles with certain safety features may tend to drive more carefully, resulting in vehicle safety features designed to improve

CDS data, 59% of the injuries that were coded ''A'' injuries were in fact medically minor (AIS 0–1), while 39% of serious (AIS 3) and 27% of life-threatening (AIS 4–5) injuries are not coded ''A.'' NHTSA does not include serious casualties in its analysis of the effects of vehicle mass and size on societal safety because of these inaccuracies.

[357] Wenzel (2012b), pp. 59–60, especially Figure 4–10.

crashworthiness or compatibility, such as side airbags, being also associated with lower crash frequency.

As with NHTSA's analysis of fatality risk per VMT, lower mass is not consistently associated with increased casualty risk per crash across all footprint deciles for any combination of vehicle type and crash type. Lower mass is associated with increased casualty risk per crash in a majority of footprint deciles for 9 of the 27 crash and vehicle combinations, but few of these increases are statistically significant. On the other hand, lower mass is associated with decreased risk in a majority of footprint deciles for 12 of the 27 crash and vehicle combinations.

The correlation between mass and the casualty risk per crash by vehicle model is very low, after accounting for all of the control variables in the logistic regression model except for vehicle mass and footprint. Furthermore, when casualty rates are aggregated at the make-model level, there is no significant correlation between the residual, unexplained risk and vehicle weight. Even after accounting for many vehicle, driver, and crash factors, the variation in casualty risk per crash by vehicle model is quite large and unrelated to vehicle weight. That parallels the LBNL Phase 1 report, which found similar variation in fatality rates per VMT at the make-model level. The variations among individual models may reflect differences in vehicle design, differences in the drivers who choose such vehicles, and statistical variation due to the limited data for individual models. To the extent the variations are due to differences in vehicle design rather than vehicle selection or statistical variations, there is potential for lowering fatality or casualty rates through improved vehicle design. To the extent that the variations are due to differences in what drivers choose what vehicles, it is possible that including variables that account for these factors in the regression models would change the estimated relationship between mass or footprint and risk.

NHTSA notes that the statistical variation due to the limited data for individual models is an additional source of uncertainty inherent in the technique of aggregating the data by make and model, a technique whose primary goal is not the estimation of the effect of mass reduction on safety.

g. Reports by Van Auken & Zellner, DRI—''Updated Analysis of the Effects of Passenger Vehicle Size and Weight on Safety,'' 2012

The International Council on Clean Transportation (ICCT), the Energy Foundation, and American Honda Motor Co. contracted Mike Van Auken and John Zellner of Dynamic Research Institute (DRI) to conduct a study to update the analysis of the effects of passenger vehicle size and weight on safety, based on the newly released NHTSA 2011 database. As noted earlier, DRI reports its study in three parts: Phase I,[358] II,[359] and Supplement.[360] This study was not complete in time for the NPRM, but was finished in time to be submitted to the docket as part of ICCT's public comments. The study has not yet been peer reviewed.

Phase I, which analyzed CY 1995–2000 fatalities in MY 1991–1999 vehicles to replicate the NHTSA 2003 and 2010 studies, has already been discussed and responded to above. The purpose of Phase II was to extend and refined the analytical methods used by DRI in the Phase I of this program to the more recent model year and calendar year data used in the Kahane (2011) analysis, in order to confirm the Kahane (2011) results and to estimate the effects of vehicle weight and size reduction on fatalities per 100 reported crash involvements and reported crash involvements per VMT (which DRI calls, respectively, ''effect on crashworthiness/crash compatibility'' and ''effect on crash avoidance'').

The Phase II study was accomplished by updating the regression analysis tools to use the newer databases for 2000 through 2007 model year light passenger vehicles in the 2002 through 2008 calendar years. The fatal and induced exposure databases were compiled by NHTSA from the U.S. DOT FARS database and accident data files from 13 U.S. States. In addition, police reported accident data files were obtained from 10 states. These 10 states were a subset of the 13 induced-exposure data states which NHTSA used. Data for the other three states were not available to non-government researchers at the time of this analysis.

The main results of the DRI Phase II analyses are as follows:

- The DRI one-stage analysis was able to reproduce NHTSA's baseline results very closely. However, in these analyses, DRI, like NHTSA, defines the induced-exposure cases to be the non-culpable vehicles involved in two-vehicle crashes. Later, in its supplemental report, DRI considers limiting the induced-exposure cases to stopped vehicles.

- The DRI two-stage analysis was able to replicate the DRI and NHTSA one stage results.
- The DRI Phase II two-stage results, which used more recent data were directionally similar to the DRI Phase I two-stage results. They showed an increase in reported crash involvements per VMT for lighter and smaller vehicles, but reductions of fatalities per 100 reported crash involvements. The DRI results for crash avoidance are also similar to those of Wenzel Phase 2 (2011b).
- The two-stage results for passenger cars weighing less than 3,106 pounds indicated that the increase in fatalities attributed to mass reduction was due to an increase in the number of crashes per exposure, more than offsetting a reduction in the number of fatalities per crash. The underlying reasons for these offsetting effects are unknown at this time, but could involve driver, vehicle, environment or accident factors that have not been controlled for in the current analyses. These results are similar to those obtained in Wenzel Phase 2 (2011b).

The overall results from DRI Phase II indicated very close agreement between the DRI and NHTSA one-stage results using the same methods and data. The results also indicate that the DRI one-stage and two-stage results are similar but have some differences due to the number of stages in the regression analysis. It may be possible to reduce these differences in the future by updating the state accident data for the 2008 calendar year, and adding ''internal control variables.''

The DRI Supplemental report discusses in further detail two previous key assumptions that were used in the Kahane (2011), Wenzel (2011b), and DRI (2012b) reports, and describes two alternative assumptions. The previous key assumptions were that the effects of vehicle weight and size can be best modeled by curb weight and footprint; and that the crash exposure is best represented by non-culpable vehicle induced-exposure data. The alternative assumptions are that the weight and size can be best modeled by curb weight, wheelbase, and track width; and that the crash exposure is best represented by stopped-vehicle induced-exposure data (because non-culpable vehicle data may underrepresent vehicles and drivers that are better at avoiding crashes, even if they would have been non-culpable in those crashes). Some of the potential advantages and disadvantages of the previous assumptions and these alternative assumptions are described in the DRI supplemental report.

[358] Van Auken and Zellner (2012a).

[359] Van Auken and Zellner (2012b), Van Auken and Zellner (2012c).

[360] Van Auken and Zellner (2012d).

The results in the DRI Supplemental report indicate a range of estimates for the effects of a 100 pound curb mass reduction based on the type of induced-exposure data that is used and the candidate vehicle weight and size model. These results indicate:

- The estimated effects of mass reduction on fatalities are not statistically significant for any vehicle category, if the wheelbase and track model is used with the non-culpable vehicle induced-exposure data. (This assumes the width of confidence bounds is similar to those seen in the Kahane (2011) analyses.)
- The estimated effects of mass reduction on fatalities either result in a statistically significant decrease in fatalities (for truck-based LTVs weighing 4,594 lbs or more), or are not statistically significant (for all other vehicle categories), if the stopped-vehicle induced-exposure data is used (irrespective of the two candidate size models, e.g., the footprint model, or the wheelbase and track width model).
- The estimated effect of curb mass reduction for passenger cars weighing less than 3,106 pounds is a statistically significant increase in fatalities (when compared to the jackknife based confidence intervals) only if the curb weight and footprint model is used with the non-culpable vehicle induced-exposure data.
- All other estimated effects of mass reduction on fatalities are not statistically significant when compared to the jackknife based confidence intervals.

In addition, the variance inflation factors are approximately the same when modeling the independent effects of curb weight, wheelbase and track width as when modeling curb weight and footprint, which suggests there is no adverse effect for modeling with track width and wheelbase in the context of potential overparameterization and excessive multicollinearity. In addition, wheelbase and track width would be expected to have separate, different, physics-based effects on vehicle crash avoidance and crashworthiness/compatibility, which effects are confounded when they are combined into a single variable, footprint.

DRI further recommended that the final version of the Kahane (2011) report include models based on curb weight, wheelbase and track width; and also include results based on non-culpable stopped-vehicle induced-exposure data as well as non-culpable vehicle induced-exposure. DRI concludes that the latter could be addressed by averaging the estimates from both the stopped-vehicle induce-exposure and the non-culpable vehicle induced-exposure, and incorporate the range of estimates into the reported uncertainty in the results (i.e., confidence intervals).

DRI also recommended that NHTSA provide the following additional variables in the current publicly available induced-exposure dataset so that other researchers can reproduce the sensitivity to the induced-exposure definition:

- An additional variable indicating whether each induced-exposure vehicle was moving or stopped at the time of the initial impact. This variable could then be used to derive a non-culpable stopped-vehicle induced-exposure dataset from the non-culpable vehicle induced-exposure dataset.
- Add accident case identifiers to the induced-exposure dataset that are suitable for linking to the original state accident data files, but do not otherwise disclose any private information. This would assist researchers with access to the original accident data in better understanding the induced-exposure data.

As noted in the preceding discussion of the Kahane (2012) and Wenzel (2012a) reports, NHTSA and LBNL have added models based on track width and wheelbase and/or stopped-vehicle induced exposure to the report. Table II–28 (test nos. 1, 2, and 3) and Table II–29 (tests nos. 15, 16, and 17) show results for those models. NHTSA has also made available to the public an induced-exposure database limited to stopped vehicles.

h. DOT Summary and Response to Recent Statistical Studies

The preceding sections reviewed three groups of reports issued in 2012 that estimated the effect of mass reduction on societal fatality or casualty risk, based on statistical analyses of crash and exposure data for model year 2000–2007 vehicles: NHTSA/Kahane's report and LBNL/Wenzel's Phase 1 report analyze fatality rates per VMT. DRI/Van Auken's reports likewise estimate the overall effect of mass reduction on fatalities per VMT, but they also provide separate sub-estimates of the effect on fatalities per 100 reported crash involvements and on reported crash involvements per VMT (which Van Auken calls ''effect on crashworthiness/compatibility'' and ''effect on crash avoidance''). Wenzel's Phase 2 report analyzes casualty rates per VMT, including sub-estimates of the effects on casualties per 100 crash involvements and crashes per VMT. ''Casualties'' include fatalities and the highest police-reported level of nonfatal injury (usually called level ''A'').

For the final regulatory analysis, like the preliminary analysis, NHTSA and EPA rely on the coefficients in the NHTSA/Kahane study for estimating the potential safety effects of the CAFE and GHG standards for MYs 2017–2025. NHTSA takes this opportunity to summarize and compare the reports and also explain why we continue to rely on the results of our own study in projecting safety effects.

The important common feature of these 2012 reports is that they all support the same principal conclusions—in NHTSA's words:

- The societal effect of mass reduction while maintaining footprint, if any, is small.[361]
- Any judicious combination of mass reductions that maintain footprint and are proportionately higher in the heavier vehicles is [likely to be safety-neutral—i.e., it is] unlikely to have a societal effect large enough to be detected by statistical analyses of crash data.[362]

This greatly contrasts with the disagreement in 2004–2005, based on earlier fatality databases, when DRI estimated a decrease of 1,518 fatalities per 100-pound mass reduction in all vehicles while maintaining wheelbase and track width[363] while NHTSA estimated a 1,118-fatality increase for downsizing all vehicles by 100 pounds (with commensurate reductions in wheelbase and track width).[364] In comparison, the estimates from 11 sensitivity tests using the current database only range from a 211-fatality reduction to an increase of 486, only 25 percent of the earlier range, and basically down to the level of statistical uncertainty typically inherent in this type of analysis.[365] NHTSA believes two or possibly three conditions may have contributed to the extensive convergence of the results. One is the extensive dialogue and cooperation among researchers, including the agreement to use NHTSA's database and discussions that led to consistent definitions of control variables or shared analysis techniques. The second is the real change in the new-vehicle fleet and perhaps also in driving patterns over the

[361] Kahane (2012), p. 1.

[362] *Ibid.,* p. 16.

[363] Van Auken and Zellner (2005b), sum of 836 for passenger cars (Table 2, p. 27) and 682 for LTVs (Table 5, p. 36).

[364] Kahane, C.J. (2003), *Vehicle Weight, Fatality Risk and Crash Compatibility of Model Year 1991–99 Passenger Cars and Light Trucks,* NHTSA Technical Report. DOT HS 809 662. Washington, DC: National Highway Traffic Safety Administration, *http://www-nrd.nhtsa.dot.gov/Pubs/809662.PDF.* sum of 71 and 234 on p. ix, 216 and 597 on p. xi.

[365] Kahane (2012), p. 113, scenario 3 in Table 4–2.

past decade, which appears to have attenuated some of the stronger effects of mass reduction and footprint reduction. A third possible factor is that multicollinearity may somehow have become less of an issue with the new database and with the new technique of treating CUVs and minivans as a separate class of vehicles.

Even though the studies now agree more than they disagree, there are still qualitative differences among the results. The baseline NHTSA findings indicate a statistically significant fatality increase for mass reduction in cars weighing less than 3,106 pounds. The NHTSA results do not encourage mass reduction in the lightest cars, at least for the foreseeable future, as long as so many heavy cars and LTVs remain on the road. But DRI's two analyses substituting track width and wheelbase for footprint or stopped-vehicle induced exposure for non-culpable vehicles each reduce the estimate fatality-increasing effect of mass reduction in lighter-than-average cars to a statistically non-significant level, while the simultaneous application of both techniques reduces the effect close to zero.

DRI suggests that track width and wheelbase have more intuitive relationships with crash and fatality risk than footprint and do not aggravate multicollinearity issues, as evidenced by variance inflation factors; and that stopped-vehicle induced-exposure data may be preferable because non-culpable vehicle data may underrepresent vehicles and drivers that are good at avoiding crashes. NHTSA finds DRI's argument plausible and has now included both techniques among the sensitivity tests in its 2012 report. But these sensitivity tests have not replaced NHTSA's baseline analysis. In the regressions for cars and LTVs, wheelbase often did not have the expected relationships with risk and added little information (In the regressions for CUVs and minivans, it was track width that had little relationship with risk). Limiting the induced-exposure data to stopped vehicles is a technique that earlier peer reviewers criticized, eliminates 75 percent of the induced-exposure cases (even more on high-speed roads), and may underrepresent older drivers. Furthermore, Table II–28 shows that some of the other sensitivity tests increase the fatality-increasing effect of mass reduction in light cars to about the same extent that these techniques diminish it. On the whole, NHTSA does not now see adequate justification for mass reduction in light cars, but additional analysis may be considered as the vehicle fleet changes.[366]

Another analysis strategy of DRI and also of Wenzel's Phase 2 report is to obtain separate estimates of the effect of mass reduction on fatalities [or casualties] per reported crash and reported crashes per VMT, as well as the composite estimate of its effect on fatalities per VMT. Van Auken and Wenzel both call the first estimate the ''effect on crashworthiness/compatibility'' and the second, the ''effect on crash avoidance.'' NHTSA believes the separate estimates are computationally valid, but these names are inaccurate characterizations that can lead to misunderstandings. For example, ICCT argues that the relationship between mass reduction and crash avoidance observed in the DRI and LBNL Phase 2 studies (i.e., that crash frequency increases as mass decreases) is counterintuitive.[367] NHTSA believes the metric of fatalities per reported crash takes into account not just crashworthiness but also certain important aspects of crash avoidance, namely the severity of a crash. In addition, it could be influenced by how often crashes are reported or not reported, which varies greatly from State to State and depending on local circumstances. As Wenzel notes, these analyses produced unexpected results, such as a reduction in crash frequency with side air bags, or an increase in fatalities per crash when the driver is male (when, in fact, males are less vulnerable than females, given the same physical insult[368]) or when it is nighttime. The fatality rates are higher for male drivers and at night because the crashes are more severe, not primarily because of crashworthiness issues. By the same token, the effect of mass reduction on fatalities or casualties per crash need not be purely an effect on ''crashworthiness and compatibility'' but may also comprise some aspects of crash avoidance.

Wenzel's Phase 1 and Phase 2 reports show that when fatality or casualty rates are aggregated at the make-model level, differences between the models ''overwhelm'' the effect of mass. Likewise, in the basic regression analyses, the effects of many control variables are much stronger than the effect of mass. NHTSA does not dispute the validity of these analyses or disagree with the findings, but they must not be misinterpreted. Specifically, it would be wrong to conclude that the effect of mass reduction should not be estimated at all because other ambient effects are considerably stronger. Researchers must often measure a weak effect in the presence of strong effects—for example: Studying the light from faraway galaxies despite the presence of much stronger light from nearby stars; evaluating a dietary additive based on a sample of test subjects who vary greatly in age, weight, and eating habits. Furthermore, the technique of aggregating the rates by make-model, while useful for graphically depicting the effect of mass relative to other factors, is no substitute for regression analyses on the full database in terms of directly estimating the effects of mass reduction on safety; at best, the analysis aggregated by make-model can indirectly generate less precise estimates of these effects. NHTSA believes the sensitivity tests in Table II–28 and Table II–29 are useful for addressing the effects of other factors, since most of these tests consist of alternative ways to quantify those factors. The tests showed two consistent trends: almost all (18 of Wenzel's 19 and all 11 of Kahane's) estimated a fatality increase for mass reduction in cars weighing less than 3,106 pounds and almost all (18 of Wenzel's and 10 of Kahane's) estimated a societal benefit if mass is reduced in the LTVs weighing 4,594 pounds or more.

Wenzel's Phase 2 report on casualty risk introduces one more source of data-driven uncertainty. To achieve adequate sample size, it must rely on the injury data in State crash files, specifically the highest reported level of nonfatal injury, usually called level ''A.'' But the coding of injury in police-reported crash databases is usually not based on medical records. ''A'' injuries do not necessarily correspond to life-threatening or seriously disabling injuries as defined by medical professionals. In 2000–2008 National Automotive Sampling System data, 59% of ''A'' injuries were in fact medically minor (levels 0 or 1 on the Abbreviated Injury Scale, based on subsequently retrieved medical records), while 39% of the serious (AIS 3) and 27% of life-threatening (AIS 4–5) injuries were not coded ''A.'' Despite this, Wenzel's composite results for casualties per VMT show about the same effects for mass reduction as Kahane's analyses of fatalities per VMT—e.g., in the lighter cars, the estimated effect of a 100-pound mass reduction is slightly more detrimental for casualties per VMT (1.86% increase[369]) than for fatalities

[366] *Ibid.*, pp. 115–119.

[367] Docket No. NHTSA–2010–0131–0258, p. 10.

[368] Evans, L. (1991). *Traffic Safety and the Driver.* New York: Van Nostrand Reinhold, pp. 22–28.

[369] Wenzel (2012b), p. v, Table ES.1, column G.

(1.56% increase [370]). NHTSA concurs with analyzing casualties per VMT, but, given that so many of the ''A'' injuries are minor while quite a few disabling injuries are not ''A,'' does not believe the results are as critical as the fatality analyses.

i. 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 vehicle 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, that database cannot fully represent what vehicles will be on the road in the MYs 2017–2025 timeframe. The vehicles manufactured in the 2000–2007 timeframe were not subject to footprint-based fuel economy standards. As explained earlier, 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 MYs 2000–2007 vehicles may not be fully representative of the vehicles that will be on the road in 2017 and beyond.

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. However, we 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 funded an independent review of statistical studies and held a mass-safety workshop in February 2011 in order to help the agencies sort through the ongoing debates over how statistical analysis of the historical relationship between mass and safety should be interpreted. 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 this aspect of the problem has been resolved. Moreover, the independent review of 18 statistical reports by UMTRI suggested that differences in data were probably less significant than the agencies may have thought. UMTRI stated that statistical analyses of historical crash data should be examined more closely for potential multicollinearity issues that exist in some of the current analyses. 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 2012 statistical fatality report finds directionally similar but fewer 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. As the Alliance mentioned in its comments noted above, future updated analyses will be necessary to determine how the effect of mass reduction on safety 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 have been 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, based on historical trends, 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. Moreover, 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 2012 study for estimating the potential safety effects of the 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 II.G.5.a below discusses the methodology used by the agencies in more detail. While the results of the safety effects analysis are less statistically significant than the results in the MYs 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, and have acted accordingly in developing the final 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 historical statistical analysis. As discussed in the first part of this section, for example, careful changes in design and/or materials used might mitigate some of the potential increased risk from mass reduction for vehicle self-protection,

[370] Kahane (2012), p. 12.

through improved distribution of crash pulse energy, etc. At the same time, these lightweighting techniques can sometimes lead to 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 advisable. 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 thus crash fatalities. 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 completed several technical/engineering projects described below to estimate the maximum potential for advanced materials and improved designs to reduce mass in the MY 2017–2021 timeframe, while continuing to meet safety regulations and maintain functionality and affordability of vehicles. Another NHTSA-sponsored study will estimate the effects of these design changes on overall fleet safety. The detailed discussions about these studies can be found in the Joint TSD section 3.3.5.5.

A. NHTSA awarded a contract in December 2010 to Electricore, with EDAG and George Washington University (GWU) as subcontractors, to study the maximum feasible amount of mass reduction of a mid-size car—specifically, a Honda Accord—while maintaining the functionality of the baseline vehicle. The project team was charged to maximize the amount of mass reduction with the technologies that are considered feasible for 200,000 units per year production volume during the time frame of this rulemaking while maintaining the retail price in parity (within ±10% variation) with the baseline vehicle. When selecting materials, technologies and manufacturing processes, the Electricore/EDAG/GWU team utilized, to the extent possible, only those materials, technologies and design which are currently used or planned to be introduced in the near term (MY 2012–2015) on low-volume production vehicles. This approach, commonly used in the automotive industry, is employed by the team to make sure that the technologies used in the study will be feasible for mass production for the time frame of this rulemaking. The Electricore/EDAG/GWU team took a ''clean sheet of paper'' approach and adopted collaborative design, engineering and CAE process with built-in feedback loops to incorporate results and outcomes from each of the design steps into the overall vehicle design and analysis. The team tore down and benchmarked 2011 Honda Accord and then undertook a series of baseline design selections, new material selections, new technology selections and overall vehicle design optimization. Vehicle performance, safety simulation and cost analyses were run in parallel to the design and engineering effort to help ensure that the design decisions are made in-line with the established project constrains.

While the project team worked within the constraint of maintaining the baseline Honda Accord's exterior size and shape, the body structure was first redesigned using topology optimization with six load cases, including bending stiffness, torsion stiffness, IIHS frontal impact, IIHS side impact, FMVSS pole impact, FMVSS rear impact and FMVSS roof crush cases. The load paths from topology optimization were analyzed and interpreted by technical experts and the results were then fed into low fidelity 3G (Gauge, Grade and Geometry) optimization programs to further optimize for material properties, material thicknesses and cross-sectional shapes while trying to achieve the maximum amount of mass reduction. The project team carefully reviewed the optimization results and built detailed CAD/CAE models for the body structure, closures, bumpers, suspension, and instrumentation panel. The vehicle designs were also carefully reviewed to ensure that they can be manufactured at high volume production rates,

Multiple materials were used for this study. The body structure was redesigned using a significant amount of high strength steel. The closures and suspension were designed using a significant amount of aluminum. Magnesium was used for the instrument panel cross-car beam. A limited amount of composite material was used for the seat structure.

Safety performance of the light-weighted design was compared to the safety rating of the baseline MY2011 Honda Accord for seven consumer information and federal safety crash tests using LS–DYNA.[371] These seven tests are the NCAP frontal test, NCAP lateral MDB test, NCAP lateral pole test, IIHS roof crush, IIHS lateral MDB, IIHS front offset test, and FMVSS No. 301 rear impact tests. These crash simulation analyses did not include use of a dummy model. Therefore only the crash pulse and intrusion were compared with the baseline vehicle test results. The vehicle achieved equivalent safety performance in all seven self-protection tests comparing to MY 2011 Honda Accord with no damage to the fuel tank. Vehicle handling is evaluated using MSC/ADAMS [372] modeling on five maneuvers, fish-hook test, double lane change maneuver, pothole test, 0.7G constant radius turn test and 0.8G forward braking test. The results from the fish-hook test show that the light-weighted vehicle can achieve a five-star rating for rollover, same as baseline vehicle. The double lane change maneuver tests show that the chosen suspension geometry and vehicle parameter of the light-weighted design are within acceptable range for safe high speed maneuvers.

Overall the complete light weight vehicle achieved a total weight savings of 22 percent (332kg) relative to the baseline vehicle (1480 kg). The study has been peer reviewed by three technical experts from the industry, academia and a DOE national lab. The project team addressed the peer review comments in the report and also composed a response to peer review comment document. The final report, CAE model and cost model are published in docket NHTSA–2010–0131 and can also be found on NHTSA's Web site.[373] The peer review comments with responses to peer review comments can also be found at the same docket and Web site.

B. EPA, along with ICCT, funded a contract with FEV, with subcontractors EDAG (CAE modeling) and Munro & Associates, Inc. (component technology research) to study the feasibility, safety and cost of 20% mass reduction on a 2017–2020 production ready mid-size

[371] LS–DYNA is a software developed by Livermore Software Technologies Corporation used widely by industry and researchers to perform highly non-linear transient finite element analysis.

[372] MSC/ADAMS: Macneal-Schwendler Corporation/Automatic Dynamic Analysis of Mechanical Systems.

[373] Final report, CAE model and cost model for NHTSA's light weighting study can be found at NHTSA's Web site: *http://www.nhtsa.gov/fuel-economy.*

CUV (crossover utility vehicle) specifically, a Toyota Venza while trying to achieve the same or lower cost. The EPA report is entitled ''*Light-Duty Vehicle Mass-Reduction and Cost Analysis—Midsize Crossover Utility Vehicle''.* [374] This study is a Phase 2 study of the low development design in the 2010 Lotus Engineering study ''An Assessment of Mass Reduction Opportunities for a 2017–2020 Model Year Vehicle Program'',[375] herein described as ''Phase 1''.

The original 2009/2010 Phase 1 effort by Lotus Engineering was funded by Energy Foundation and ICCT to generate a technical paper which would identify potential mass reduction opportunities for a selected vehicle representing the crossover utility segment, a 2009 Toyota Venza. Lotus examined mass reduction for two scenarios—a low development (20% MR and 2017 production with technology readiness of 2014) and high development (40% MR and 2020 production with technology readiness of 2017). Lotus disassembled a 2009 Toyota Venza and created a bill of materials (BOM) with all components. Lotus then investigated emerging/current technologies and opportunities for mass reduction. The report included the BOM for full vehicle, systems, sub-systems and components as well as recommendations for next steps. The potential mass reduction for the low development design includes material changes to portions of the body in white (underfloor and body, roof, body side, etc.), seats, console, trim, brakes, etc. The Phase 1 project achieved 19% (without the powertrain), 246 kg, at 99% of original cost at full phase-in after peer review comments taken into consideration.[376,377] This was calculated to be −$0.45/kg utilizing information from Lotus.

The peer reviewed Lotus Phase 1 study created a good foundation for the next step of analyses of CAE modeling for safety evaluations and in-depth costing (these steps were not within the scope of the Phase 1 study) as noted by the peer reviewer recommendations.[378]

Similar to Lotus Phase 1 study, the EPA Phase 2 study begins with vehicle tear down and BOM development. FEV and its subcontractors tore down a MY 2010 Toyota Venza in order to create a BOM as well as understand the production methods for each component. Approximately 140 coupons from the BIW were analyzed in order to understand the full material composition of the baseline vehicle. A baseline CAE model was created based on the findings of the vehicle teardown and analysis. The model's results for static bending, static torsion, and modal frequency simulations (NVH) were obtained and compared to actual results from a Toyota Venza vehicle. After confirming that the results were within acceptable limits, this model was then modified to create light-weighted vehicle models. EDAG reviewed the Lotus Phase 1 low development BIW ideas and found redesign was needed to achieve the full set of acceptable NVH characteristics. EDAG utilized a commercially available computerized optimization tool called HEEDS MDO to build the optimization model. The model consisted of 484 design variables, 7 load cases (2 NVH + 5 crash), and 1 cost evaluation. The outcome of EDAG's lightweight design optimization included the optimized vehicle assembly and incorporated the following while maintaining the original BIW design: Optimized gauge and material grades for body structure parts, laser welded assembly at shock towers, rocker, roof rail, and rear structure subassemblies, aluminum material for front bumper, hood, and tailgate parts, TRBs on B-pillar, A-pillar, roof rail, and seat cross member parts, design change on front rail side members. EDAG achieved 13% mass reduction in the BIW including closure. If aluminum doors were included then an additional decrease of 28 kg could be achieved for a total of 18% mass reduction from the body structure. All other systems within the vehicle were examined for mass reduction, including the powertrain (engine, transmission, fuel tank, exhaust, etc.). FEV and Munro incorporated the Lotus Phase 1 low development concepts into their own idea matrix. Each component and sub-system chosen for mass reduction was scaled to the dimensions of the baseline vehicle, trying to maximize the amount of mass reduction with cost effective technologies and techniques that are considered feasible and manufacturable in high volumes in MY2017. FEV included a full discussion of the chosen mass reduction options for each component and subsystem.

Safety performance of the baseline and light-weighted designs (Lotus Phase 1 low development and the final EPA Phase 2 design) were evaluated by EDAG through their constructed detailed CAD/CAE vehicle models. Five federal safety crash tests were performed, including FMVSS flat frontal crash, side impact, rear impact and roof crush (using IIHS resistance requirements) as well as Euro NCAP/IIHS offset frontal crash. Criteria including the crash pulse, intrusion and visual crash information were evaluated to compare the results of the light weighted models to the results of the baseline model. The light weighted vehicle achieved equivalent safety performance in all tests to the baseline model with no damage to the fuel tank. In addition, CAE was used to evaluate the BIW vibration modes in torsion, lateral bending, rear end match boxing, and rear end vertical bending, and also to evaluate the BIW stiffness in bending and torsion.

The Phase 2 study 2010 Toyota Venza light weight vehicle achieved, with powertrain, a total weight savings of 18 percent (312 kg) relative to the baseline vehicle (1710 kg) at −$0.43/kg, and the cost figure is near zero at 20 percent. The study report and models have been peer reviewed by four technical experts from a material association, academia, DOE, and a National Laboratory. The peer review comments for this study were generally complimentary, and concurred with the ideas and methodology of the study. A few of the comments required further investigation, which were completed for the final report. The project team addressed the peer review comments in the report and also composed a response to peer review comment document. Changes to the BIW CAE models resulted in minimal differences. The final report is published in EPA's docket EPA–HQ–OAR–2010–0799 and the CAE LS DYNA model files and overview cost model files are found on EPA's Web site *http://www.epa.gov/otaq/climate/publications.htm#vehicletechnologies*. The peer review comments with responses to peer review comments can also be found at the same docket and Web site.

C. The California Air Resources Board (CARB) funded a study with Lotus Engineering to further develop the high development design from Lotus' 2010 Toyota Venza work (''Phase 1''). The CARB-sponsored Lotus ''Phase 2'' study

[374] FEV, ''*Light-Duty Vehicle Mass-Reduction and Cost Analysis—Midsize Crossover Utility Vehicle''*. July 2012, EPA Docket: EPA–HQ–OAR–2010–0799.

[375] Systems Research and Application Corporation, ''Peer Review of Demonstrating the Safety and Crashworthiness of a 2020 Model-Year, Mass-Reduced Crossover Vehicle (Lotus Phase 2 Report)'', February 2012, EPA docket: EPA–HQ–OAR–2010–0799.

[376] The original powertrain was changed to a hybrid configuration.

[377] Cost estimates were given in percentages—no actual cost analysis was presented for it was outside the scope of the study, though costs were estimated by the agency based on the report.

[378] RTI International,''Peer Review of Lotus Engineering Vehicle Mass Reduction Study'' EPA–HQ–OAR–2010–0799–0710, November 2010.

provides the updated design, crash simulation results, detailed costing, and analysis of the manufacturing feasibility of the BIW and closures. Based on the safety validation work, Lotus strengthened the design with a more aluminum-intensive BIW (with less magnesium). In addition to the increased use of advanced materials, the new design by Lotus included a number of instances in which multiple parts were integrated, resulting in a reduction in the number of manufactured parts in the lightweight BIW. The Phase 2 study reports that the number of parts in the BIW was reduced from 419 to 169. The BIW was analyzed for torsional stiffness and crash test safety with Computer-Aided Engineering (CAE). The new design's torsional stiffness was 32.9 kNm/deg, which is higher than the baseline vehicle and comparable to more performance-oriented models. The research supported the conclusion that the lightweight vehicle design could pass standard FMVSS 208 frontal impact, FMVSS 210 seatbelt anchorages, FMVSS child restraint anchorage, FMVSS 214 side impact and side pole, FMVSS 216 roof crush (with 3xcurb weight), FMVSS 301 rear impact, IIHS low speed front, and IIHS low speed rear. Crash tests simulated in CAE showed results that were listed as acceptable for all crash tests analyzed. No comparisons or conclusions were made if the vehicle performed better or worse than the baseline Venza. For FMVSS 208 frontal impact, Lotus based its CAE crash test analyses on vehicle crash acceleration data rather than occupant injury as is done in the actual vehicle crash. The report from the study stated that accelerations were within acceptable levels compared to current production vehicle acceleration results and it should be possible to tune the occupant restraint system to handle the specific acceleration pulses of the Phase 2 high development vehicle. FMVSS 210 seatbelt anchorages is concerned with seatbelt retention and certain dimensional constraints for the relationship between the seatbelts and the seats. Overall both the front and rear seatbelt anchorages met the requirements specified in the standard. FMVSS 214 side impact show the energy is effectively managed. Since dummy injury criteria was not used in the CAE modeling, a maximum intrusion tolerance level of 300 mm was instituted which is the typical distance between the door panel and most outboard seating positions. For example, the Phase 2 design was measured at 115mm for the crabbed barrier test. The side pole test resulted in 120 mm intrusion for the 5th percentile female and intrusion was measured at 190 mm for the 50th percentile male. The report stated FMVSS 216 roof crush simulation shows the Phase 2 high development vehicle will meet roof crush performance requirements under the specified load case of 3 times the vehicle weight. For the FMVSS rear impact, results show plastic strain in the fuel tank/system components to be less than 3.5%, which is less than the 10% strain allowed in the test. The pressure change in the fuel tank is less than 2% so risk of tank splitting is minimal. The IIHS low speed front and rear show no body structural issues, however styling adjustments should be made to improve the rear bumper low speed performance.

The Lotus design achieved a 37% (141 kg) mass reduction in the body structure, a 38% (484kg) mass reduction in the vehicle excluding the powertrain, and a 32% (537 kg) mass reduction in the entire vehicle including the powertrain. The report was peer reviewed by a cross section of experts and the comments were addressed by Lotus in the peer review documents. The comments requiring modification were incorporated into the final document. The documents can be found on EPA's Web site *http://www.epa.gov/otaq/climate/publications.htm#vehicletechnologies.*

D. NHTSA has contracted with GWU to build a fleet simulation model to study the impact and relationship of light-weighted vehicle design with injuries and fatalities. This study will also include an evaluation of potential countermeasures to reduce any safety concerns associated with lightweight vehicles in the second phase. NHTSA has included 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 one funded by EPA and the International Council on Clean Transportation (ICCT). In addition to the lightweight vehicle models, these projects also created CAE models of the baseline vehicles. To estimate the fleet safety implications of light-weighting, CAE crash simulation modeling was conducted to generate crash pulse and intrusion data for the baseline and three light-weighted vehicles when they crash with objects (barriers and poles) and with four other vehicle models (Chevy Silverado, Ford Taurus, Toyota Yaris and Ford Explorer) that represent a range of current vehicles. The simulated acceleration and intrusion data were used as inputs to MADYMO occupant models to estimate driver injury. The crashes were conducted at a range of speeds and the occupant injury risks were combined based on the frequency of the crash occurring in real world data. The change in driver injury risk between the baseline and light-weighed vehicles will provide insight into the safety performance these light-weighting design concepts. This is a large and ambitious project involves several stages over several years. NHTSA and GWU have completed the first stage of this study. The frontal crash simulation part of the study is being finished and will be peer reviewed. The report for this study will be available in NHTSA–2010–0131. Information for this study can also be found at NHTSA's Web site.[379]

The countermeasures section of the study is expected to be finished in early 2013. This phase of the study is expected to provide information about the relationship of light-weighted vehicle design with injuries and fatalities and to provide the capability to evaluate the potential countermeasures to safety concerns associated with light-weighted vehicles. NHTSA plans to include the following items in future phases of the study to help better understanding the impact of mass reduction on safety.

- Light-weighted concept vehicle to light-weighted concept vehicle crash simulation;
- Additional crash configurations, such as side impact, oblique and rear impact tests;
- Risk analysis for elderly and vulnerable occupants;
- Safety of light-weighted concept vehicles for different size occupants.
- Partner vehicle protection in crashes with other light-weighted concept vehicles;

While this study is expected to provide information about the relationship of light-weighted vehicle design with injuries and fatalities and to provide meaningful information to NHTSA on potential countermeasures to reduce any safety concerns associated with lightweight vehicles, because this study cannot incorporate all of the variations in vehicle crashes that occur in the real world, it is expected to provide trend information on the effect of potential future designs on highway safety, but is not expected to provide information that can be used to modify the coefficients derived by Kahane that relate mass reduction to highway crash fatalities. Because the coefficients from

[379] Web site for fleet study can be found at *http://www.nhtsa.gov/fuel-economy.*

the Kahane study are used in the agencies' assessment of the amount of mass reduction that may be implemented with a neutral effect on highway safety, the fact that the fleet simulation modeling study is not complete does not affect the agencies' assessment of the amount of mass reduction that may be implemented with a neutral effect on safety.

Global Automakers commented that lightweighting strategies ''should be based on real world experience and in reliance upon laboratory test data.'' [380] The agencies continue to believe that reasonable conclusions regarding the safety implication of mass reduction can be drawn from CAE simulations. As ICCT stated in their comments, CAE simulations are powerful tools that have improved rapidly over the years in terms of their ability to optimize vehicle designs and predict material and vehicle behavior in real life. Use of these highly sophisticated CAE tools has become standard industry practice in helping to verify and validate designs before real parts and vehicles are built. As the Alliance stated, however, CAE capabilities for conventional materials, such as steel and aluminum, are more mature than those of advanced materials, such as magnesium and composites. Steel and aluminum are the major materials used in some of the studies, such as EPA's and NHTSA's light-weighting studies that determined that a baseline vehicle's mass could be reduced by approximately 20 percent while maintaining safety comparable to the baseline vehicle.

Thus, even though CAE tools are used heavily, the agencies acknowledge the concerns the Alliance raised in its comments about CAE capabilities for some potential advanced materials for crashworthiness, and have been mindful of this issue in developing our studies. NHTSA's study took a similar approach in vehicle body structure design as the FutureSteelVehicle, but with less aggressive material usage (e.g., using thicker gauges of steel). Only those materials, technologies and design which are currently used or planned to be introduced in the near term (MY 2012–2015) on low-volume production vehicles are used in NHTSA's concept design. This approach is employed by the team to make sure that the technologies used in the study will be feasible for mass production for the time frame of this rulemaking. Even though NHTSA's study is not directly based on laboratory testing of the light-weighted design as Global Automaker suggested, the materials, designs and approaches used in the study are currently employed in mass production vehicles, which gives NHTSA confidence that results from its study are practical and feasible in the rulemaking timeframe. EPA's study used a similar approach. It includes a baseline model which was run through crash simulations and the results were comparable to physical crash data of the vehicle in the same tests. For the light weighted design, the BIW was maintained while various components were lightened through incorporation of high strength steels whose properties reflect those materials commonly used today. The light weighted CAE model crash results were then compared to those from the baseline CAE model crash results. The model run results from the light weighted vehicle had equal or better performance on intrusion, acceleration, etc. The materials, designs and approaches used in the study are currently employed in mass production vehicles, which gives EPA confidence that results from its study are practical, feasible and reasonable in the rulemaking timeframe.

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 U.S. 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 mass 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 fleet wide 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 or redesigned 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. The Lotus light-weighted Venza structure 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 vehicles. Transition from the current fleet was considered. He concluded that protocols resulting in safer transitions

[380] Global Automakers comments, Docket No. NHTSA–2010–0131, at *pg* 3.

(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: *i.e.,* that the most effective mass reduction in terms of reducing GHG emissions was not necessarily the safest.

German discussed several important points on the future of mass reduction. Similar to Kahane's discussion of the difficulties of isolating the impact of mass 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 the safety impacts of size and weight are small and difficult to quantify when compared to driver, driving influences, and vehicle design influences. 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 mass reduction. Field highlighted the complexity of institutional changes that may be necessitated by mass 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 which are 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 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 final rule?

a. What was the Agencies' methodology for estimating safety effects for the final rule?

As explained above, the agencies consider the latest 2012 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 2012 analysis to calculate specific estimates of safety effects of the final rule, based on the analysis of how much mass reduction manufacturers might use to meet the final rule.

The CAFE/GHG standards do not mandate mass reduction, or require 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 more stringent CAFE/GHG standards. To estimate the amount of mass reduction to apply in the rulemaking analysis, the agencies considered fleet safety effects for mass reduction. As shown in Table II–24 and Table II–25, both the Kahane 2011 preliminary report and the Kahane 2012 final report show 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 as discussed in the Joint TSD Section 3.3.5.5. Thus, 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 and meet (or surpass) all applicable federal safety standards, 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.

In this final rule analysis, NHTSA utilized the 2012 Kahane study relationships between weight and safety, expressed as percent changes in fatalities per 100-pound mass 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, which are not accounted for in the study. For example, the two important new safety standards that were discussed above for electronic stability control and side 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 grow, 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 agencies 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 both the Kahane 2011prelimirary analysis and the Kahane 2012 final analysis), coupled with the reduced number of baseline fatalities, results in smaller absolute increases in fatalities than those predicted in the MYs 2012–2016 rulemaking.

NHTSA examined the impacts of identifiable safety trends over the lifetime of the vehicles produced in each model year from 2007 through 2020. An estimate of these impacts was contained in a previous agency report that examined the impact of both safety standards and behavioral safety trends on fatality rates.[381] In the NPRM analysis, based on these projections, we estimated a 12.6 percent reduction in fatality levels between the 2007 fatality base year and 2020 for the combination of safety standards and behavioral changes anticipated in this study (such as electronic stability control, head-curtain air bags, and increased belt use). See 76 FR 74959. The estimates derived from applying NHTSA fatality percentages to a baseline of 2007 fatalities were 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 2020. Using this same methodology, for the final rule analysis, which is based on a 2010 baseline fleet, we estimated a 9.6 percent reduction in fatality level between 2010 and 2020 for the anticipated combination of safety standards and behavioral changes that will occur during that time frame.[382] The estimates derived from applying NHTSA fatality percentages to a baseline of 2010 fatalities were multiplied by 0.904 to account for changes that NHTSA believes will take place in passenger car and light truck safety between the 2010 baseline on-road fleet and year 2020.

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 the agencies believe that mass reduction of up to 20 percent is feasible on light trucks, CUVs and minivans, [383] but that less mass reduction should be implemented on other vehicle types to avoid increases in societal fatalities. For the NPRM analysis, NHTSA used the mass reduction levels shown in Table II–31 with the fatality coefficients derived in Kahane 2011 preliminary study.

TABLE II–31—MASS REDUCTION LEVELS TO ACHIEVE SAFETY NEUTRAL RESULTS IN THE CAFE NPRM ANALYSIS

Absolute (percent)	Subcompact and Sub-compact Perf. PC (percent)	Compact and Compact Perf. PC (percent)	Midsize PC and Midsize Perf. PC (percent)	Large PC and Large Perf. PC (percent)	Minivan LT (percent)	Small, Midsize and Large LT (percent)
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.

In order to find a safety neutral compliance path for use in the agencies' final rulemaking analysis given the coefficients from the Kahane 2012 study, the maximum amount of mass reduction applied in the final rule analysis has been modified from the NPRM levels for compact passenger cars and midsize passenger cars as shown in Table II–32. Specifically, the maximum amount of mass reduction for compact passenger cars and compact performance passenger cars is reduced in the agencies' respective models from 2% as used in the NPRM to 0% in the final rule analysis, while for midsize passenger cars and midsize performance passenger cars, it is reduced from 5% as used in the NPRM to 3.5% in the final rule analysis.

TABLE II–32—MASS REDUCTION LEVELS TO ACHIEVE SAFETY NEUTRAL RESULTS IN THE FINAL RULE ANALYSIS

Absolute (%)	Subcompact and sub-compact Perf. PC (percent)	Compact and compact Perf. PC (percent)	Midsize PC and midsize Perf. PC (percent)	Large PC and large Perf. PC (percent)	Minivan LT (percent)	Small, midsize and large LT (percent)
MR1*	0.0	0.0	1.5	1.5	1.5	1.5

[381] 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 5 comparing 2020 to 2007 (37,906/43,363 = 0.874 or a reduction of 12.6% (100% − 87.4% = 12.6%). Since 2008 was a recession year, it did not seem appropriate to use that as a baseline, so 2007 was used as the baseline for fatalities in the NPRM. Note that additional improvements may occur between 2020 and 2025. However, since current research only projected the impact of changes through 2020, only those improvements could have been applied to that analysis.

[382] 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 5 comparing 2020 to 2010 (37,906/41,945 = 0.904 or a reduction of (100% − 90.4% = 9.6%). Note that additional improvements may occur between 2020 and 2025. However, since current research only projected the impact of changes through 2020, only those improvements could be applied to this analysis.

[383] 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–32—MASS REDUCTION LEVELS TO ACHIEVE SAFETY NEUTRAL RESULTS IN THE FINAL RULE ANALYSIS—Continued

Absolute (%)	Subcompact and sub-compact Perf. PC (percent)	Compact and compact Perf. PC (percent)	Midsize PC and midsize Perf. PC (percent)	Large PC and large Perf. PC (percent)	Minivan LT (percent)	Small, midsize and large LT (percent)
MR2	0.0	0.0	3.5	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–33 shows the amount of mass reduction in pounds for these percentage mass reduction levels for a typical vehicle weight in each subclass.

TABLE II–33—EXAMPLES OF MASS REDUCTION (IN POUNDS) FOR DIFFERENT VEHICLE SUBCLASSES USING THE PERCENTAGE INFORMATION AS DEFINED IN TABLE II–32 FOR FINAL RULE ANALYSIS

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	0	56	62	64	56	64	80
MR2 (lbs)	0	0	130	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

These maximum amounts of mass reduction discussed above were applied in the technology input files for the CAFE model. Within some of the light truck classes, additional limitations were placed on the maximum amount of mass reduction for some of the vehicles based on which Kahane study safety class the vehicles were in, as is explained below. By way of background, NHTSA divides vehicles into classes for purposes of applying technology in the CAFE model in a way that differs from the Kahane study which divides vehicles into classes for purposes of determining safety coefficients. These differences require that the ''safety class'' coefficients be applied to the appropriate vehicles in the CAFE ''technology subclasses.'' For the reader's reference, for purposes of this final rule, the safety classes and the technology subclasses relate [384] as shown in Table II–34.

TABLE II–34—MAPPING BETWEEN SAFETY CLASSES AND TECHNOLOGY CLASSES

Safety class	*Technology class*
PC (Passenger Car)	Subcompact PC. Subcompact Perf. PC. Compact PC. Compact Perf. PC. Midsize PC. Midsize Perf. PC. Large PC. Large Perf. PC.
LT (Light Truck)	Small LT. Midsize LT. Large LT.
CM (CUV and Minivan).	Subcompact PC. Subcompact Perf. PC. Large PC. Large Perf. PC. Minivan. Small LT. Midsize LT. Large LT.

In the NPRM analysis, the maximum amount of mass reduction for vehicles that would fall into the light truck safety class and would also fall into the small and midsize light truck technology subclasses was limited to 10%, as shown in Table II–35. In the final rule analysis, in order to find a safety-neutral compliance path using the new safety coefficients, for vehicles in the light truck safety class that also fall into the SmallLT technology subclass, mass reduction was limited to a maximum of 1.5%, as shown in Table II–36. For vehicles in the light truck safety class that also fall into the MidsizeLT technology subclass, the amount of mass reduction applied depends on vehicle mass: if the vehicle curb weight is greater than or equal to 4,000 pounds, the maximum amount of mass reduction allowed is 7.5%; if the vehicle curb weight is less than 4,000 pounds, the maximum amount is 1.5%. Small and midsize light truck (SmallLT and MidsizeLT) that fall in the CUV and Minivan (CM) safety class are allowed up to 20% mass reduction. These changes from the NPRM analysis were incorporated in order to maximize the amount of overall fleet mass reduction in a way that achieved a safety neutral result with the updated coefficients from the Kahane 2012 study.

[384] This is not to say that all vehicles within a technology subclass will necessarily fall within a single safety class—as the chart shows, some technology subclasses are divided among safety classes.

TABLE II–35—MAXIMUM AMOUNT OF MASS REDUCTION LIMITS FOR LIGHT TRUCK SAFETY VEHICLE CLASS FOR THE NPRM CAFE MODEL ANALYSIS

NRPM—2008 Market input file / Safety Class	Tech class: Small LT	Tech class: Midsize LT
LT	Apply MR3 at 10%	Apply MR3 at 10%
CM *	MR5 (20%)	MR5 (20%)

* CM = CUV and MiniVan.

TABLE II—36—MAXIMUM AMOUNT OF MASS REDUCTION LIMITS FOR LIGHT TRUCK SAFETY VEHICLE CLASS FOR THE FINAL RULE CAFE MODEL ANALYSIS

Final rule—2008 & 2010 market input file / Safety Class	Tech class: Small LT	Tech class: Midsize LT
LT	Apply MR1 at 1.5%	Vehicle Weight ≥ 4000, apply MR2 at 7.5%; Vehicle Weight ≥ 4000, apply MR1 at 1.5%.
CM	MR5 (20%)	MR5 (20%)

Table II–37 shows CAFE model results for societal safety for each model year based on the application of the above mass reduction limits.[385] These are the 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 mass reduction limitations used in the CAFE model, which allow more mass reduction in the heavy LTVs, CUVs, and minivans than in other vehicles. As the negative coefficients only appear for LTVs greater than 4,594 lbs., CUVs, and minivans, a statistically significant improvement in safety can only occur if more weight is taken out of these vehicles than out of passenger cars or smaller light trucks. Combining passenger car and light truck safety estimates for the final rule results in a decrease in fatalities over the lifetime of the nine model years of MY 2017–2025 of 8 fewer fatalities with the 2010 baseline and of 107 fewer fatalities with the 2008 baseline. Broken up into passenger car and light truck categories, there is an increase of 135 fatalities in passenger cars and a decrease of 143 fatalities in light trucks with the 2010 baseline, and there is an increase of 78 fatalities in passenger cars and a decrease of 185 fatalities in light trucks with the 2010 baseline. NHTSA also analyzed the results for different regulatory alternatives in Chapter IX of its FRIA; the difference in the results by alternative depends upon how much mass reduction is used in that alternative and the types and sizes of vehicles that the mass reduction applies to.

TABLE II–37—NHTSA CALCULATED MASS-SAFETY-RELATED FATALITY IMPACTS OF THE FINAL RULE OVER THE LIFETIME OF THE VEHICLES PRODUCED IN EACH MODEL YEAR USING 2008 AND 2010 BASELINE

Fatalities	Baseline fleet	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	Total
Passenger Cars	2010	3–	7–	13–	12–	18–	19–	23–	22–	19–	135–
	2008	2	5	13	12	13	10	11	9	1	78
Light Trucks	2010	(5)–	(9)–	0–	(5)–	(18)–	(21)–	(24)–	(30)–	(31)–	(143)–
	2008	(5)	(13)	(17)	(29)	(27)	(27)	(27)	(29)	(11)	(185)
Total	2010	(2)–	(3)–	13–	7–	(1)–	(2)–	(2)–	(8)–	(12)–	(8)–
	2008	(3)	(8)	(3)	(17)	(14)	(17)	(16)	(20)	(10)	(107)

Using the same coefficients from the 2012 Kahane study, EPA used the OMEGA model to conduct a similar analysis. After applying these percentage increases to the estimated mass reductions per vehicle size by model year assumed in the Omega model, Table II–38 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.

[385] 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 the NPRM (as well as this final rule). About 1.4 million 2 wheel drive SUVs have been redefined as passenger cars instead of light trucks. The Kahane 2011 and 2012 analyses continue to use the definitions used in the Kahane 2003 analysis.

TABLE II–38—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	5	9	14	20	26	30	35	40	45	223
Light trucks	−5	−11	−16	−22	−29	−40	−52	−64	−77	−317
Total	−1	−1	−2	−2	−3	−10	−18	−25	−32	−94

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 include the following: 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 light-weighted vehicles become more prevalent. Going forward, we will continue to monitor the crash data as well as changes in vehicle mass and conduct analyses to understand the interaction of vehicle mass and size on safety.

Additionally, we note that the total amount of mass reduction used in the agencies' analysis for this rulemaking was 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 or amounts 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.

As discussed in Chapter 2 of the 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 fewer than 10 percent of MY 2008 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 do not expect a significant increase in this segment of the market. Please see Chapter 2 of the Joint TSD for additional discussion.

The agencies acknowledge that this final rule does not prohibit manufacturers from redesigning vehicles to change wheelbase and/or track width (footprint). However, as NHTSA explained in promulgating the MY 2008–2011 light truck CAFE standards and the MY 2011 passenger car and light truck CAFE standards, and as the agencies jointly explained in promulgating the MYs 2012–2016 CAFE and GHG standards and the proposal for this final rule, we believe that 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 with respect to their footprint-based targets. However, NHTSA and EPA have previously explained, because such production shifts could run counter to market demands, they could also be competitively unattractive. We sought 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. Detailed responses to the comments that the agencies received on this topic can be found in preamble Section II.C. Notwithstanding the agencies' current judgment that such deliberate reengineering or production shifts 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. So, based on the regulatory design, the analysis assumes this final rule will not have the effects described above. The agencies will monitor the vehicle fleet going forward to see if there are changes in vehicle footprint, weight, or if there are shifts in the production volumes of models that are produced, and consistent with confidentiality and other requirements, the agencies intend to make these data publicly available when they are compiled and will use that information to inform the mid-term review.

c. What are the Agencies' plans going forward?

The agencies will closely be monitoring the visible effects of CAFE/GHG standards on vehicle safety as these standards are implemented, and will conduct a full analysis of safety impacts as part of NHTSA's future rulemaking to establish final MYs 2022–2025 standards and the mid-term evaluation. We are mindful of the comments submitted by the Alliance and Volvo that there are many uncertainties associated with the agencies' safety analysis in this rulemaking, including the course of development of vehicle technologies (including, but not limited to, light-weighting technologies) to achieve these standards given the timeframe covered by this rulemaking, the composition of the future fleet mix with respect to vehicle weight, vehicle size, vehicle compatibility/incompatibility that could result in response to the standards set in this rulemaking, the continued development of alternative drive trains and their penetration and how those changes interact with changes in vehicle weight, the new development of safety technologies (both active and passive), and the vehicle turn-over rate, which is driven by many factors outside of the agencies' or manufacturers' control. As the Alliance stated in its comments, ''Achieving the proposed CAFE and GHG standards will rely on the availability of commercially viable emerging technologies for manufacturers to adopt. Should these technologies fail to mature as anticipated, greater reliance on mass reduction and downsizing in order to achieve these standards could occur.'' [386] The agencies emphasize that the final standards are premised almost entirely on increased penetration of technologies which already exist, or which are expected to be in commercial application in the early model years of the standards. See Joint TSD section 3.1. (explaining, technology-by-technology, which are already in use and their effectiveness, and which are considered available for purposes of the analyses underlying this rulemaking). The Alliance also stressed that the agencies should ''continuously update the safety analysis'' going forward, and that updating the safety analysis as part of the mid-term evaluation was ''critical'' ''to reflect the most recent crash data and revised projections regarding mass reduction scenarios,'' because ''the proposed mid-term evaluation is essential in order to assure that the maximum feasible fuel economy benefits are obtained in a cost-effective and safety neutral manner.'' [387] With respect to NHTSA's looking-ahead approach [388] in assessing the feasible amount of mass reduction and the evaluation of concept vehicles, the Alliance stated that ''it is not sufficient to only consider regulatory and consumer information crash tests. A comprehensive evaluation of vehicle safety must also take into account real-world impact scenarios and the special requirements of vulnerable populations (e.g., children and elderly). These must also be adequately accounted for in any agency policy decisions.'' NHTSA does its best in the fleet simulation study to consider as many real world crash scenarios as possible. In the fleet simulation study, NHTSA is including risk functions for different populations. All of the crash results are weighted for their actual occurrence rates. As stated in NHTSA's 2011–2013 research and rulemaking priority plan,[389] the agency currently has programs looking into the areas of safety for vulnerable occupants. NHTSA will monitor the performance of these vulnerable occupants in the context of the changing fleet in response to the fuel economy program.

NHTSA acknowledges these concerns and will closely monitor the safety data, the trends in vehicle weight and size, the trends in vehicle mass reduction, as well as the trend for the active and passive vehicle safety during the period between the release of this final rule and the future rulemaking to establish final CAFE standards for MYs 2022–2025 and the mid-term evaluation. Consistent with confidentiality and other requirements, NHTSA intends to make these data publicly available when they are compiled. We agree with the comments by Global Automakers that ''with sufficient lead-time, the implementation of vehicle lightweighting strategies can be phased in, making it possible to observe the safety implications in comparison with vehicles in the existing fleet.'' [390] The lead-time incorporated into these standards will help the agencies and manufacturers monitor these trends and take appropriate action. NHTSA will also continue and finish its study for estimating fleet safety impacts due to lightweighting using the CAE models available to the agency. NHTSA will also make appropriate updates to the statistical study of historical data on the effects on mass and size societal safety on an ongoing basis. At the same time, NHTSA will continue to assess its analytical methods for assessing the effects of vehicle mass and size on societal safety and make appropriate updates if necessary.

III. EPA MYs 2017–2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards

A. Overview of EPA Rule

1. Introduction

The U.S. Environmental Protection Agency (EPA) is finalizing greenhouse gas (GHG) emissions standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles (hereafter light-duty vehicles) for MYs 2017 through 2025. These vehicle categories, which include cars, sport utility vehicles, minivans, and pickup trucks used for personal transportation, are currently responsible for almost 60% of all U.S. transportation related GHG emissions.

This rule is the second EPA rule to regulate light-duty vehicle GHG emissions under the Clean Air Act (CAA), building upon the GHG emissions standards for MYs 2012–2016 that were established in 2010,[391] and the third rule to regulate GHG emissions from the transportation sector.[392] Combined with the standards already in effect for MYs 2012–2016, these standards will result in MY 2025 light-duty vehicles emitting approximately one-half of the GHG emissions of MY 2010 light duty vehicles and represent the most significant federal action ever taken to reduce GHG emissions (and improve fuel economy) in this country's history.

Soon after the completion of the successful MYs 2012–2016 rulemaking in May 2010, the President, with support from the auto manufacturers and the United Auto Workers, requested that EPA and NHTSA work to extend the National Program to MYs 2017–2025 light duty vehicles. The agencies were requested by the President 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.'' [393] EPA's standards are a result of our work with NHTSA and CARB in developing such a continuation of the National Program. This final rule provides important benefits to society and consumers in the form of reduced GHG emissions and reduced consumption of oil, and significant fuel savings for consumers. It provides the automobile industry with the important certainty and lead time 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 allows for the important continuation of the National Program that started with MYs 2012–2016, and ensures that automakers will be able to continue producing and selling a single fleet of vehicles across the U.S.

From a societal standpoint, the 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 light-duty vehicles sold in MYs 2017–2025. These savings come on top of savings that would already be achieved through the continuation of EPA's MYs 2012–2016 standards.[394] EPA estimates that

[386] Alliance comments, Docket No. NHTSA–2010–0131, at *pg* 5.

[387] *Id.,* at *pg* 6.

[388] Alliance categorized NHTSA's studies for feasible amount of mass reduction and fleet simulation as ''looking-ahead'' approach versus the statistical analysis as ''looking-back'' approach which investigates the historical data.

[389] *http://www.nhtsa.gov/staticfiles/rulemaking/pdf/2011–2013_Vehicle_Safety-Fuel_Economy_Rulemaking-Research_Priority_Plan.pdf.*

[390] Global Automakers comments, Docket No. NHTSA–2010–0131, at *pg* 3.

[391] 75 FR 25324 (May 7, 2010).

[392] 76 FR 57106 (September 15, 2011) established GHG emission standards for heavy-duty vehicles and engines for model years 2014–2018.

[393] The Presidential Memorandum is found at *http://www.whitehouse.gov/the-press-office/presidential-memorandum-regarding-fuel-efficiency-standards.*

[394] The cost and benefit estimates provided here are only for the MYs 2017–2025 rulemaking. EPA and DOT's rulemakings establishing standards for MYs 2012–2016, and DOT's MY 2011 rulemaking, are already part of the baseline for this analysis. See

fuel savings will far outweigh higher vehicle costs, and that the net benefits to society will be in the range of $326 billion (7% discount rate) to $451 billion (3% discount rate) 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 455 million metric tons, oil savings of 2.5 million barrels per day, and net benefits of $158 billion using the $22/ton CO_2 social cost of carbon value. Cumulative net benefits, for calendar years 2017 through 2050 and expressed as a net present value in 2012, are projected to be $616 billion (7% discount rate) to $1.4 trillion (3% discount rate).

These standards will save consumers significant monies over time. The new technology that will be necessary to meet the CO_2 standards is projected to add $1800 to the cost of a new MY 2025 vehicle. These costs come on top of costs that would already be imposed through the continuation of EPA's MYs 2012–2016 standards. But those consumers who drive their MY 2025 vehicle for its entire lifetime will save, on average, $5700 (7% discount rate) to $7400 (3% discount rate) in fuel savings, for a net lifetime savings of $3400 (7% discount rate) to $5000 (3% discount rate).

For those consumers who purchase a new MY 2025 vehicle with cash, the discounted fuel savings will offset the higher vehicle cost (plus sales tax and higher insurance and maintenance costs up to that time) in about 3.2 years (3% discount rate), i.e., that is the ''break-even'' point and after that ongoing fuel savings will greatly exceed the small increases in insurance and maintenance costs. Those consumers that buy a new MY 2025 vehicle with a 5-year loan (assuming a 5.35% interest rate) will benefit from a positive monthly cash flow of about $12 (or $140 per year), on average, as the monthly fuel savings more than offsets the higher monthly payment.

EPA projects even more favorable payback and monthly cash flow for used vehicle buyers, as most of the incremental technology cost is paid for by the initial buyer due to depreciation. A consumer who pays cash for a 5 or 10-year old used vehicle will typically reach payback in approximately one year, while the monthly cash flow savings for a credit purchase (assuming a 9.35% interest rate) will typically be around $20 per month.

EPA Regulatory Impact Analysis 7.4 for the combined cost and benefit projections for the MYs 2012–2016 and 2017–2025 rulemakings.

The 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 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 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 rule including the history and rationale for a National Program that allows manufacturers to build a single fleet of light-duty vehicles that can satisfy all federal and state requirements for GHG emissions and fuel economy, the level and structure of the GHG emissions and corporate average fuel economy (CAFE) standards, the compliance flexibilities 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 GHG emissions standards. After providing an overview of key information in this section (III.A), EPA discusses the 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 standards (III.D); provisions for certification, compliance, and enforcement (III.E); the projected reductions in GHG emissions due to the standards and the associated effects of these reductions (III.F); the impact of the rule on non-GHG emissions and their associated effects (III.G); the estimated cost, economic, and other impacts of the rule (III.H); and various statutory and executive order issues (III.I).

2. Why is EPA establishing MYs 2017–2025 standards for light-duty vehicles?

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. All of these findings were recently affirmed by the D.C. Circuit in *Coalition for Responsible Regulation* v. *EPA* (No. 09–1322, June 26, 2012 (D.C. Circuit)).[395] A more in depth explanation of observed and projected changes in GHGs and climate change, and the impact of climate change on public health, welfare, society, and the environment, is included in Section III.F below.

Mobile sources represent a significant 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 2010, mobile sources emitted 30% of all U.S. GHGs, and have been the source of the largest absolute increase in U.S. GHGs since

[395] See slip op. p. 30 (upholding all of EPA's findings and stating ''EPA had before it substantial record evidence that anthropogenic emissions of greenhouse gases 'very likely' caused warming of the climate over the last several decades. EPA further had evidence of current and future effects of this warming on public health and welfare. Relying again upon substantial scientific evidence, EPA determined that anthropogenically induced climate change threatens both public health and public welfare. It found that extreme weather events, changes in air quality, increases in food- and water-borne pathogens, and increases in temperatures are likely to have adverse health effects. The record also supports EPA's conclusion that climate change endangers human welfare by creating risk to food production and agriculture, forestry, energy, infrastructure, ecosystems, and wildlife. Substantial evidence further supported EPA's conclusion that the warming resulting from the greenhouse gas emissions could be expected to create risks to water resources and in general to coastal areas as a result of expected increase in sea level.'')

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 (CO_2) is the end product of fossil fuel combustion. During combustion, the carbon stored in the fuels is oxidized and emitted as CO_2 and smaller amounts of other carbon compounds. Methane (CH_4) emissions are a function of the methane content of the motor fuel, the amount of hydrocarbons passing uncombusted through the engine, and any post-combustion control of hydrocarbon emissions (such as catalytic converters). Nitrous oxide or N_2O (and nitrogen oxide or 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 vehicle air conditioning 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 GHG emissions, and authorizes EPA to revise them from time to time. See *Coalition for Responsible Regulation* v. *EPA* (No. 09–1322, June 26, 2012 (D.C. Circuit)) holding that under section 202(a), EPA has a mandatory duty to issue standards controlling emissions of greenhouse gases from new motor vehicles once it made a positive endangerment determination, and rejecting all arguments to the contrary as inconsistent with ''[b]oth the plain text of Section 202(a) and precedent'' (slip op. p. 40). This preamble describes the revisions to the current standards to control emissions of CO_2 and HFCs from new light-duty motor vehicles.[396] For further discussion of EPA's authority under section 202(a), see Section I.D.

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). As noted, the D.C. Circuit rejected all industry and State challenges to the endangerment finding, holding that EPA's endangerment determination was supported by ''substantial scientific evidence''. *Coalition for Responsible Regulation* v. *EPA* (No. 09–1322, June 26, 2012 (D.C. Circuit)) slip op. p. 30.

3. What is EPA finalizing?

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

This section provides an overview of EPA's final rule. The key public comments are discussed in the sections that follow, which provide the details of the program. A fuller discussion of comments is in EPA's separate Response to Comments document.

The major elements of EPA's final rule are being finalized as proposed, including overall stringency and timing, and the CO_2-footprint target curves. With respect to the key program design elements, a few changes have been made subsequent to the proposal, in response to public comment, including the addition of multiplier incentives for dedicated and dual fuel CNG vehicles for MYs 2017–2021, temporary lead time provisions for intermediate volume manufacturers, and some relatively minor changes in the off-cycle credit and hybrid pick-up truck incentive programs.

EPA is finalizing new tailpipe carbon dioxide (CO_2) emissions 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.[397] 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 rule, 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 CO_2 emissions-footprint standard curves and the various compliance flexibilities that are available to the manufacturers in meeting the tailpipe CO_2 standards.

EPA projects that the tailpipe CO_2 standards will yield a fleetwide average light vehicle CO_2 emissions compliance target level in MY 2025 of 163 grams per mile,[398] which represents an average fleetwide 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 CO_2 emissions would be reduced by about 3.5 percent per year from MYs 2017 through 2021, and by about 5 percent per year from MYs 2022 through 2025.

The following three tables, Table III–1 through Table III–3, summarize EPA's projections of what the standards mean in terms of 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

[396] EPA is not amending the substantive standards adopted in the 2012–2016 light-duty vehicle rule for N_2O and CH_4, but is revising the options that manufacturers have in meeting the N_2O and CH_4 standards, and to the timeframe for manufacturers to begin measuring N_2O emissions. See Section III.B below.

[397] EPA is not changing the 0.010 gram per mile N_2O or 0.030 gram per mile CH_4 standards which were established in the MYs 2012–2016 rulemaking. See Section III.B for a discussion of the N_2O and CH_4 standards.

[398] This translates to 54.5 mpg if met exclusively with fuel economy technologies.

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, as well as the actual utilization of incentives and credits, will be either higher or lower than the EPA projections.[399]

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 CO_2-footprint curve standards as well as the projected mixes of cars and trucks and vehicle footprint distributions.

The columns under ''Incentives'' represent the projected emissions impact of the advanced technology multiplier incentives,[400] as well as the pickup truck incentives. Also shown under incentives is the projected impact of the flexibilities provided to intermediate volume manufacturers. These incentives allow manufacturers to meet their compliance targets with CO_2 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 CO_2'' is the sum of the CO_2 Compliance Target and the values 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, fuel use from these vehicles will impact the overall GHG reductions associated with the 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 compliance value for EV/PHEV/FCVs and the advanced technology multiplier on overall program GHG emissions is discussed in more detail below in Section III.C.2.d.

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, as well as certain off-cycle technologies. 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 meet their compliance targets with 2-cycle test CO_2 emissions values higher than otherwise. For the off-cycle credit program, values are projected for two technologies—active aerodynamics and stop-start systems—EPA is not quantifying the use of additional off-cycle technologies at this time because of a lack of information with respect to the likely use of additional off-cycle technologies.

In the MYs 2012–2016 rule, we estimated the impact of the Temporary Leadtime Allowance Alternative Standards 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.

The column ''Projected 2-cycle CO_2'' 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 standards. This value is the sum of the projected fleetwide credit, incentive, and Compliance Target values.

TABLE III–1—EPA PROJECTIONS FOR FLEETWIDE TAILPIPE EMISSIONS COMPLIANCE WITH CO_2 STANDARDS—PASSENGER CARS[401]

[Grams per mile]

Model year	Projected CO_2 compliance target	Incentives[402]		Projected achieved CO_2	Credits			Projected 2-cycle CO_2
		Advanced technology multiplier	Intermediate volume provisions		Off cycle credit	A/C refrigerant	A/C efficiency	
2016 (base)	225[403]	0	0	225	0.4	5.4	4.8	235
2017	212	0.6	0.1	213	0.5	7.8	5.0	226
2018	202	1.1	0.3	203	0.6	9.3	5.0	218
2019	191	1.6	0.1	193	0.7	10.8	5.0	210
2020	182	1.5	0.1	183	0.8	12.3	5.0	201
2021	172	1.2	0.0	173	0.8	13.8	5.0	193
2022	164	0.0	0.0	164	0.9	13.8	5.0	184
2023	157	0.0	0.0	157	1.0	13.8	5.0	177
2024	150	0.0	0.0	150	1.1	13.8	5.0	170
2025	143	0.0	0.0	143	1.4	13.8	5.0	163

[399] All EPA projections in the preamble are relative to a 2008-based reference fleet; see the EPA Regulatory Impact Analysis for projections relative to a 2010-based reference fleet.

[400] The advanced technology multiplier incentive applies to EVs, PHEVs, FCVs, and CNG vehicles. The projections reflect EPA projections of the use of EVs and PHEVs for MYs 2017–2021. It is, of course, possible that there will be FCVs and CNG vehicles during this timeframe as well.

[401] Projected results using 2008-based fleet projection analysis. These values differ slightly from those shown in the proposal because of revisions to the MY 2008-based fleet and updates to the analysis.

[402] An incentive not reflected in this table is the 0 gram per mile compliance value for EV/PHEV/FCVs. See text for explanation.

[403] The projected compliance levels for 2016 are different than those which were projected in the MYs 2012–2016 rule. Our assessment for this rule is based on a predicted 2016 compliance target of 224 for cars, 297 for trucks, and 252 for the fleet. This 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–2—EPA PROJECTIONS FOR FLEETWIDE TAILPIPE EMISSIONS COMPLIANCE WITH CO_2 STANDARDS—LIGHT TRUCKS [404]

[Grams per mile]

Model year	Projected CO_2 compliance target	Incentives [405]		Projected achieved CO_2	Credits			Projected 2-cycle CO_2
		Pickup mild HEV + strong HEV	Intermediate volume provisions		Off cycle credit	A/C refrigerant	A/C efficiency	
2016 (base)	[406] 298	0	0.0	298	0.7	6.6	4.8	310
2017	295	0.1	0.2	295	0.9	7	5	308
2018	286	0.2	0.3	287	1.0	11	5	304
2019	277	0.3	0.2	278	1.2	13.4	7.2	299
2020	269	0.4	0.2	270	1.4	15.3	7.2	294
2021	249	0.5	0.0	250	1.5	17.2	7.2	276
2022	237	0.6	0.0	238	2.2	17.2	7.2	264
2023	225	0.6	0.0	226	2.9	17.2	7.2	253
2024	214	0.7	0.0	214	3.6	17.2	7.2	242
2025	203	0.8	0.0	204	4.3	17.2	7.2	233

[404] Projected results using 2008-based fleet projection analysis. These values differ slightly from those shown in the proposal because of revisions to the MY 2008-based fleet and updates to the analysis.
[405] An incentive not reflected in this table is the 0 gram per mile compliance value for EV/PHEV/FCVs. See text for explanation.
[406] The projected compliance levels for 2016 are different than those which were projected in the MYs 2012–2016 rule. Our assessment for this rule is based on a predicted 2016 compliance target of 224 for cars, 297 for trucks, and 252 for the fleet. This 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 CO_2 STANDARDS—COMBINED PASSENGER CARS AND LIGHT TRUCKS [407]

[Grams per mile]

Model year	Projected CO_2 compliance target	Incentives [408]			Projected achieved CO_2	Credits			Projected 2-cycle CO_2
		Advanced technology multiplier	Pickup mild HEV + strong HEV	Intermediate volume provision		Off cycle credit	A/C refrigerant	A/C efficiency	
2016 (base)	[409] 250	0	0	....	250	0.5	5.8	4.8	261
2017	243	0.4	0.0	0.1	243	0.6	7.5	5.0	256
2018	232	0.7	0.1	0.3	234	0.8	9.9	5.0	249
2019	222	1.0	0.1	0.1	223	0.9	11.7	5.8	242
2020	213	1.0	0.1	0.1	214	1.0	13.4	5.8	234
2021	199	0.8	0.2	....	200	1.1	15.0	5.8	222
2022	190	0.0	0.2	....	190	1.4	15.0	5.8	212
2023	180	0.0	0.2	....	181	1.7	15.0	5.8	203
2024	171	0.0	0.2	....	172	1.9	14.9	5.7	194
2025	163	0.0	0.3	....	163	2.3	14.9	5.7	186

[407] Projected results using 2008-based fleet projection analysis. These values differ slightly from those shown in the proposal because of revisions to the MY 2008-based fleet and updates to the analysis.
[408] The one incentive not reflected in this table is the 0 gram per mile compliance value for EV/PHEV/FCVs. See text for explanation.
[409] The projected compliance levels for 2016 are different than those which were projected in the MYs 2012–2016 rule. Our assessment for this rule is based on a predicted 2016 compliance target of 224 for cars, 297 for trucks, and 252 for the fleet. This 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–4 shows the projected real world CO_2 emissions and fuel economy values associated with the 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 and off-cycle credits,[410] 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 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

[410] Air conditioner efficiency and off-cycle credits are subtracted from the Projected 2-cycle CO_2 values (which include the air conditioner efficiency and off-cycle credits) because they will decrease real world CO_2 emissions and increase real world fuel economy. The same results can be obtained from starting with the Projected Achieved CO_2 values in Tables III–1 through Table III–3 and adding the A/C Refrigerant values.

performance, driver behavior, climate conditions, fuel composition, congestion, etc. Issues associated with future projections of this factor are discussed in TSD 4. 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.[411]

TABLE III–4—EPA PROJECTIONS FOR THE AVERAGE, REAL WORLD FLEETWIDE TAILPIPE CO_2 EMISSIONS AND FUEL ECONOMY ASSOCIATED WITH THE 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)	287	381	320	30.9	23.3	27.8
2017	276	378	313	32.2	23.5	28.4
2018	266	373	304	33.5	23.9	29.2
2019	255	363	294	34.8	24.5	30.2
2020	244	357	284	36.4	24.9	31.3
2021	234	334	269	38.0	26.6	33.1
2022	223	318	256	39.9	27.9	34.7
2023	215	304	244	41.3	29.3	36.4
2024	205	289	233	43.4	30.8	38.1
2025	196	277	223	45.4	32.1	40.0

As discussed both in Section I and later in Section III, EPA is finalizing 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 also finalizing a one-time provision allowing credits generated in MYs 2012–2016 to be carried forward through MY 2021. These provisions are not expected to change the emissions reductions achieved by the standards, but should reduce the cost of achieving those reductions. The tables above do not reflect the year to year impact of these provisions. For example, car-to-truck or truck-to-car credit transfers could affect the projected values in Table III–1 and Table III–2, but such credit transfers between cars and trucks would not be expected to change the results for the combined fleet, reflected in Table III–3.

The rule also exempts from the standards a limited set of vehicles: emergency and police vehicles, and (as in the MYs 2012–2016 GHG standards) vehicles manufactured by small businesses. As discussed in Section III.B below, these exclusions have a 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 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 Greenhouse Gas Emissions Standards

i. Model Year Lifetime Analysis

Section I.C provides a comprehensive discussion of the projected benefits and costs associated with 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 technology 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 is 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 standards are projected to save approximately 2 billion metric tons of GHG emissions and nearly 4 billion barrels of oil. These savings come on top of savings that would already be achieved through the continuation of EPA's MYs 2012–2016 standards.[412]

Table III–6 provides a summary of the most important projected economic impacts of the 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, and then are summed up across all model years. With a 3% discount rate, cumulative incremental vehicle program costs for MYs 2017–2025 vehicles are $150 billion (with $136 billion of that being new technology and $14 billion being increased maintenance), fuel savings are $475 billion, other monetized benefits are $126 billion, and program net benefits are projected to be $451 billion. Using a 7% discount rate, the projected program net benefits are $326 billion.

TABLE III–5—SUMMARY OF GHG EMISSIONS AND OIL SAVINGS FOR MODEL YEAR LIFETIME ANALYSIS OF CO_2 STANDARDS

	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)	30.5	69.6	108	149	216	270	320	371	423	1,956

[411] So this value will be different if there is significant use of diesel fuel.

[412] The cost and benefit estimates provided here are only for the MYs 2017–2025 rulemaking. EPA and DOT's rulemakings establishing standards for MYs 2012–2016, and DOT's MY 2011 rulemaking, are already part of the baseline for this analysis.

TABLE III–5—SUMMARY OF GHG EMISSIONS AND OIL SAVINGS FOR MODEL YEAR LIFETIME ANALYSIS OF CO_2 STANDARDS—Continued

	MY 2017	MY 2018	MY 2019	MY 2020	MY 2021	MY 2022	MY 2023	MY 2024	MY 2025	Cumulative MY 2017–2025
Oil Savings (Billion Barrels)	0.06	0.13	0.20	0.28	0.41	0.53	0.64	0.75	0.86	3.87

TABLE III–6—SUMMARY OF KEY PROJECTED ECONOMIC IMPACTS, ON A LIFETIME PRESENT VALUE BASIS,[413] FOR MODEL YEAR LIFETIME ANALYSIS OF CO_2 STANDARDS

[Billions of 2010 dollars]

	3% discount rate	7% discount rate
Incremental Vehicle Program Cost	$150	$144
Societal Fuel Savings[414]	475	364
Other Benefits	126	106
Program Net Benefits	451	326

[413] Present value discounts all values to the first year of each MY, then susms those present values across MYs, in 2010 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 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 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 EPA GHG emissions standards based on this calendar year analysis. In calendar year 2025, EPA projects GHG savings of 140 million metric tons and oil savings of 0.76 million barrels per day. These would grow to 569 million metric tons of GHG savings and 3.2 million barrels of oil per day by calendar year 2050. Program net benefits are projected to be $19.3 billion in calendar year 2025, growing to $217 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 $616 billion (7% discount rate) to $1.4 trillion (3% discount rate).

More details associated with this calendar year analysis of the GHG standards are presented in Sections III.F (including projected annual GHG savings for CYs 2017–2050) and III.H (including projected annual oil savings for CYs 2017–2050).

TABLE III–7—SUMMARY OF KEY PROJECTED IMPACTS FOR CO_2 STANDARDS—CALENDAR YEAR ANALYSIS[415]

	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	27.0	140	271	455	569		
Oil Savings (Million Barrels per Year)	4.7	51.2	277	547	926	1,161		
Oil Savings (Million Barrels per Day)	0.01	0.14	0.76	1.5	2.5	3.2		
Incremental Vehicle Program Cost (billions of 2010$)	−$2.47	−$9.19	−$32.9	−$35.9	−$41.0	−$46.5	−$561	−$247
Societal Fuel Savings (billions of 2010$)[416]	$0.65	$7.4	$41.7	$86.4	$155	$212	$1,600	$607
Other Benefits (billions of 2010$)	$0.14	$1.59	$9.28	$21.2	$40.0	$47.2	$395	$256
Program Net Benefits (billions of 2010$)[417]	−$1.65	$0.15	$19.3	$73.9	$158	$217	$1,430	$616

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 CO_2 emissions standards on individual consumers who own and drive MY 2025 light-duty vehicles.

Table III–8 projects, on average, several key consumer impacts associated with the tailpipe CO_2 emissions standards 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 AEO2012 early release fuel price projections of $3.63 per gallon in calendar year 2017, rising to $3.87 per gallon in calendar year 2025 and $4.24 per gallon in calendar year 2040 (all fuel prices include taxes).

EPA projects that the new technology necessary to meet the MY 2025 tailpipe emissions standards would add, on average, an extra $1800 (including markup) to the sticker price of a new

[414] All fuel impacts are calculated with pre-tax fuel prices of $3.22 per gallon in calendar year 2017, rising to $3.49 per gallon in calendar year 2025, and $3.88 per gallon in calendar year 2040, and electricity prices of $0.09 per kWh in 2017 and $0.10 in 2025, and $0.11 per kWh in 2040, all in 2010 dollars.

[415] 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.

[416] All fuel impacts are calculated with pre-tax fuel prices of $3.22 per gallon in calendar year 2017, rising to $3.49 per gallon in calendar year 2025, and $3.88 per gallon in calendar year 2040, and electricity prices of $0.09 per kWh in 2017, rising to $0.10 in 2025, and $0.11 per kWh in 2040, all in 2010 dollars.

[417] Assuming the 3% average SCC value and other benefits of the program not presented in this table.

MY 2025 light-duty vehicle. Including higher vehicle sales taxes, and first-year insurance and maintenance costs, the projected incremental first-year cost to the consumer is about $2000 on average. The projected incremental lifetime vehicle cost to the consumer, reflecting higher maintenance costs and insurance premiums over the life of the vehicle, is, on average, about $2400 (3% discount rate) or $2300 (7% discount rate). For consumers who drive MY 2025 light-duty vehicles over the full vehicle lifetimes, the final standards are projected to yield a net savings of $3,400 (7% discount rate) to $5,000 (3% discount) over the lifetime of the vehicle, as the discounted lifetime fuel savings of $5,700–$7,400 (7% and 3% discount rates, respectively) is 2.5–3.1 times greater than the 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 3.2–3.4 years means that, for a consumer that buys a new MY 2025 vehicle with cash, the discounted fuel savings for that consumer would more than offset the total incremental vehicle costs (including technology, sales tax, insurance and maintenance), up to that time, in about 3.3 years. If the consumer owns the vehicle beyond this payback period, the vehicle will save money for the consumer as the ongoing fuel savings greatly exceed the small ongoing incremental insurance and maintenance costs. For a consumer that buys a new MY 2025 vehicle with a 5-year loan, the average monthly cash flow savings of $11 (7% discount rate) or $13 (3% discount rate), or annual savings of $130–$150, shows that the consumer would benefit immediately as the discounted monthly fuel savings more than offsets the higher monthly costs from higher incremental loan payments, plus insurance and maintenance costs.

The consumer impacts are even more favorable for used vehicle buyers, as most of the incremental technology cost is paid for by the original purchaser. EPA projects that the payback period would be 1.1 years for a 5-year old used vehicle, and about 6 months for a 10-year old used vehicle. Consumers that buy a used 5-year old vehicle with a 3-year loan would realize monthly cash flow savings of about $21–23 per month, and these savings would be $23–24 for a buyer of a 10-year old vehicle with a 3-year loan.

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 21 fewer metric tons of CO_2 and consume 2,300 fewer gallons of gasoline due to the tailpipe CO_2 emissions standards.

TABLE III–8—SUMMARY OF KEY PROJECTED CONSUMER IMPACTS FOR MY 2025 CO_2 STANDARDS [418] [419]

	3% Discount rate	7% Discount rate
Incremental Vehicle Technology Cost	$1800.	
Incremental First-Year Vehicle Cost to Consumer [420]	$2000.	
Incremental Lifetime Vehicle Cost to Consumer [421]	$2400	$2300.
Lifetime Consumer Fuel Savings [422]	$7400	$5700.
Lifetime Consumer Net Savings [423]	$5000	$3400.
Payback Period-New Vehicle-Cash Purchase	3.2 years	3.4 years.
Payback Period-Used 5 Year Old Vehicle-Cash Purchase	1.1 years	1.1 years.
Payback Period-Used 10 Year Old Vehicle-Cash Purchase	0.5 years	0.5 years.
Monthly Cash Flow Savings-New Vehicle-5 Year Loan	$13	$11.
Monthly Cash Flow Savings-Used 5 Year Old Vehicle-3 Year Loan	$23	$21.
Monthly Cash Flow Savings-Used 10 Year Old Vehicle-3 Year Loan	$24	$23.
First Year CO_2 Savings [424]	1.6 metric tons.	
Lifetime CO_2 Savings	21 metric tons.	
First Year Gasoline/Oil Savings	180 gallons.	
Lifetime Gasoline/Oil Savings	2300 gallons.	

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 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 adopting 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 changing the methane and nitrous oxide emissions standards already in place (although EPA is changing some 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 GHG emissions 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 setting 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, as well as some emerging technologies. 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 allowing manufacturers to petition EPA to develop a manufacturer-specific standard in lieu of the main standard.

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 costs for all candidate technologies including 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 also projects that the fuel savings over the life of the vehicles will more than offset the increase in cost associated with the technology used to meet the standards.

EPA 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 at least a limited extent across the fleet, or will soon be commercialized by one or more major manufacturers. As discussed in Section III.D.7, after accounting for expected improvements in air conditioning systems, many MY 2012 and MY 2013 vehicles would already be able to meet GHG emissions targets for MY 2017 without additional changes in powertrain technology, and some vehicles could meet GHG emissions targets for some later model years as well. The vast majority of the emission reductions that would result from this rule would result from the increased use of currently available technologies such as engines with direct injection, turbocharging, and cooled exhaust gas recirculation, stop-start systems, advanced transmissions with more gears and more efficient gearing mechanisms, and improved tires, aerodynamics, and accessories. Various combinations of these technologies can work for different vehicle models, and typically there are multiple technology paths for achieving compliance for a given model. 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. Less stringent standards would forego emission reductions which are feasible, cost effective, and cost feasible, with short consumer payback periods. More stringent standards would increase cost—both to manufacturers and to consumers—with the potential for overly aggressive penetration rates for advanced technologies, especially in the face of unknown degree of consumer acceptance of both the increased costs and the technologies themselves. See Section III.D.6 for EPA's analysis of alternative GHG emissions standards.

EPA has also evaluated the impacts of these standards with respect to reductions in GHGs and reductions in oil usage. For the lifetime of the MYs 2017–2025 vehicles we estimate GHG reductions of approximately 2 billion metric tons and fuel reductions of nearly 4 billion barrels of oil. These savings come on top of savings that would already be achieved through the continuation of EPA's MYs 2012–2016 standards.[425] 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 indicates that the overall

[418] Average impact of all MY 2025 light-duty vehicles, excluding VMT rebound effect.

[419] Most values have been rounded to two significant digits in this summary table and therefore may be slightly different than tables elsewhere.

[420] Incremental First-Year Vehicle Cost to Consumer includes the incremental vehicle technology cost, average nationwide sales tax, first-year increased insurance premiums, and first-year increased maintenance costs.

[421] Incremental Lifetime Vehicle Cost to Consumer includes the incremental vehicle technology cost, average nationwide sales tax, and the discounted costs associated with incremental lifetime insurance premiums and maintenance costs.

[422] All fuel impacts are calculated with fuel prices, including fuel taxes, of $3.87 per gallon in calendar year 2025, rising to $4.24 per gallon in calendar year 2040, and electricity prices of $0.10 per kWh 2025, and $0.11 per kWh in 2040, all in 2010 dollars.

[423] Lifetime Consumer Fuel Savings minus Incremental Lifetime Vehicle Cost to Consumer.

[424] CO_2 and gasoline savings reflect vehicle tailpipe-only and do not include CO_2 and oil savings associated with fuel production and distribution.

[425] The cost and benefit estimates provided here are only for the MYs 2017–2025 rulemaking. EPA and DOT's rulemakings establishing standards for MYs 2012–2016, and DOT's MY 2011 rulemaking, are already part of the baseline for this analysis.

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 MYs 2017–2025 vehicles to be $451 billion with a 3% discount rate and $326 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 rule is predicated and the substantial lead times afforded under the proposal (which by MY 2025 allow for multiple vehicle redesign cycles and so affords opportunities for adding technologies in the most cost efficient manner, see 75 FR 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 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 (D.C. Cir. 2001) (great discretion to balance statutory factors in considering level of technology-based standard, and statutory requirement ''to [give appropriate] consideration to the cost of applying * * * technology'' does not mandate a specific method of cost analysis); see also *Hercules Inc.* v. *EPA,* 598 F. 2d 91, 106 (D.C. Cir. 1978) (''In reviewing a numerical standard we must ask whether the agency's numbers are within a zone of reasonableness, not whether its numbers are precisely right''); *Permian Basin Area Rate Cases,* 390 U.S. 747, 797 (1968) (same); *Federal Power Commission* v. *Conway Corp.,* 426 U.S. 271, 278 (1976) (same); *Exxon Mobil Gas Marketing Co.* v. *FERC,* 297 F. 3d 1071, 1084 (D.C. Cir. 2002) (same).

5. Other Related EPA Motor Vehicle Regulations

a. EPA's Heavy-Duty GHG Emissions Rulemaking

In August 2011, EPA and NHTSA completed 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 57125–27.

b. EPA's Plans for Further Standards for Light-Duty 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 non-greenhouse 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.*'' [426] EPA has been 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 is also coordinating with the State of California.

Based on this assessment, in the near future, EPA expects to propose a separate program that would, in general, affect the same set of new vehicles on approximately the same timeline as would the new light-duty vehicle GHG emissions standards. It would be designed to primarily 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 contribute to these problems.

EPA expects that this 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 coordinated future product development plans with a full understanding of the major regulatory requirements they will be facing over the long term. This regulatory approach would give manufacturers certainty in planning given the long time period and 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.[427] If the certification test fuel is changed to include ethanol 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

[426] The Presidential Memorandum is found at: *http://www.whitehouse.gov/the-press-office/presidential-memorandum-regarding-fuel-efficiency-standards.*

[427] *See* 40 CFR § 86.113–94(a).

CAFE standards.[428] 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. Model Year 2017–2025 GHG Standards for Light-duty Vehicles, Light-duty Trucks, and Medium duty Passenger Vehicles

EPA is establishing standards to control the emissions of greenhouse gases (GHGs) from MY 2017 and later light-duty vehicles. Carbon dioxide (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. The standards regulate CO_2 on a gram per mile (g/mile) basis, and are separately applied to a manufacturer's car and truck fleets. Under these standards, industry-wide average emissions for the light-duty fleet are projected to be 163 g/mile of CO_2 in model year 2025.[429] EPA will 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 changing the averaging, banking, and trading program elements from the MY 2012–2016 rule, as discussed in Section III.B.4, with the exception of a one-time carry-forward of any credits generated in MYs 2010–2016 to be used anytime through MY 2021. The standards described herein 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.''

EPA is also establishing provisions for small and intermediate-sized manufacturers. For small volume manufacturers with less than 5,000 vehicles, EPA is finalizing its proposal to allow these manufacturers to petition EPA for alternative standards, which would be established on a case-by-case basis (see Section III.B. 5). For intermediate-sized limited line manufacturers, EPA had requested comment on whether there is a need for additional lead time, and after considering public comments on this topic, is finalizing provisions providing additional lead time until MY 2021 for manufacturers with sales of less than 50,000 vehicles (see Section III.B.6). As with the MY 2012–2016 light-duty vehicle standards, EPA is exempting manufacturers that meet the Small Business Administration's definition of a small business from the standards (see section III.B. 7). EPA is also finalizing its proposal to exempt police and emergency vehicles from the GHG standards, beginning in MY 2012, consistent with how these vehicles are treated under the CAFE program (see section III.B.8).

The MY 2012–2016 rule established several program elements that will remain in place, without change. EPA is not changing the CH_4 and N_2O emissions standards from the MY 2012–2016 rule, but is making revisions to a manufacturer's options for meeting the CH_4 and N_2O standards, and to the date when N_2O emissions must be measured rather than estimated using engineering judgment (see section III.B.9). These revisions 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 will remain in place for MY 2017 and later, including improvements to address both hydrofluorocarbon (HFC) refrigerant direct losses (i.e., system ''leakage'') and indirect CO_2 emissions related to the increased load on the engine (also referred to as ''A/C efficiency'' related emissions). The overall maximum number of credits available for reducing the effects of A/C system leakage (including shifting to alternative refrigerants) and for improving A/C efficiency remain the same as those in the MY 2012–2016 rule, although we are incorporating a new test procedure for measuring A/C efficiency improvements and making several minor program revisions, as discussed in section III.C.1 and chapter 5.1 of the joint TSD. The CO_2 standards take into account EPA's projection of the average amount of air conditioner credits expected to be generated across the industry.

As discussed in section III.C, EPA is finalizing several provisions that allow manufacturers to generate credits for use in complying with the standards or that provide additional incentives for use of advanced technologies. These include credits for technologies that reduce CO_2 emissions during off-cycle operation that are not reasonably accounted for by the 2-cycle tests used for compliance purposes. Compared to the promulgated MY 2012–2016 program, EPA is streamlining the process by which off-cycle credits can be documented and approved. The streamlining includes establishing a pre-defined list of off-cycle technologies and associated credits which may be utilized by manufacturers without prior approval by EPA. The pre-defined list will be available beginning in MY 2014. EPA proposed the pre-defined list for MYs 2017 and later, but has revised the start date in response to comments, as discussed in III.C.5. In addition, EPA is establishing incentives for the use of certain types of alternate fueled vehicles or advanced GHG control technologies. Thus, EPA is adopting multipliers for EVs, PHEVs, and FCVs, whereby these vehicles count as more than one vehicle in a manufacturer's compliance calculation. In addition, in response to comments, EPA is also finalizing a multiplier for compressed natural gas (CNG) vehicles. The multiplier incentives are described in section III.C.2. EPA is also adopting specified g/mile credits 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 full-size pick-up credits and incentives for advanced ''game changing'' technologies are described in section III.C.3.

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

Consistent with the proposal, EPA is establishing standards that are projected to meet an industry-wide average for the light-duty fleet of 163 g/mile of CO_2 in model year 2025. The level of 163 g/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.[430] [431] EPA continues 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. For passenger cars, the 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 the challenges manufacturers of full-

[428] EPCA requires that CAFE tests be determined from the EPA test procedures in place as of 1975, or procedures that give comparable results. 49 U.S.C. 32904(c).

[429] 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.

[430] In comparison, the MY 2016 CO_2 standard was projected (in the previous rule) to achieve a national fleet-wide average, covering both cars and trucks, of 250 g/mile.

[431] 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. Also, the fuel economy equivalent assumes gasoline fuel is primary; diesel fuels (for example) would give a different fuel economy equivalent.

size pickup trucks face in reducing the GHG emissions while preserving the utility (e.g., towing and payload capabilities) of those vehicles, EPA is setting standards requiring 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 changing the slopes of the CO_2-footprint curves for light-duty trucks from those in the MY 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 special challenges for improving the GHG of large light trucks while maintaining cargo hauling and towing utility. For model years 2022 through 2025, EPA is setting a rate of CO_2 reduction for light-duty trucks of 5 percent per year, starting from the model year 2021 truck standard.

EPA's standards include EPA's projection of average industry wide CO_2-equivalent emission reductions from A/C improvements, where the 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 tables below show overall fleet average levels for both cars and light trucks that are projected over the phase-in period of these standards. The actual fleet-wide average g/mile 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 schedule of standards allows an incremental phase-in to the MY 2025 level, and reflects consideration of the appropriate lead-time and engineering redesign cycles for each manufacturer to implement 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 later model years, unless and until revised by EPA in a future rulemaking.

EPA has estimated the overall fleet-wide CO_2-equivalent emission levels that correspond with the attribute-based standards, based on the projections of the composition of each manufacturer's fleet in each year of the program. As noted above, EPA estimates that, on a combined fleet-wide national basis, the 2025 MY 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. Tables Table III–9 and Table III–10 provide these estimates for each manufacturer. The values in the tables presented in this section utilize the 2008-based fleet projection as described in section II.B of the preamble. For an analysis of the standards using the 2010-based projection, refer to chapter 10 of EPA's RIA (Regulatory Impact Analysis).

TABLE III–9—ESTIMATED FLEET CO_2-EQUIVALENT LEVELS CORRESPONDING TO THE STANDARDS 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	221	211	200	190	180	172	164	157	150
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	215	204	193	184	174	166	159	151	144
Honda	211	200	190	180	171	163	156	149	142
Hyundai	211	200	190	180	171	163	156	149	142
Kia	207	197	186	177	167	160	153	146	139
Lotus	195	185	175	166	157	150	143	137	131
Mazda	208	198	187	178	169	161	154	147	140
Mitsubishi	207	197	187	177	168	160	153	146	139
Nissan	214	204	193	183	174	166	159	152	145
Porsche	195	185	175	166	157	150	143	137	131
Spyker-Saab	207	197	187	177	168	160	153	146	139
Subaru	199	189	180	170	161	154	147	140	134
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	210	199	189	179	170	162	155	148	141
Volkswagen	205	194	185	175	166	158	151	144	138

TABLE III–10—ESTIMATED FLEET CO_2-EQUIVELENT LEVELS CORRESPONDING TO THE STANDARDS 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

TABLE III–10—ESTIMATED FLEET CO_2-EQUIVELENT LEVELS CORRESPONDING TO THE STANDARDS FOR LIGHT TRUCKS (G/MILE)—Continued

	2017	2018	2019	2020	2021	2022	2023	2024	2025
Ferrari	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ford	304	294	287	281	261	248	236	223	212
Geely-Volvo	278	266	258	250	231	220	209	199	189
General Motors	309	299	291	283	262	249	236	224	213
Honda	280	270	262	253	234	223	212	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	227	216	206	196	186
Mitsubishi	266	254	246	238	220	209	199	189	180
Nissan	293	283	275	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	252	240	233	225	207	197	187	178	169
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	282	274	266	247	235	223	211	201
Volkswagen	295	284	276	267	248	236	225	214	203

Companies with ‘‘N/A’’ do not presently have trucks in their fleet.

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.[432] 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 Section II.B of this preamble and Chapter 1 of the joint TSD.

TABLE III–11—ESTIMATED FLEET-WIDE CO_2-EQUIVALENT LEVELS CORRESPONDING TO THE STANDARDS

Model year	Cars CO_2 (g/mile)	Trucks CO_2 (g/mile)	Fleet CO_2 (g/mile)
2017	212	295	243
2018	202	285	232
2019	191	277	222
2020	182	269	213
2021	172	249	199
2022	164	237	190
2023	157	225	180
2024	150	214	171
2025 and later	143	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 212 to 143 g/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 g/mile. These numbers do not reflect the effects of flexibilities and credits in the program.[433] The estimated achieved values can be found in Chapter 3 of the RIA.

As noted above, EPA is establishing standards that set 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 standards. Manufacturers can achieve the standards' important CO_2 emissions reductions through the application of feasible control technology at reasonable cost. The standards provide manufacturers with the needed lead time for this program and reflect appropriate consideration of manufacturer product redesign cycles. EPA places important weight on the fact that the rule provides a long planning horizon to achieve the very challenging emissions standards being established, 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. EPA's full discussion of lead time and the feasibility of the final standards, including our response to these comments, can be found in Section III.D.

In the MY 2012–2016 final rule, EPA established several provisions which will continue to apply for the MY 2017–2025 standards. Consistent with the requirement of CAA section 202(a)(1) that standards be applicable to vehicles ‘‘for their useful life,'' the MY 2017–2025 vehicle standards will apply for the useful life of the vehicle. Under section 202(i) of the Act, which

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

[433] Nor do they reflect ABT (Averaging Banking and Trading).

authorized the Tier 2 standards, EPA established a useful life period of 10 years or 120,000 miles, whichever first occurs, for all light-duty vehicles and light-duty trucks.[434] This useful life applies to the MY 2012–2016 GHG standards and EPA is adopting it as well for MYs 2017–2025. As with the MY 2012–2016 standards, the in-use emission standard is 10% higher for a model than the emission levels used for certification and compliance with the fleet average standards based on the footprint curves. This difference in the in-use standard reflects issues of production variability and test-to-test variability. The in-use standard is discussed in section III.E. Finally, EPA is not making 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).

EPA has analyzed the feasibility of achieving the CO_2 standards, based on projections of the technology and technology penetration rates 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 RIA. EPA also presents the overall estimated costs and benefits of the car and truck CO_2 standards in section III.H. In developing the rule, EPA has evaluated the kinds of technologies that could be utilized by the automobile industry, as well as the associated costs for the industry and fuel savings for the consumer, the magnitude of the GHG and oil reductions that may be achieved, and other factors relevant under section 202(a) of the CAA.

The vast majority of public comments expressed strong support for the stringency levels proposed in the 2017–2025 National Program. Stakeholders in support included environmental NGO's, consumer groups, automakers, automotive suppliers, labor unions, veterans groups and national security organizations, and many private citizens. Notably, there was broad support for the proposed standards by auto manufacturers including BMW, Chrysler, Ford, GM, Honda, Hyundai, Kia, Jaguar/Land Rover, Mazda, Mitsubishi, Nissan, Tesla, Toyota, Volvo as well as the Alliance of Automobile Manufacturers and the Global Automakers.

Several environmental organizations and consumer groups (Center for Biological Diversity, Union of Concerned Scientists, Northeast States for Coordinated Air Use Management, Consumers Union, and American Council for an Energy-Efficient Economy, International Council on Clean Transportation) suggested that alternatives evaluated by the EPA with higher penetration rates of advanced technologies were technically feasible. A description of the EPA's statutory authority under the CAA as it related to the application of technology-based standards to achieve emissions reductions are provided in Section I.D.2. A discussion of the feasibility of this rulemaking and that of alternative scenarios evaluated can be found in III.D.

Some manufacturers that supported the proposed standards noted various challenges in achieving them. Chrysler noted challenges of meeting the standard within the timeframe of product development cycles, BMW suggested that prior adoption of advanced technologies results in fewer options available for compliance, and Nissan expressed concern regarding the uncertainty projecting cost-effective and feasible technologies so far into the future. These comments are addressed in Section III.D.

Porsche, Jaguar Land Rover, and Suzuki raised concerns about feasibility and adequate lead time for intermediate volume, limited line manufacturers. As discussed in section III.B.6, EPA is providing intermediate volume manufacturers with additional lead time in response to these comments. Aston Martin, Lotus and McLaren, three manufacturers who currently qualify as small volume manufacturers under the MY 2012–2016 program, commented in support of EPA's proposal to allow SVMs to petition for manufacturer-specific alternative standards. These manufacturers stressed the unique challenges they would face in meeting the MY 2017–2025 standards due to their extremely limited ability to average across small volume fleets and their disadvantage in the marketplace due to the lack of economies of scale. EPA is finalizing the proposal to allow SVMs to petition EPA for alternative CO_2 standards based on a demonstration of significant feasibility and lead-time difficulties in meeting the primary standards (see section III.B.5). Ferrari, several Ferrari dealers, and Global Automakers raised significant feasibility concerns regarding the proposed standards and commented in strong support of provisions which would allow a manufacturer to establish SVM status by showing that it is operationally independent of other companies. As discussed in section III.B.5, EPA is finalizing provisions allowing manufacturers with sales of less than 5,000 vehicles owned by a larger manufacturer to make a demonstration that they are operationally independent from their parent company and thus allow these manufacturers to be eligible for SVM alternative standards.

2. What are the CO_2 attribute-based standards?

As with the MY 2012–2016 standards, for MYs 2017–2025 EPA is establishing separate car and truck standards; that is, vehicles defined as cars have one set of footprint-based curves, and vehicles defined as trucks have a different set. In general, for a given footprint, the CO_2 g/mile target[435] for trucks is 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 MY 2012–2016 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 MY 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 (rather than 66 sq ft as in the curves for the MY 2012–2016 standards). The transition is also designed to prevent the curve from one year from crossing the previous year's curve.

Written in mathematic notation, the function is as follows:[436]

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[434] See Regulatory text for the official coefficients and equation. The information presented here is a summary.

[435] Because compliance is based on the full range of vehicles in a manufacturer's car and truck fleets, with lower emitting vehicles compensating for higher emitting ones, the emission levels of specific vehicles within the fleet are referred to as targets, rather than standards.

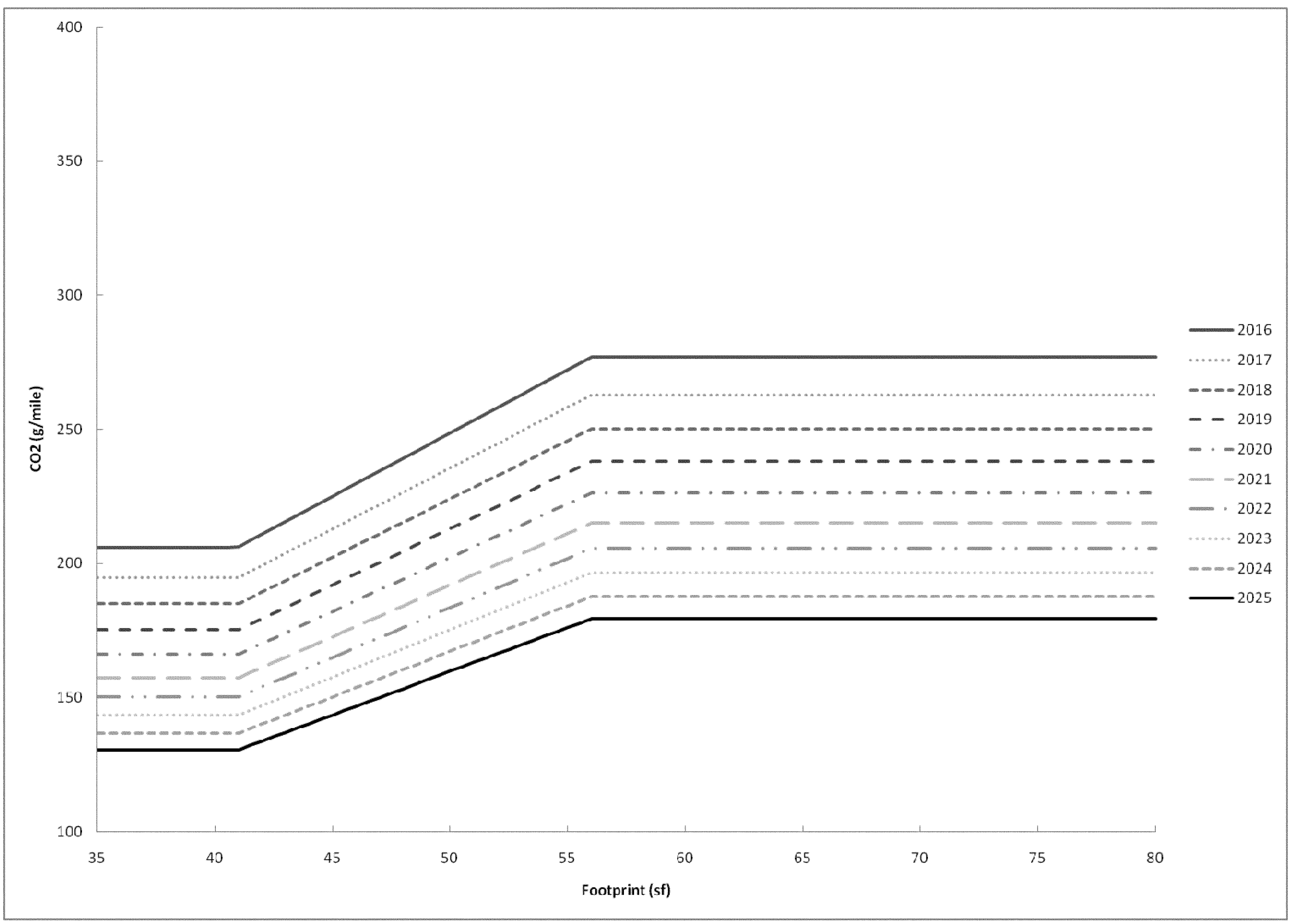
PASSENGER CAR TARGET = MIN (B,MAX(A, C * FOOTPRINT+D))

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)

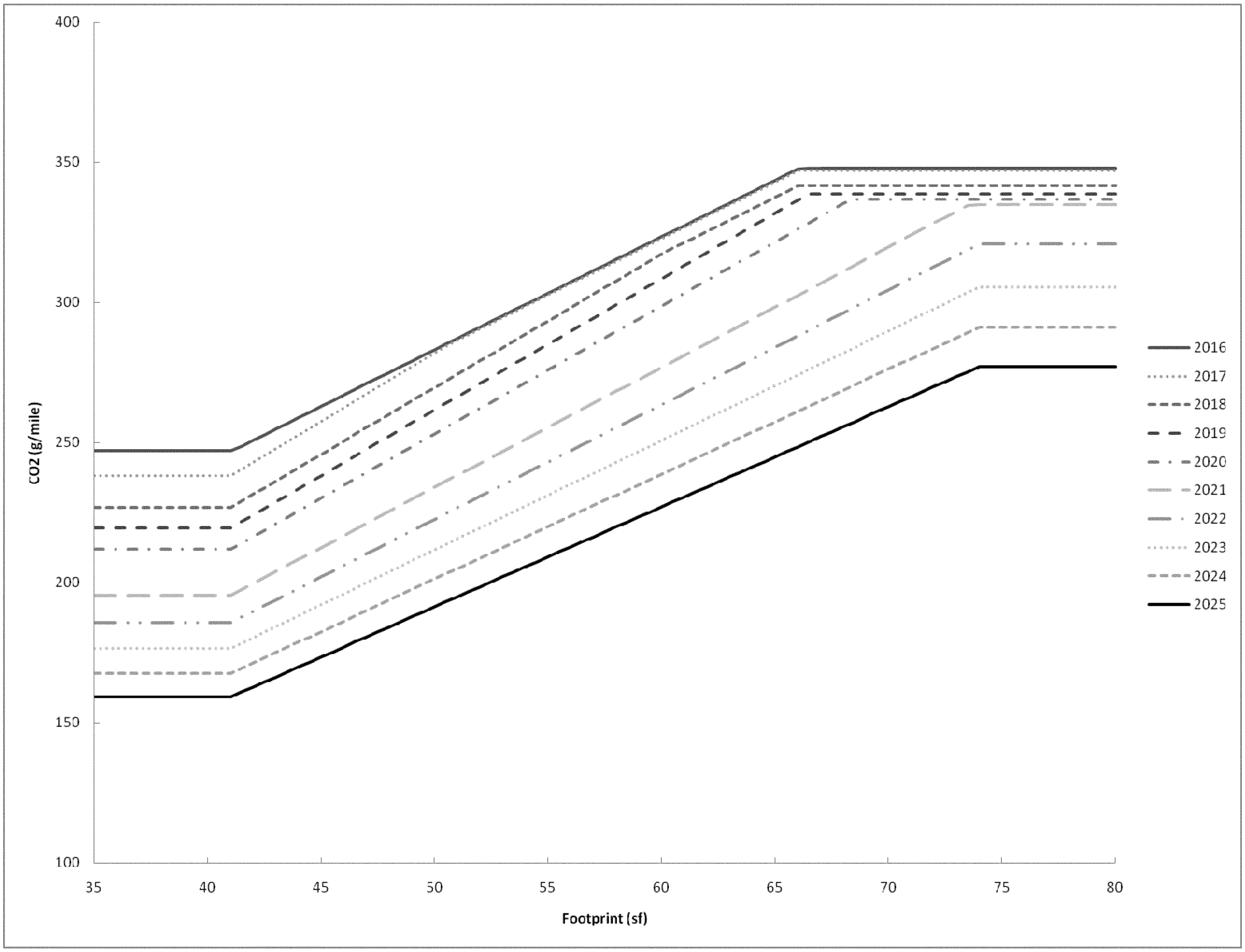
Coefficient	2017	2018	2019	2020	2021	2022	2023	2024	2025
A	238.1	226.8	219.5	211.9	195.4	185.7	176.4	167.6	159.1
B	347.2	341.7	338.6	336.7	334.8	320.8	305.6	291.0	277.1
C	4.87	4.76	4.68	4.57	4.28	4.09	3.91	3.74	3.58
D	38.3	31.6	27.7	24.6	19.8	17.8	16.0	14.2	12.5
E	246.4	240.9	237.8	235.9	234.0	234.0	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 III-1 Car Curves



[436] See Regulatory text for the official coefficients and equation. The information presented here is a summary.

Figure III-2 –Truck Curves



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The MY 2017 car curve is similar to the MY 2016 curve in slope. By contrast, the MY 2017 truck curve is steeper relative to the MY 2016 curve.[437] Both car and truck curves gradually flatten from year to year as increases in stringency are applied consistently across footprints; i.e. a constant percentage increase in stringency along the entire curve results in greater absolute reductions for larger footprints than for smaller ones.[438] As a further change from the MY 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. For further discussion of these topics, please see section II.C and chapter 2 of the joint TSD.

There were a number of comments on the relative stringency of the car versus truck curves. Several manufacturers noted that the relative stringency of car and truck curves was appropriate (Ford, GM). Of the larger manufacturers, Volkswagen, Toyota, Honda and Mercedes commented that the standards for passenger cars were too stringent relative to light trucks. Volkswagen suggested that the difference in stringency places manufactures that primarily make passenger cars at a disadvantage, and proposed reducing the annual reduction in GHG emissions from passenger cars to 4%. Mercedes noted the standards ''are extremely aggressive, especially for a company that traditionally sells in the luxury car market'', and suggested additional flexibilities (off-cycle credits) to account for crash avoidance technologies and to allow for trading between the light-duty and heavy-duty fleets.

Comments from other organizations expressed similar concern that the curves favor trucks over cars (American Council for an Energy-Efficient Economy, Consumers Union, Union of Concerned Scientists). Some commenters suggested that the difference between car and truck curves would lead to gaming, through the reclassification of less-efficient cars as trucks (International Council on Clean Transportation, Consumers Union).

There were also a number of comments on the shape of the car and truck curves. Several commenters proposed that the curves be modified by moving the cutpoints for the smaller vehicles to the left, to discourage

[437] Furthermore, curves are constrained so that they do not cross the previous year's curve, as described in Chapter 2 of the Joint TSD.

[438] There is more justification provided in chapter 2.5.3.1 of the joint TSD.

downsizing (Insurance Institute for Highway Safety, Institute for Policy Integrity), or to make the curves flatter, to discourage upsizing (Whitefoot and Skerlos). The agencies' consideration of these and other comments and of the updated technical analyses did not lead to changes to the level of the standards nor in the shapes of the curves discussed above. These comments and the agencies' response are discussed in greater detail in section II.B and III.D of the Preamble, as well as Chapter 2 of the joint TSD.

3. Mid-Term Evaluation

Given the long time frame at issue in implementing standards for MY2022–2025, 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 will conduct a comprehensive mid-term evaluation and agency decision-making process as described below. No changes are being made to the mid-term evaluation that was discussed and proposed.

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. In order to align the agencies proceedings for MYs 2022–2025 and to maintain a joint national program, EPA and NHTSA will finalize their actions related to MYs 2022–2025 standards concurrently.

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 adopted today, EPA would be legally bound to make a final decision, by April 1, 2018, on whether the MY2022–2025 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 MY 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 MY2022–2025 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 rule[439] 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).[440]

[439] See 40 CFR 86.1818–12(h).

[440] 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

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 MY2022–2025 GHG standards will remain in effect unless and until EPA changes them by rulemaking. NHTSA intends to issue conditional standards for MY2022–2025 in the LDV rulemaking being initiated this fall for MY2017 and later model years. The CAFE standards for MY2022–2025 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.

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 MY2022–2025 with at least 18 months lead time, but additional lead time may be provided.

EPA understands that California intends to conduct a mid-term evaluation of its program that is coordinated with EPA and NHTSA and is based on a similar set of factors as outlined above. California submitted a waiver request under the Clean Air Act to EPA on June 27, 2012 for its MYs 2017–2025 standards.[441] The regulatory package submitted to EPA for a waiver includes such a mid-term evaluation. EPA understands that California intends to continue promoting harmonized state and federal vehicle standards. The waiver request notes California's commitment to accept compliance with EPA greenhouse gas emission standards, as compliant with California's greenhouse gas program.[442] Therefore, if EPA revises its 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.

Overall Support for Finalizing the Mid-term Evaluation

Every automaker and associations representing either auto makers or suppliers who commented on the proposed mid-term evaluation indicated that this evaluation was essential to their support of the proposal and urged the agencies to finalize a comprehensive mid-term evaluation. These commenters included General Motors, Chrysler, Ford, Nissan, Toyota, Hyundai America Technical Center, Mercedes-Benz, Mitsubishi Motors, Volvo Car Corporation, Porsche, Ferrari, KIA, the Alliance of Auto Manufacturers, the Global Automakers, the Motor & Equipment Manufacturers Association (MEMA), National Association of Manufacturers (NAM), EcoMotors International, Inc., and Johnson Controls, Inc. Two automakers, Chrysler and Nissan, specifically predicated their support of the MY2017–2025 National Program on the agencies finalizing the proposed mid-term evaluation. In addition, a number of other organizations including the United Auto Workers (UAW), the International Council on Clean Transportation (ICCT), U.S. Chamber of Commerce, Securing America's Future Energy (SAFE), as well as 112 members of the U.S. House of Representatives (in a letter to both agency heads) expressed strong support for finalizing the proposed mid-term evaluation.

Many environmental and consumer organizations, as well as many private citizens, both at the three public hearings and in written comments, expressed concern that the mid-term evaluation might be used as an opportunity to weaken the standards or to delay the environmental benefits of the National Program. Many stressed the expectation that the mid-term should be used as an opportunity to strengthen the MY2017–2025 standards. These commenters included the Pew Charitable Trust, Sierra Club, Union of Concerned Scientists (UCS), American Medical Association of California, the National Association of Clean Air Agencies (NAACA), the Ecology Center and more than 30,000 individual citizens who submitted letters to the docket. The ICCT expressed their strong support for the mid-term evaluation and NESCAUM in discussing the need to evaluate technology incentives on the overall GHG goals of the program indicated their support of the mid-term review for this purpose.

As discussed above, the mid-term evaluation will be a comprehensive and robust evaluation of all of the relevant factors. EPA is clear that any evaluation of the appropriateness of the standards and any decision to go forward with revising the standards will consider making the standards more or less stringent, whatever is most appropriate under the circumstances at that time. It would be inappropriate to limit EPA's consideration to either just increasing or just reducing the stringency of the standards. Instead, EPA will determine the appropriate course to follow based on all of the information, evidence, and views in front of it, including those provided during public notice and comment.

Two commenters opposed finalizing the mid-term evaluation. Natural Resources Defense Council (NRDC) stated that it was both unnecessary and potentially disruptive to automakers' product planning and would add uncertainty to a nine year period. The National Automobile Dealers Association (NADA) did not support the mid-term evaluation since it did not support the need for the underlying rulemaking ''so soon after having set standards for MY2012–2016, and before having had the benefit of learning from how those standards work in the real world.'' EPA believes that the evaluation process will not be disruptive to the automakers product planning. Instead it provides a framework that allows manufacturers the certainty to go forward and prepare for these standards, as it both adopts them now as final standards and establishes a mechanism to evaluate and change them in the future, if appropriate. The common support from the manufacturers indicates that this is the case. The opposition by NADA is premised on their opposition to adopting standards in this rulemaking, which is addressed elsewhere.

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.

[441] Letter from Mary D. Nicols, Chairman, California Air Resources Board to Lisa P. Jackson, Administrator, U.E. EPA requesting the Administrator treat the amended ZEV requirements as within the scope of the previously granted waivers for the ZEV program or alternatively to grant a new waiver of preemption under CAA section 209(b). The waiver request also asks for an expedited review prior to the start of its Clean Cars Program. Until the waiver is granted, California will not be able to enforce the program. The waiver process requires an opportunity for a public hearing and a 30 day comment period after the hearing before making a determination on the waiver.

[442] State of California Air Resources Board. Resolution 12–11, January 26, 2012, at 20 incorporated by referenced in Board's March 22, 2012 final approval action. *Available at http://www.arb.ca.gov/regact/2012/cfo2012/res12-11.pdf* (last accessed July 9, 2012).

Ensuring Coordination of Mid-term Evaluation

Ford, Toyota, NRDC and the UCS stressed the importance of a coordinated mid-term evaluation by EPA and NHTSA that should also include the California Air Resources Board (CARB). EPA agrees with this comment, as indicated by the discussion above. In adopting their GHG standards the California Air Resources Board (CARB), directed CARB's Executive Officer to, ''participate in U.S. EPA's mid-term review of the 2022 through 2025 model year passenger vehicle greenhouse gas standards * * *'' and to also, ''continue collaborating with EPA and NHTSA as their standards are finalized and in the mid-term review.'' [443] In addition, the Board directed CARB's Executive Officer that ''It is appropriate to accept compliance with the 2017 through 2025 model year National Program as compliance with California's greenhouse gas emission standards in the 2017 through 2025 model years, once United States Environmental Protection Agency (U.S. EPA) issues their final rule on or after its current July 2012 planned release, provided that the greenhouse gas reductions set forth in U.S. EPA's December 1, 2011 Notice of Proposed Rulemaking for 2017 through 2025 model year passenger vehicles are maintained, except that California shall maintain its own reporting requirements.''[444]

Clean Air Act Authority To Conduct a Mid-term Evaluation

A number of auto manufacturers submitted comments agreeing that section 202(a) of the Clean Air Act (CAA) authorizes the proposed mid-term evaluation. Chrysler noted that the EPA had a ''firm legal basis to conduct the mid-term evaluation under section 307(d) of the Clean Air Act (CAA) and the Administrative Procedures Act to reconsider regulations based on new information as well as under section 202(a) of the CAA under which EPA proposed the mid-term evaluation.'' The Global Automakers stated that a mid-term evaluation was, ''not only permissible under the Clean Air Act, but also required because of the uncertainties inherent in projecting regulatory requirements nine to twelve years into the future,'' continuing that it ''would have been arbitrary and capricious for EPA to promulgate GHG emissions standards for model years as far into the future as MY2022–2025 without providing for a mid-term evaluation.'' Nissan indicated support for the views expressed by the Global Automakers and stated further that ''a robust and comprehensive mid-term review is legally necessary to ensure that the standards for the later model years are supported by substantial evidence and are not arbitrary and capricious. (Citing Motor Vehicle Mfr's Ass'n v. State Farm, 463 U.S. 29,42 (1983) listing examples of arbitrary and capricious agency activity).''

EPA agrees that section 202(a) provides the agency with ample authority to undertake the mid-term evaluation. EPA does not agree that the mid-term evaluation is authorized under CAA section 307(d), as the mid-term evaluation is not a reconsideration of the standards under that provision. Instead the mid-term evaluation will be undertaken under EPA's general authority to establish emissions standards under section 202(a). EPA does not agree that the mid-term evaluation is legally required, or that the standards adopted today would be arbitrary and capricious or without substantial evidence to support them absent such a mid-term evaluation. The final rule and supporting information and analysis amply justify the reasonableness and appropriateness of the final GHG standards adopted by EPA, irrespective of the provisions for a mid-term evaluation. In any case, that issue is not before EPA as EPA is exercising its discretion to adopt provisions for a mid-term evaluation, for the reasons discussed above.

The Center for Biological Diversity (CBD) challenged the basis for the mid-term evaluation and specifically argued that any interim rulemaking should be based on a presumption that the stringencies of the standards will not decrease. As discussed above, the mid-term evaluation will be a robust and comprehensive evaluation, and it would be inappropriate to limit EPA's consideration to either just increasing or just reducing the stringency of the standards. Instead, EPA will determine the appropriate course to follow based on all of the information, evidence, and views in front of it, including those provided during public notice and comment. CBD also raised a concern that EPA would be applying a faulty weighting of the statutory factors under the CAA. CBD stated that highlighting the manufacturers' ability to comply was improper, and instead decisive weighting should be placed on energy conservation. EPA disagrees that it is improper to carefully consider the impact on manufacturers' ability to comply. When EPA conducts the mid-term evaluation, EPA will be evaluating standards that have already been adopted and for which manufacturers are required to comply. The ability to comply is an important part of determining the appropriateness of these standards. For example, ability to comply is directly tied to lead time, a factor EPA is required to consider under section 202(a). EPA does not agree that it is appropriate to assign decisive weighting to any one factor, such as energy conservation. That is contrary to conducting a holistic assessment, where EPA carefully considers all of the relevant factors under section 202(a) and gives them the weight that is appropriate in light of all of the circumstances.

Recommendations for Additional ''Check-ins'' or Periodic Status Reports

Several automakers, auto suppliers and industry associations (General Motors, Chrysler, Daimler Automotive Group, Hyundai, Alliance of Automobile Manufacturers, Global Automakers, Inc and Johnson Controls) suggested that, in addition to the proposed formal mid-term evaluation, the agencies should also undertake a series of smaller, focused technical evaluations or ''check-ins' leading up to and potentially following the mid-term evaluation. Such check-ins, these commenters asserted, would allow the agencies to consider the latest relevant technical information, as well as other key issues. Several environmental organizations (Sierra Club, UCS, NRDC, and CBD) submitted comments opposing these focused technical evaluations or ''check-ins,'' arguing that these would be time consuming and too premature to judge technology readiness for the MY2022–2025 standards, and would undermine the intent and effectiveness of the mid-term evaluation. A number of environmental organizations also supported periodic updates on technology progress and compliance trends. The Sierra Club, while not supportive of the ''check-in'' concept, did urge agency transparency and access to data that would allow the public to ''effectively and timely monitor compliance trends and technology applications.'' The ICCT recommended that EPA and NHTSA conduct periodic updates on technology progress and consider periodic status reports in advance of the mid-term evaluation so that all interested parties could have access to key data that would be important in documenting progress in technology improvements and implementation.

[443] See California Low-Emission Vehicles (LEV) & GHG 2012 regulations approved by State of California Air Resources Board, Resolution 12–11 (March 22, 2012). Available at *http://www.arb.ca.gov/regact/2012/leviiighg2012/leviiighg2012.htm* (last accessed June 5, 2012).

[444] Id., CARB Resolution 12–11 at 20.

As discussed above, the agencies will conduct a comprehensive mid-term evaluation and agency decision-making process for the MYs 2022–2025 standards as described in the proposal. The agencies expect to continue ongoing stakeholder dialogue, including in depth technical dialogue with automakers on their confidential technology development efforts and product plans for MYs 2022–2025. EPA does not believe that additional or more frequent reports, as suggested by some commenters would be an efficient way to prepare for the mid-term evaluation.

Timeline and Process for Mid-term Evaluation

Several auto companies including Ford, Toyota and Porsche noted the importance of the agencies meeting the proposed November 15, 2017, deadline for issuing the draft Technical Assessment Report (TAR) so that there is adequate time for a reasonable public comment period while still insuring that EPA meet its proposed April 1, 2018 deadline for determining whether the standards established for MY2022–2025 are appropriate under CAA section 202(a). The Alliance of Automobile Manufacturers, Global Automakers, and the National Association of Manufacturers also expressed concern with the agencies' proposed schedule for undertaking the mid-term evaluation. These commenters recommended that additional details be written into the final regulatory text to provide more procedural certainty including: a start date for the evaluation, a schedule of major milestones, specific studies the agencies plan to conduct, and details of the peer review process. Toyota, Hyundai and Mercedes-Benz in their comments noted their support for these recommendations as well. Mitsubishi urged the agency to work with stakeholders well in advance of the mid-term to develop a sound review process and framework. Both the Union of Concerned Scientists and NRDC stated that the timing of the mid-term evaluation should be conducted as close as possible to the beginning of MY2022 so that the mid-term evaluation could most accurately capture the status of technology and the vehicle market for those model years under review.

EPA acknowledges the timing and other concerns raised by all commenters and continues to believe that the approach laid out in the proposal provides an appropriate balance between certainty and needed flexibility by providing end dates by which it must issue the draft TAR (November 15, 2017) and determine whether the MY2022–2025 standards are appropriate under section 202(a) of the Clean Air Act (April 1, 2018). Additional regulatory details on the timing or content of the mid-term evaluation are not needed and would not be an efficient way to prepare for and conduct the mid-term evaluation.

Additional Evaluation Factors Should Be Considered

In its proposal, EPA indicated that it would consider a range of relevant factors in conducting the mid-term evaluation, including but not limited to those listed in the preamble and proposed regulatory text. Quite a few commenters suggested that EPA expand the list of these high level factors. The Alliance of Automobile Manufactures recommended numerous additions to the list of factors including, ''current and expected availability of state and Federal incentives/subsidies for advanced technology vehicles,'' ''the end-of-life costs associated with advanced technology vehicles,'' and ''consumer demand for and acceptance of fuel-efficient technologies, and consumer valuation of fuel savings.'' Honeywell encouraged the agencies to, ''commit * * * to a detailed review of emerging boosting technologies that may considerably advance vehicle emissions and fuel economy performance during the later years of the rulemaking.'' The Institute for Policy Integrity commented that the agencies ''should amend their list of factors to specifically reflect any potential changes to benefits estimates, in addition to changes to costs or the state of technology.'' Mitsubishi Motors commented that the mid-term factors must include an evaluation of the sufficiency of the EV infrastructure, including whether there have been any significant industry-wide economic setbacks making EVs and other overall fuel economy targets impracticable, consumer acceptance of EVs and a thorough evaluation of an EV multiplier in MYs 2022 through 2025 in order to continue EV market penetration. Also, Mitsubishi noted that the mid-term should include consideration of compliance options for OEMs with limited product lines. The National Association of Clean Air Agencies (NACAA) suggested that EPA evaluate the use of credits by automobile manufacturers and the impact of credit use on average fleet performance. The Clean Air Association of the Northeast States for Coordinated Air Use Management (NESCAUM) noted that it expected EPA to monitor upstream emissions from the power grid to determine whether the improvements assumed to occur were realized. Finally, the Sierra Club recommended that the agencies provide the public with data on credit use by manufacturers, technology penetration both overall and by manufacturers, and sales by vehicle footprints. The Alliance for Automakers also indicated that the agencies should seek expert peer-reviewed information including the National Academy of Sciences to answer a number of questions associated with the Mid-term reviews.

A number of other commenters, including Ford, the UCS and ICCT supported the mid-term evaluation provisions as proposed by EPA. Ford commented that they believed the agencies had struck an appropriate balance between an exhaustive list and a high-level approach and pointed to proposed regulatory language ''including but not limited to * * *'' as critical language that should be maintained in final rule. Ford further noted that factors that turn out to be most important six years from now are not necessarily foreseeable today and not necessarily the ones listed in the proposed rule. The ICCT noted that ''it is impossible to define all the criteria for review at this time * * *'' And UCS agreed that ''a holistic assessment of all of the factors * * * without placing decisive weight on any particular factor or projects'' is the correct approach in conducting the mid-term evaluation.''

EPA is finalizing the list of factors as proposed.[445] We believe these factors are broad enough to encompass all appropriate factors that should be considered during the mid-term evaluation, and provide the agency with an appropriate balance in that the list identifies major factors to consider and includes a clear provision for inclusion of other appropriate factors. This avoids trying to identify in detail at this time the myriad issues and factors that will be of concern in the mid-term evaluation. As in this rulemaking, in the mid-term evaluation EPA expects to place primary reliance on peer-reviewed studies. Additionally, as NAS reports are published, EPA will give careful consideration to reports and their findings as well as any reports and findings from other scientific and technical organizations.

As discussed above, the MY2022–2025 GHG standards will remain in effect unless and until EPA changes them by rulemaking. The National Association of Manufacturers (NAM) commented that EPA should not take the default position that the existing 2022–2025 model year standards will remain in place unless changed by

[445] See § 86.1818–12 (h).

rulemaking. Rather, they argued the existing standards should be rescinded immediately upon a determination that they are inappropriate, leaving the 2021 standards in effect until the revised standards are finalized. Another commenter, Toyota requested that, ''in the event EPA does not take final agency action concerning the 2022–2025 model year standards by April 1, 2020, the 2021 model year GHG standards remain as the 'default' standards until such time as EPA does take final agency action providing at least 18-months of lead time prior to the applicable model year. EPA believes the appropriate approach is what was proposed; EPA is adopting the MY2022–2025 GHG standards at this time, and they will go into effect unless EPA revises them. The mid-term evaluation process is an effective and timely way to address any concerns that may arise in the future concerning the appropriateness of these standards. EPA believes this provides the right degree of certainty to the standards that are adopted today, along with a clear and effective mechanism for the timely evaluation of the standards and their revision if EPA determines in the future that they are no longer appropriate based on the circumstances at that time.

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. 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.[446] As proposed, EPA is continuing essentially the same comprehensive program for averaging, banking, and trading of credits as provided in the MY2012–2016 program, 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 which might otherwise arise, 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 and we view them as equally integral to the MY 2017–2025 standards.[447] As proposed, EPA is finalizing a change to 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. 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 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. The credit carry-back provisions allow a manufacturer to carry a deficit in its fleet average standards for up to three model years. 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 continuing with this approach for the MY 2017–2025 standards. (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 generally remain in place for MY 2017 and later, EPA is finalizing its proposal to allow all unused credits generated in MY 2010–2016 (but not MY 2009 early credits) to be carried forward through MY 2021. See § 86.1865–12(k)(6)(ii). 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 provides 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 early model years of today's program as they transition from the 2016 standards to the progressively more stringent standards for MY 2017 and later. It also provides an additional incentive for manufacturers to generate credits earlier, for example in MYs 2014 and 2015, because those credits may be used through MY 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 at issue would otherwise have been allowed to expire. Rather, the credits would be used or traded to other manufacturers.

EPA did not propose 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 GHG credits.[448] In response to these concerns, EPA placed restrictions on the use of MY 2009 credits (for example, MY 2009 credits may not be traded) and did not propose to expand opportunities for their utilization.

Transferring credits refers to exchanging credits between the two averaging sets, passenger cars and trucks, within a manufacturer. For example, credits accrued by over-compliance with a manufacturer's car fleet average standard could be used to offset debits accrued due to that manufacturer not meeting the truck fleet average standard in a given year. Finally, accumulated credits may be traded to another manufacturer. EPA is finalizing provisions consistent with MYs 2012–2016 to allow 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 provision just discussed above for a one-time extended carry-forward of MY2010–2016 credits), under EISA, credits generated in the CAFE program can be carried forward for 5 model years

[446] See 75 FR 25412–413.

[447] These reasons likewise underly EPA's decision to adopt similar types of ABT provisions in the GHG standards for heavy duty vehicles and engines. See 76 FR 57127–29.

[448] 75 FR 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.

or back for 3, and can also be transferred between a manufacturer's fleets or traded to another manufacturer. Transfers of credits across a manufacturer's car and truck averaging sets are also allowed under CAFE, 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.[449]

EPA received comments from manufacturers, suppliers, and others emphasizing the need for flexibility and supporting the credit programs in general. Manufacturers supported the proposed approach to the ABT program. Manufacturers commented that the one-time carry-forward of greenhouse gas reduction credits through the 2021 model year rewards early investment and provides better flexibility to account for market conditions that may impact year-over-year compliance. NESCAUM commented that allowing credit transfers between a manufacturer's passenger car and light truck fleet will facilitate compliance without reducing the GHG benefits of the program, as do provisions for carry-forward and carry-back of generated credits.

One commenter raised concerns regarding the ABT provisions. CBD commented that the proposed one-time carry forward of GHG credits was contrary to EISA provisions, and unjustified, and recommended that EPA not finalize the provision. CBD further commented similarly that, ''the Agencies may not increase the availability of credit transfers between the two fleets, passenger vehicles and light trucks. The existence of statutory caps for these transfers is a strong indication of Congressional disapproval of extending them further, and the Clean Air Act's silence on that issue does not override EISA's statutory restriction.''

EPA does not agree with these comments. The extension of the credit carry-forward provisions supports the ultimate objectives of CAA section 202 (a) by providing flexibility to achieve GHG emission reductions at lower cost, and to reduce the lead time needed to do so. And although the agencies have worked stringently to harmonize the two sets of standards under the different statutory authorities, the National Program also properly takes advantage of the additional flexibilities afforded by the CAA to achieve reductions of GHGs where appropriate to do so. See section I.B and I.D above (noting features such as more flexible credit generating and unlimited transferring mechanisms, and no option to pay fines in lieu of compliance). Since EPA believes that extending the carry-forward provision allows additional flexibility, encourages earlier penetration of emission reduction technologies sooner than might otherwise occur, and does so without reducing the overall effectiveness of the program. EPA is therefore extending the credit carry-forward provision as proposed.

Volkswagen recommended that EPA allow a 5 year carry back of debits, but did not provide supporting rationale as to why such a change is needed. As noted in section I.B above, EPA is retaining a 3 year credit carry-back due to concerns that a five year period could slow progress toward meeting standards, and could lead to situations where some manufacturers find it impossible to make up past year deficits. EPA believes that credit carry-back is an important flexibility because it allows manufacturers to address situations where they fall into a deficit because, for example, their fleet mix at the end of the year is not the same as the fleet mix anticipated at the beginning of the year. EPA is concerned that a longer period may encourage manufacturers to rely on deficits as a primary strategy to comply with the program and would slow the rate of progress manufacturers would make in reducing emissions.

Daimler Automotive Group commented that EPA should allow credits for Class 2b vehicles (heavy duty pickups and vans) generated in the medium duty GHG program to be applied in the light duty truck programs as well. Daimler commented that the medium duty GHG program for these vehicles has an ABT program which is similar to the light duty program and that these similarities should allow credits to be traded between them. In response, EPA believes such a change is outside the scope of the proposal as EPA did not propose any changes that would affect the heavy-duty vehicle standards. EPA believes the suggested approach raises significant issues regarding the potential impact on both programs, including competitiveness issues, which would need to be thoroughly explored through a notice and comment rulemaking process. Only a small portion of light-duty vehicle manufacturers produce vehicles in the heavy-duty category and EPA believes that it is important to maintain a level playing field for light-duty vehicle manufacturers not participating in the heavy-duty vehicle market. Moreover, the standards for heavy duty pickups and vans are based on a different attribute (a work factor attribute which is not determined exclusively by footprint) than the standards for light duty trucks, the projected technology basis for the standards differ, and the programs' model years do not coincide. Furthermore, it is possible that allowing credit transfers between heavy-duty and light-duty vehicles could impact stringency of both the light and heavy-duty standards. ABT provisions are an integral part of establishing appropriate standards under Section 202(a) of the Clean Air Act. In order to properly evaluate the implications of adopting such credit transfers, a detailed analysis would need to be done to assess the potential impacts of these types of credit transfers, with an opportunity for public review and input, and EPA has not performed such an analysis.[450] All of these factors require careful analysis before any decisions can reasonably be made regarding credit transfers between these different vehicle sectors.

5. Small Volume Manufacturer Standards

EPA is finalizing provisions, as proposed, allowing eligible small volume manufacturers (SVMs) the option to petition EPA to develop an alternative CO_2 standard for their company, determined on a case-by-case basis in a public process. An SVM utilizing this option will 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. The detailed approach being finalized for the SVM standards and the eligibility requirements for these standards, as well as comments received by EPA, are described in detail below. EPA is also extending eligibility for the SVM GHG provisions to very small manufacturers that are owned by large manufacturers but are able to establish that they are operationally independent. All of the comments EPA received on these issues supported the proposal to allow manufacturer-specific standards for SVMs, and also supported extending these provisions to include operationally independent manufacturers which are otherwise

[449] See generally 49 U.S.C. § 32903 and section IV below.

[450] In the heavy-duty vehicle and engine final rule, EPA noted that it intends to consider whether broader credit transfers are appropriate, including transfers between light and heavy-duty vehicles, as part of the next phase of the heavy-duty regulations. See 76 FR 57128.

SVMs. There are three manufacturers that meet the definition of SVM currently: Aston Martin, Lotus, and McLaren. 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.

In the MY 2012–2016 program, EPA recognized that for very small volume manufacturers, the CO_2 standards adopted for MY 2012–2016 would be extremely challenging and potentially infeasible for very small manufacturers, at least absent purchase of 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, and stated that we would establish appropriate SVM standards at a later time. See 76 FR 74988. As part of establishing eligibility for the exemption from the MY 2012–2016 standards, 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.

EPA continues to believe that 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 comments and discussions leading to the proposal, 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 vehicle 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.

Prior to EPA's proposal, the agencies held detailed technical discussions with the manufacturers eligible for the exemption under the MY 2012–2016 program and reviewed detailed confidential product plans of each manufacturer. Based on the information provided and subsequent public comments, 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 product offerings of SVMs. However, selecting a single set of standards that would apply to all SVMs would be difficult, if not unreasonable, because each manufacturer's product lines vary significantly. Standards 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 for them to reduce emissions. Therefore, EPA is finalizing, as proposed, a case-by-case alternative standard approach as a way to establish standards that will require SVMs to continue to innovate to reduce emissions and do their ''fair share'' under the GHG program.

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 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 established for them.[451] NHTSA has adopted alternative standards for some small volume manufacturers under these CAFE provisions and continually reviews applications as they are submitted.[452] 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 2012 vehicle models certified by large volume manufacturers that are comparable to the SVM's planned MY 2016 vehicle models.[453] 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. In their LEV III rule, CARB adopted SVM alternative CO_2 standard provisions that are essentially the same as those being finalized by EPA.[454] CARB also adopted provisions for operationally independent manufacturers, similar to those described in EPA's request for comments in the proposed rule.

The EU process allows small manufacturers to apply for a derogation from the primary CO_2 emissions reduction targets.[455] 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

[451] 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.

[452] Alternative CAFE standards are provided in 49 CFR 531.5(e).

[453] 13 CCR 1961.1(D).

[454] Final Regulatory Order, Amendments to Sections 1900, 1956.8, 1960.1, 1961, 1961.1, 1965, 1968.2, 1968.5, 1976, 1978, 2037, 2038, 2062, 2112, 2139, 2140, 2145, 2147, 2235, and 2317, and Adoption of new Sections 1961.2 and 1961.3, Title 13, California Code of Regulations, p. 82.

[455] 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.''

public.[456] 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 Framework for Case-by-Case SVM Standards

As proposed, SVMs will become subject to the GHG program beginning with MY 2017. Starting in MY 2017, SVMs will be required to meet the primary program standards unless EPA establishes alternative standards for the manufacturer. In addition, since SVMs will no longer be exempt from the program, they will no longer be required to seek to purchase credits from other manufacturers in order to maintain the exemption. As proposed, 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 will notify the manufacturer and provide an additional 30 days for the manufacturer to provide all necessary information. EPA will 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 will be available to the public for review in the docket. After a period for public comment, EPA will 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.

As proposed, manufacturers may 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 may 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, 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 does not apply to new market entrants, discussed in section III.C.5.e below. The subsequent case-by-case standard setting will follow the same notice and comment process as outlined above.

As proposed, 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. See 76 FR 74989. This provides assurance to manufacturers that they will have at least 12 months lead time to prepare for the upcoming model year.

EPA received comments from Aston Martin, Lotus, and McLaren (the three manufacturers potentially eligible for SVM standards based on their status under the MY2012–2016 program) fully supporting EPA's proposed approach to establishing alternative standards through a case-by-case manufacturer petition process. They commented that this approach is not only technically appropriate but that adopting the case-by-case SVM GHG mechanism would align EPA's approach with that of NHTSA, the EU, and CARB, furthering the desirable objective of harmonization.

EPA received comments from the Global Automakers that the standards should be issued at least 18 months prior to the first affected model year. Global Automakers did not provide supporting data or rationale for their comments and EPA did not receive similar comments directly from others, including the SVMs most directly affected. EPA is concerned with the timing suggested by the commenter. EPA expects that the EPA rulemaking process will take about 12 months, which would provide manufacturers with a minimum of 17 months lead time prior to the earliest possible start date for MY 2017, if they submit their petition by the July 30, 2013 deadline (August 1, 2014 to January 1, 2016). EPA views this scenario as worst case in terms of lead time because manufacturers may petition earlier than July 30, 2014 and also may begin their MY 2017 production later than January 1, 2016. EPA expects that in most cases, manufacturers will have more than 18 months lead time. In addition, lead time will be one of the primary considerations in determining the feasibility of potential alternative standards. EPA is retaining the 12 month lead time provisions as proposed, as EPA views the 12 month period as a reasonable balance between the timing constraints of establishing reasonable alternative standards prior to MY 2017 and the need to provide adequate lead time to manufacturers to meet those standards.

EPA requested comments on allowing SVMs to comply early with the MY 2017 SVM alternative standard established for them. As discussed in the NPRM, manufacturers may want to certify to the MY 2017 standards in earlier model years (e.g., MY 2015 or MY 2016). See 76 FR 74989. Under the MY 2012–2016 program, SVMs are eligible for an exemption from the CO_2 standards, but as part of the exemption are required to make a good faith effort to purchase credits from other manufacturers. By opting to certify early to the SVM alternative standard in lieu of this exemption, manufacturers would avoid having to seek out credits to purchase. As noted in the proposal, EPA would not allow certification for vehicles already produced by the manufacturer, so the applicability of this early opt-in provision would be limited to the later years of the MY 2012–2016 program, due to the timing of establishing the SVM standards. An early compliance option also may be beneficial for new manufacturers entering the market that qualify as SVMs.

EPA did not receive any critical comments and received supportive comments from the SVMs regarding its request for comment regarding early optional compliance. Therefore, EPA is including in the final program early opt-in provisions for manufacturers, allowing them the option of meeting their MY 2017 standard (i.e. the case-by-case standard adopted pursuant to the standards and procedures described

[456] *http://ec.europa.eu/clima/documentation/transport/vehicles/cars_en.htm*

below) in MYs 2015 and 2016. Manufacturers selecting this option will not be required to seek to purchase credits from other manufacturers in those earlier model years when they choose optional certification.

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. As proposed, SVMs petitioning EPA for alternative standards must submit the data and information listed below which EPA will use, in addition to other relevant information, in determining an appropriate alternative standard for the SVM. EPA will also consider data and information provided by commenters during the comment process in determining the final level of the individual SVM's standards. EPA did not receive comments on these data requirements.

SVMs must provide the following information as part of their petition for SVM standards:

Vehicle Model and Fleet Information

• MYs that the application covers—up to five 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 vehicles produced by other manufacturers similar to those produced by the petitioning SVM and certified in MYs 2012–2013 (or latest two 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 [457]

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

As proposed, EPA will weigh several factors in determining what CO_2 standards are appropriate for a given SVM's fleet. These factors will 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 will also consider opportunities to generate A/C and off-cycle credits that are available to the manufacturer. Lead time will 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. As proposed, these provisions will generally apply to SVM standards as well, with the exception that SVMs meeting alternative standards will not be allowed to trade credits (i.e., sell or otherwise provide) to other manufacturers. SVMs will 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 finalized, SVMs will be able to generate and use credits internally, under the credit carry-forward and carry-back provisions. Under a case-by-case approach, EPA does not view such credits as windfall credits and not allowing internal banking could stifle potential innovative approaches for SVMs. SVMs will also be able to transfer credits between the car and light trucks categories. EPA did not receive any comments regarding the ABT provisions as they apply to SVMs meeting alternative standards.

e. SVM Standards Eligibility

i. Current SVMs

The MY 2012–2016 rulemaking limited eligibility for the SVM exemption 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.[458]

[457] 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.

[458] 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.

As proposed, EPA is retaining the 5,000 vehicle cut-point and rolling three year average approach which we believe is appropriate as a primary criterion for eligibility as an SVM. The 5,000 vehicle sales threshold allows for some sales growth by SVMs, as the SVMs in the market today typically have annual sales of below 2,000 vehicles. 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 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. EPA did not receive comments on these provisions. As discussed below, EPA is not tying eligibility to having been in the market in MY 2008 or MY 2009, or in any other year, and is instead finalizing eligibility criteria for new SVMs newly entering the U.S. market.

ii. New SVMs (New Entrants to the U.S. Market)

The SVM exemption 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 did not propose to include such a provision for the SVM standards eligibility criteria for MY 2017–2025. See 76 FR 74991. 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, this type of eligibility condition could serve as a potential market barrier by hindering new SVMs from entering the U.S. market.

For new market entrants, EPA is finalizing the proposed provision allowing a manufacturer the option of applying for an alternative standard for MY2017–2025 pursuant to the criteria and process described above. The new SVM would not be able to certify their vehicles under the alternative standards until those standards are established. As discussed in the proposal, 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 the application and develop standards using the public process just described, and to provide necessary lead-time to the manufacturer. EPA received no adverse comments regarding the timing of the process contemplated in the proposal. In addition to the information and data described below, EPA is requiring 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, will provide evidence of the applicant's legitimacy. As part of this review, EPA reserves the right to not undertake its SVM standards development process for companies that do not exhibit a legitimate and documented effort to enter the U.S. market.

As discussed in the proposal, 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. See 76 FR 74991. EPA believes that it would not be appropriate to establish alternative SVM standards for a new market entrant that plans a steep ramp-up in U.S. vehicle sales. Therefore, as proposed for new entrants, U.S. vehicle sales must remain below 5,000 vehicles for the each of its 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). The certificate(s) of conformity for vehicles sold by new entrant SVMs will be conditioned on staying within the sales threshold, as provided in § 40 CFR 86.1848. If a new market entrant sells more than this number of vehicles for the first five years in the market, vehicles sold above the 5,000 vehicle threshold will not be covered by the alternative standards. In such cases where the resulting fleet average is not in compliance with the standards, the manufacturer will be subject to enforcement action and the manufacturer will also 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 will be possible for a manufacturer already in the market that drops below the 5,000 vehicle threshold in a future year to attempt to establish eligibility. As proposed, EPA will 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 will not apply. EPA did not receive comments regarding the above provisions for SVM new market entrants.

iii. Corporate Ownership 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.[459] As proposed, EPA is generally retaining these aggregation provisions as part of the eligibility criteria for the SVM standards for MYs 2017–2025.[460] However, as discussed below, EPA requested comment on and is finalizing provisions allowing manufacturers that otherwise would not be eligible for the GHG SVM provisions due to these aggregation requirements, to demonstrate to the Administrator that they are ''operationally independent'' based on the criteria described below. If the Administrator determines that a manufacturer is operationally

[459] For other programs, the eligibility cut point for SVM flexibility is 15,000 vehicles rather than 5,000 vehicles.

[460] 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.

independent, that manufacturer will be eligible for the alternative SVM CO_2 standards as well as the remaining years of the MY 2012–2016 exemption even if the manufacturer is more than 10 percent owned by another firm.

As we noted at proposal, Ferrari requested in its comments to the proposed 2012–2016 GHG standards that manufacturers be allowed 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 current eligibility criteria for SVM status. However, Ferrari believed that it would qualify as ''operationally independent'' under appropriate criteria and would qualify as an SVM for the GHG program if evaluated independent of the other Fiat brands. 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) and EPA pursued the issue further in this proceeding. See 76 FR 74991–92. Specifically, we sought comment on expanding eligibility for the SVM GHG standards and provisions to manufacturers who would have U.S. annual sales of less than 5,000 if its own vehicles based on a demonstration that they are ''operationally independent'' of other companies because it operates its research, design, production, and manufacturing independently from the parent company.

In particular, EPA requested 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 requested comment on the concern that manufacturers could change their corporate structure to take advantage of such provisions (that is, gaming). EPA requested comment on approaches 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 requested comments on the possible implications of this approach on market competition. EPA acknowledged 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 requested 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.

All of the comments on this issue supported allowing manufacturers to qualify for alternative standards based on a showing of operational independence. Ferrari commented in full support of the operational independence concept and the criteria laid out in the proposal, stating that the GHG standards could otherwise severely limit Ferrari in the U.S. market. Several Ferrari dealers commented in the support of the operational independence provision, citing potential for loss of sales and jobs at dealerships if this provision were not finalized. Global Automakers also strongly supported the operational independence provisions.

With regard to EPA's request for comments regarding the potential for gaming, Ferrari commented that the criteria considered by EPA, discussed below, will serve as a sufficient safeguard. Ferrari commented that the cost of restructuring a company to separate all design, R&D, production and testing facilities from the parent company, along with the expense of developing completely new powertrains and platforms, would be prohibitively expensive. Ferrari also commented that the requirements for a newly spun-off manufacturer to establish itself as operationally independent over a two year period, during which the company will have to meet the GHG standards in order to remain in the U.S. market, will also discourage potential gaming. Several Ferrari dealers also commented that the criteria will ensure that a manufacturer seeking operational independence is truly independent. The Global Automakers commented that the criteria are sufficiently stringent and there would be virtually no ability for manufacturers to abuse the operational independence provision.

EPA is finalizing the operational independence criteria listed below, which were detailed in the request for comments in the proposal (see 76 FR 74992). 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 determining eligibility for the GHG SVM program. Manufacturers must 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).

As proposed, EPA will determine based on information provided by the manufacturer in its application, if the manufacturer currently meets the following criteria and has met them for at least 24 months preceding the application submittal and is therefore operationally independent:

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. The applicant maintains separate and independent research and development, testing, and manufacturing/production facilities.

3. The applicant does not use any vehicle engines, powertrains, or platforms developed or produced by related manufacturers.

4. Patents are not held jointly with related manufacturers.

5. The applicant maintains separate business administration, legal, purchasing, sales, and marketing departments as well as 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.

Volkswagen commented in support of the operational independence provision, but raised concerns that the above criteria are too prescriptive and difficult to apply across all circumstances of captured small volume brands. Volkswagen requested that EPA ''consider the operational independence of each manufacturer on an individual basis during the petition process. As such the degree of independence could be part of the negotiation process for setting standards for a particular SVM.'' In response, the criteria were not intended to apply to ''all circumstances'' of captured brands. The criteria were written narrowly to purposely exclude captured brands that are integrated or managed by the parent company in any substantive way. EPA's intention, as described in the proposal, is to include only companies that can be demonstrated to be completely independent, held at arm's length by the parent company without access to the resources of the parent company or related manufacturers. Further, EPA is concerned that broadening the criteria in ways suggested by the commenter would lead to gaming issues EPA is seeking to avoid, as discussed above. EPA believes that it is important to retain the above criteria in order to avoid having to make determinations regarding ''degrees'' of independence.

In addition to the criteria listed above, EPA is finalizing the following programmatic elements and framework. EPA is 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.[461] 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. Ferrari submitted supportive comments on using the EPA fuel programs as a template for the attest engagement provisions. EPA is also requiring that the application be signed by the company president or CEO.

After EPA approval, the manufacturer will be required to report within 60 days any material changes to the information provided in the application. A manufacturer will lose eligibility automatically after the material change occurs. However, EPA will confirm that the manufacturer no longer meets one or more of the criteria and thus is no longer considered operationally independent, and will notify the manufacturer. In such cases, EPA will provide two full model years lead time after the MY in which the manufacturer loses eligibility for the manufacturer to transition to the primary program standards. For example, if the manufacturer lost eligibility sometime during the manufacturer's model year 2018 (based on when the material change occurs), the manufacturer would need to meet primary program standards in MY 2021. A manufacturer losing eligibility must subsequently meet the criteria for three consecutive years before it would be allowed to petition to re-establish operational independence.

6. Additional Lead Time for Intermediate Volume Manufacturers

EPA is finalizing provisions to allow additional lead time for intermediate volume manufacturers that sell less than 50,000 vehicles per year, for the first four years of the program (MY 2017–2020). The 2012–2016 GHG vehicle standards include Temporary Lead Time 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 civil penalties instead of complying with CAFE standards, and limited line manufacturers facing special compliance challenges due to less flexibility afforded by averaging, banking and trading. The TLAAS includes additional flexibility for manufacturers with MY 2009 sales of less than 50,000 vehicles through MY 2016. For manufacturers with sales of greater than 50,000 vehicles (but less than 400,000), the program ends in MY 2015. See 75 FR 25414–416.

EPA did not propose to continue the TLAAS program for MYs 2017–2025. See 76 FR 74994. 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 civil penalties in lieu of compliance, 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 begin. More importantly, the Temporary Lead Time Allowance was just as the name describes—temporary—and EPA provided it to allow manufacturers to transition to full compliance in later model years. See 75 FR 25416. EPA received one comment, from Natural Resources Defense Council, generally supporting EPA's decision not to propose an extension of the TLAAS program.

EPA also requested comment on whether there is a need to provide some type of additional lead time for intermediate volume, limited line manufacturers. Prior to proposal, one company with U.S. sales on the order of 25,000 vehicles per year presented confidential business information indicating that it believes that the CO_2 standards for MY2017–2025 would present significant technical challenges for their company, due to the relatively small volume of products it sells in the U.S., its 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. (thus affecting their ''brand'') beginning in model year 2017, even if it adds substantial CO_2 reducing technology to its vehicles. EPA noted in its request for comments that 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). See 76 FR 74995.

Public comments supported the concept of providing additional flexibility for limited line intermediate volume manufacturers. In particular, EPA received comments from Jaguar Land Rover, Porsche, and Suzuki supporting approaches that would provide intermediate volume manufacturers with additional flexibility. These three manufacturers are eligible under the MY 2012–2016 program for the expanded TLAAS provisions through MY 2016, based on their MY 2009 sales of less than 50,000 vehicles.

Jaguar Land Rover (JLR) commented that they will be achieving very significant CO_2 reductions well in excess of industry averages. However,

[461] EPA has required attest engagements as part of its fuels programs. See 40 CFR § 80.125, 40 CFR § 80.1164 and § 80.1464.

JLR further commented that the required rates of reduction implied by the proposed curves between MY2016 and MY2017 are very challenging for lower volume, limited line manufacturers coming out of the expanded TLAAS program. JLR further commented that companies participating in the expanded TLAAS program in MY 2016 will start MY 2017 with either no CO_2 credits banked or CO_2 debits carrying forward. JLR provided confidential information regarding the companies' projected situation in the early years of the MY 2017–2025 program. JLR requested in their comments that EPA consider phasing in the MY 2017 and later program for lower volume, limited line niche manufacturers when the expanded TLAAS program ends, starting in MY 2017 and ending with MY 2021 production, with full compliance with the primary program standards in MY 2022.

Porsche commented that the transition from TLAAS to the base standards is a disproportionate burden for niche carmakers, and that the transition cannot be accomplished by gradual incremental improvements. Porsche commented that their development costs for new technology cannot be spread over a large fleet to take advantage of natural economies of scale, and that there is a disproportionate financial impact on small manufacturers, due to higher per unit cost. Porsche further commented that larger competitors can support sports car sales by fleet averaging over a broad range of products, and that their smallest competitors (SVMs) can request alternate CO_2 standards. Porsche commented that it cannot utilize either of these options. Porsche noted that EPA projected in the NPRM far greater penetration of electrification for them than for any other manufacturer. For example, EPA projected in the proposal a 30 percent HEV and 24 percent PHEV/EV penetration for Porsche in 2021. See 76 FR 75073. Porsche commented that, in the absence of relief, Porsche would face a 25 percent reduction in the GHG standards at the expiration of MY 2016, and that the proposed standards would create a hurdle that would drive them from the marketplace.

Porsche recommended three possible approaches to address their concerns; a fixed alternative standard with a program like TLAAS, case-by-case standards setting based on the performance of competitor vehicles similar to the approach proposed for SVMs, or an alternative phase-in that mitigates the potential 25 percent drop in standards in MY 2017 after TLAAS expires.

Suzuki similarly commented raising concerns that the proposed standards did not adequately recognize the lead time concerns of low-volume, limited line manufacturers like Suzuki. Suzuki commented that ''when small-volume manufacturers need to develop new technology and develop a new model/new engine to make the significant improvements necessary to comply with the proposed standards, the per-vehicle cost for the special development that is needed specifically for the U.S. market is much higher than for manufacturers with larger sales volumes.'' Suzuki suggested that EPA provide three years additional lead time to manufacturers with average U.S. sales of less than 50,000 vehicles. Under Suzuki's suggestion, such manufacturers would not be required to meet the MY 2017 standards until MY 2020 and would be required to meet MY 2018–2025 standards until MY 2021–2028. Suzuki did not provide any data or information regarding their fleet or plans for technology introduction in support of their comments.

After reviewing the comments and the feasibility issues potentially facing these manufacturers in the early years of the program, EPA is finalizing additional lead time provisions for intermediate volume manufacturers. The additional lead time will help manufacturers transition from the expanded TLAAS program in MY 2016 to the primary standards being adopted for MY 2017–2025, by helping to mitigate the steep increase in standard stringency that would otherwise occur for them in the MY 2016–2017 time frame. As discussed in the feasibility section III.D, the standards will be especially challenging for them. Also, intermediate volume manufacturers have limited ability to average due to their limited product line and will not have credits available from their own fleet due to the credit restrictions included in the TLAAS program. It is possible that the manufacturers could purchase credits from other manufacturers (and eligibility for the expanded TLAAS provisions requires manufacturers to exhaust credit purchasing opportunities), but the availability of credits is highly uncertain due to the competitive nature of the auto industry and the one time carry forward credit provision to 2021.

Manufacturers participating in the expanded TLAAS program in MY 2016 will be eligible for the additional lead time shown in the table below. Manufacturers not eligible for the expanded TLAAS program, including new market entrants, will not be eligible for the additional lead time.[462] EPA is structuring eligibility in this way because manufacturers meeting the primary program standards in MY 2016 will not be facing such a steep change in stringency in the early years of the program. As shown in the table below, in MY 2017–2018 intermediate volume manufacturers must meet their MY 2016 base standards that would have applied in MY 2016 under the primary program (i.e., in the absence of TLAAS). In effect, this requires the manufacturers to meet the standards that would have applied in MY 2017 absent the new standards being set in this MY 2017–2025 rule. By MY 2021, the manufacturer must be fully compliant with the primary MY 2021 standards.

TABLE III—12—ADDITIONAL LEAD TIME FOR INTERMEDIATE VOLUME MANUFACTURERS

Model year	Primary program standards that apply
2017	MY 2016.
2018	MY 2016.
2019	MY 2018.
2020	MY 2019.
2021	MY 2021 (full compliance).

EPA recognizes that the additional lead time being finalized does not provide the full level of relaxation recommended by the commenters and that the standards remain very challenging for these intermediate sized companies. However, EPA believes that the additional lead time provided will be sufficient to ease the transition to more stringent standards in the early years of the 2017–2025 program that could otherwise present a difficult hurdle for them to overcome. In this regard, we received comments, consistent with our assessment, indicating that additional lead time should be sufficient to allow manufacturers to meet the standards. The added lead time will allow manufacturers to better plan the introduction of technologies to bring them into compliance with the primary standards. Also, EPA is not adopting any restrictions on credit banking such as those contained in the MYs 2012–2016 TLAAS program, allowing intermediate volume manufacturers to bank credits in these years to further help smooth the transition from one model year to the next. EPA is, however, prohibiting any intermediate volume manufacturer opting to use these provisions from trading credits

[462] Expanded TLAAS is available only to manufacturers in the market in MY 2009 with annual U.S. sales of less than 50,000 vehicles.

generated under the alternative phase-in to another firm for the same reasons credit trading cannot be used by small volume manufacturers. Furthermore, because EPA believes it is reasonable, based on intermediate volume manufacturer comments and on the analysis in section III.D.6 below (documenting compliance paths for all manufacturers), for these manufacturers to achieve the primary standards by MY 2021, EPA does not believe that any further lead time is warranted. Since it is important to limit as much as possible the loss of emissions reductions associated with the additional flexibility provided, EPA is not adopting permanent alternative standards, longer phase-ins, or other flexibilities for intermediate volume manufacturers.

Porsche noted that the company submitted comments under the assumption that they would remain independent from Volkswagen and that if the status of their relationship changed such that a supplement to their comments would be in order, Porsche reserved the possibility that it may submit such comments. On August 1, 2012, VW completed its acquisition of 100 percent of Porsche's automotive business.[463] It is EPA's expectation that Porsche will no longer be eligible for the lead time provisions discussed above for MY 2017–2020. EPA expects that Porsche's fleet will be absorbed into VW's fleet for purposes of determining compliance with the GHG standards. Nevertheless, EPA has considered Porsche's comments and recommendations with regard to intermediate volume manufacturers.

7. Small Business Exemption

EPA is finalizing, as proposed, a provision to exempt small businesses from the MY2017–2025 standards, as well as establishing a voluntary opt-in provision for those small business manufacturers that wish to certify to the GHG standards in order to generate and sell credits.[464] 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.[465] The small business size criterion for vehicle manufacturers is less than 1000 employees. 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. As proposed, EPA is continuing this exemption for the MY 2017–2025 standards. EPA did not receive any adverse comments regarding continuing the exemption for small businesses, as defined.

EPA has identified about 24 entities that fit the Small Business Administration (SBA) size criterion of a small business. EPA estimates there currently are approximately five small manufacturers including three electric vehicle small business vehicle manufacturers that have recently entered the market, eight ICIs, and eleven 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.I.3 of this preamble, and in RIA Chapter 9.

At least one small business manufacturer, Fisker Automotive, in discussions with EPA prior to proposal, 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. As discussed in the proposal, 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 to encourage commercialization of the innovative technology. There would likewise be a benefit to any manufacturer seeking those credits to meet their compliance obligations. EPA proposed and is finalizing allowing small businesses to waive their small entity exemption and opt-in to the primary GHG standards based on this same rationale. This will allow small business 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. The small business would have to meet the primary standard for its fleet (that is, the small business would be allowed to opt-in to the primary program standard, but not the small volume manufacturer standards, since SVMs that receive approval of alternative standards are not eligible to generate credits for trading as explained above). As proposed, manufacturers waiving their small entity exemption must meet all aspects of the GHG standards and program requirements across their entire product line.

EPA proposed 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. See 76 FR 74994. EPA proposed this timing to avoid retroactively certifying vehicles that have already been produced. EPA proposed, however, 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 25441.

EPA received comments from Fisker requesting that EPA reconsider the timing of the opt-in provisions. Fisker commented that under EPA's proposal, manufacturers would not be able to generate credits until the end of MY 2014, even for vehicles that are produced in MYs 2012–2013. Fisker commented that this would significantly diminish the revenue generating benefit of these credits, particularly during the critical early years of their company when potential credit revenues would be of most benefit to the company. EPA is persuaded by this reasoning, and the final rule therefore provides that the opt-in provisions begin with MY 2013. See § 86.1801–12(j)(2)(i). The timing of the final rule will allow the GHG requirements to be integrated into the MY 2013 certification process for these small businesses. Once the small business manufacturer opting into the GHG program completes certification for MY 2013, the company will be eligible to generate GHG credits for their MY 2012 production. Manufacturers will not have to wait until the end of MY 2013 to generate MY 2012 credits. EPA believes this provision is responsive to the concerns of the commenter while still ensuring that the manufacturer is certified under the GHG program prior to generating credits.

EPA also received comments from Vehicle Production Group that small business entities are discussed in terms of small volume manufacturers,

[463] ''Volkswagen and Porsche finalize creation of Integrated Automotive Group,'' Volkswagen news release, August 1, 2012.

[464] Note that 'small businesses' are not the same as small volume manufacturers. The potential overlap of these terms is discussed later in this preamble sub-section.

[465] See final regulations at 40 CFR 86.1801–12(j).

independent commercial importers, and alternative fuel converters, and that limited line manufacturers should be added to the list of types of small entities affected. EPA is clarifying that, as proposed, manufacturers meeting the SBA definition of small business (1,000 employees) are exempt regardless of their production volume or number of vehicle lines produced. Also, not all small volume manufacturers qualify as small businesses, and EPA is adopting special provisions for SVMs that are non-small business companies. See Section III.B.5. EPA did not propose to change the use of the SBA definition for determining whether a manufacturer is considered a small business. EPA does not believe that using the number of vehicle lines is appropriate to determine eligibility for the small business exemption. This approach would create a loophole for large manufacturers producing a limited product line for the U.S. market and such a manufacturer would potentially be capable of selling a large volume of vehicles under such an exemption.

8. Police and Emergency Vehicle Exemption From GHG Standards

EPA is finalizing its proposal to exempt police and other emergency vehicles from the GHG standards, starting in MY2012. 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 is adopting an exemption parallel to the EPCA exemption allowing manufacturers to exempt police and emergency vehicles upon sending notification to EPA (the same notification that is sent to NHTSA would suffice). 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.[466,467] EPA continues to believe it is appropriate to provide an exemption at this time 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. As proposed, EPA is exempting 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.'' [468]

EPA received comments from manufacturers supporting the proposed emergency vehicle exemption and harmonization with the EPCA exemption. Ford further commented that without the exemption, ''manufacturers may be forced to choose between (1) deciding whether to degrade the performance of the emergency vehicles, (2) deciding to restrict the sales of its emergency vehicles, potentially even exiting the market altogether, or (3) facing non-compliance with the federal GHG standards.'' [469] EPA also received comments from Pennsylvania Department of Environmental Protection that the new technologies to generate more horsepower can be used to downsize a vehicle's engine and that ''No logical reason seems to exist as to why this new technology cannot be used for police and emergency vehicles in order to gain fuel efficiency without loss of power. Police and emergency vehicles constitute a large fleet in the United States; not including them so they can benefit from the same GHG-reducing technology would be unfortunate.''

As discussed in the proposal, 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 remains concerned that manufacturers may not be able to sufficiently reduce the emissions from these vehicles, and absent an exemption 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. EPA continues to believe that 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 vehicles with these performance characteristics must continue to be made available in the market. Therefore, EPA is finalizing the proposed exemption for police and emergency vehicles and thus not including these vehicles in the National Program at this time. 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 received comments from manufacturers that EPA should exempt police and emergency vehicles from the CH_4 and N_2O standards as well as the fleet-average CO_2 standards in order to ensure full consistency with CAFE. EPA understands that the NPRM was unclear on this point and EPA is clarifying that the exemption applies to the overall GHG program including the N_2O and CH_4 standards.

EPA received comments from Vehicle Production Group that the police and emergency vehicle exemption should be expanded to include vehicles manufactured ''for the public good,'' which would include vehicles manufactured for the specific purpose of transporting wheelchair users. EPA is not expanding the police and emergency vehicle exemption to include vehicles used ''for the public good'' as this term is not defined in current regulations and is not included in the EPCA exemption. EPA also does not believe that these other types of vehicles are designed for the severe duty cycles that are experienced by police and emergency vehicles, and therefore do not face the same potential constraints in terms of vehicle design and the application of technology.

[466] 75 FR 25409

[467] Manufacturers may 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.

[468] 49 U.S.C. 32902(e)

[469] Ford's comment was originally submitted for the MY 2012–2016 rulemaking and is incorporated by reference into Ford's comments in the MY 2017–2025 rulemaking. See Docket items EPA–HQ–OAR–2009–0472–7082.1 and EPA–HQ–OAR–2010–0799–9463, respectively.

9. Nitrous Oxide, Methane, and CO_2-Equivalent Approaches

EPA is not amending the standards for nitrous oxides (N_2O) or methane (CH_4) adopted in the 2012–2016 light-duty vehicle GHG rules. These standards serve to cap emissions of N_2O and CH_4, and generally ensure that emissions of these GHGs will not increase above current levels. The issues addressed in this rulemaking relate to means of demonstrating and documenting compliance with these standards. As proposed, EPA is extending to MY 2017 and later the provisions allowing manufacturers to use CO_2 credits on a CO_2-equivanent basis to comply with the standards for N_2O and CH_4. EPA is also finalizing additional lead time for manufacturers to use compliance statements in lieu of N_2O testing through MY 2016, as proposed. In addition, in response to comments, EPA is allowing the continued use of compliance statements in MYs 2017–2018 in cases where manufacturers are not conducting new emissions testing for a test group, but rather carrying over certification data from a previous year. EPA is also clarifying that manufacturers will not be required to conduct in-use testing for N_2O in cases where a compliance statement has been used for certification. All of these provisions are discussed in detail below. The Response to Comments document provides a full review of all comments received by EPA on issues relating to the standards for N_2O and CH_4.

a. N_2O and CH_4 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 later vehicles. 75 FR 25421–24. The light-duty vehicle standards for N_2O and CH_4 were established to cap emissions of these GHGs, where current levels are generally significantly below the cap. The cap were intended to prevent future emissions increases, and these standards were generally not expected to result in the application of new technologies or significant costs for manufacturers using current vehicle designs. In the MY 2012–2016 rule, 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.[470] 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 74211. As we noted at proposal, this could be especially challenging in the early years of the MY 2012–2016 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 CO_2-equivalent fleet-wide option ''penalizes'' manufacturers that choose this option, 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, EPA has already amended the MY 2012–2016 standards (as part of the heavy-duty GHG rulemaking) to allow manufacturers to use CO_2 credits, on a CO_2-equivalent basis, to meet the light-duty N_2O and CH_4 standards in MYs 2012–2016.[471] Manufacturers have the option of using CO_2 credits to meet either or both the N_2O standard and the CH_4 standard on a test group basis as needed. In their public comments to the proposal (in the heavy-duty rulemaking) on this issue, manufacturers urged EPA to extend this flexibility for model years after 2016, as they believed this option was more advantageous than the CO_2-equivalent fleet wide option (discussed previously) already provided in the light-duty MY 2012–2016 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 for post-2016 model years in the light-duty program would make the light- and heavy-duty GHG programs more consistent. In the final rule for heavy-duty vehicle GHG standards, EPA noted that it intended to consider this issue further in the context of new standards for MYs 2017–2025, in the then-planned future light-duty vehicle rulemaking. 76 FR 57194.

Acting on this intention, EPA proposed to extend the option of using CO_2 credits on a CO_2-equivalent basis to meet the light-duty vehicle N_2O and CH_4 standards for MYs 2017 and later. EPA is adopting this provision as proposed. EPA continues to believe that allowing use of 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. All of the comments on this issue from automakers and others supported extending this option beyond MY 2016.[472]

EPA also requested comment on establishing an adjustment to the CO_2-equivalent standard for manufacturers selecting the CO_2-equivalent option. See 76 FR 74993. Under the approach described in the proposal, 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 an agency-established adjustment factor to the CO_2-equivalent standard which would slightly increase the amount of allowed fleet average CO_2 equivalent emissions for the manufacturer's fleet. 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 purpose of this adjustment would be so manufacturers do not have to offset the typical N_2O

[470] 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 1995 IPCC Second Assessment Report (SAR) are used in the official U.S. GHG inventory submission to the United Nations Framework Convention on Climate Change (UNFCCC) per the reporting requirements under that international convention. The UNFCCC recently agreed on revisions to the national GHG inventory reporting requirements, and will begin using the 100-year GWP values from AR4 for inventory submissions in the future. According to the AR4, N_2O has a 100-year GWP of 298 and CH_4 has a 100-year GWP of 25.

[471] See 76 FR 57193–94.

[472] There likewise was no opposition to EPA's earlier proposal to amend the MYs 2012–2016 light-duty GHG standards to allow this option.

and CH_4 vehicle emissions, while holding manufacturers responsible for higher than average N_2O and CH_4 emissions levels reflected by the adjustment factor. EPA did not set out in the proposal a specific adjustment value due to a current lack of test data on estimated in-use N_2O emissions on which to base the adjustment value for N_2O. EPA requested comment on actual N_2O data which could be used as the basis for such an adjustment.[473]

EPA received comments both in support of and against establishing an adjustment factor for the fleet-wide CO_2-equivalent option. Volkswagen commented in support of an adjustment factor, pledging to work with EPA to generate proper data such that an appropriate adjustment factor could be established. General Motors (GM) disagreed with establishing an adjustment factor, arguing that using an average value for all passenger cars and light trucks to establish an adjustment factor will inherently and unduly lessen the stringency of some manufacturers' fleet average standard while increasing the stringency for others. In light of the concerns voiced by GM and a lack of data on which to base an adjustment factor for N_2O, EPA is not adopting such an approach. Thus, the CO_2 equivalent option as adopted in the MY2012 and later program, and described above, remains in effect.

GM commented that a second approach would be to modify the CO_2-equivalent equations instead of adjusting the CO_2 standard. GM commented that currently if a manufacturer chooses the option to use the CO_2-equivalent carbon related exhaust emissions (CREE) equations, it has to include all CH_4 and N_2O emissions which would result in an increase of up to approximately 3 g/mile for vehicles that would have otherwise been able to meet the N_2O and CH_4 emission standards. So, in order to make the CO_2-equivalent option more appealing, EPA would have to modify the CO_2-equivalent equations in such a fashion as to not penalize a manufacturer for meeting the current CH_4 and N_2O emission standards while still including a mechanism that would require a manufacturer to account for exceedances of the standards (i.e., fold in only CH_4 and N_2O emissions above their respective standards). EPA has considered this suggestion and believes it offers essentially the same flexibility that we are adopting in today's final rule; allowing CO_2 credits on a CO_2-equivalent basis to be used to offset exceedances of the N_2O and CH_4 standards. Because the suggested option is effectively the same as the flexibility already being finalized for MYs 2017 and beyond, EPA is not including such an approach in this final rule.

EPA also received comments from Global Automakers regarding the CO_2-equivalent fleet option provisions which require that manufacturers selecting the option use it for both their car and light truck fleets, and for both N_2O and CH_4. Global Automakers commented that they would like to see an allowance to use different compliance options for CH_4 and/or N_2O and also for passenger car and light truck fleets in the same model year. Global Automakers further commented that the restrictions limit manufacturers' compliance options without clear environmental benefit. In response, EPA is concerned that opening the program to allow manufacturers to mix their compliance options in this way would add to the complexity of the program in terms of tracking compliance, without providing meaningful additional flexibility to the manufacturer not already provided by allowing CO_2 credits to be used to offset exceedances of either the CH_4 or N_2O standards on a vehicle test group basis. Global Automakers did not provide comments regarding why this type of flexibility would be useful to manufacturers or examples of how it would be used in lieu of other compliance options. Therefore, EPA is not adopting these requested changes for the fleet-wide CO_2-equivalent 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 25423. This flexibility provided manufacturers with lead time needed to make necessary facilities changes and install N_2O measurement equipment.

In the MY 2017–2025 proposal, EPA proposed to extend the ability for manufacturers to use compliance statements based on good engineering judgment in lieu of test data through MY 2016. See 76 FR 74994. Prior to proposal, manufacturers 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 had involved a greater level of effort than previously expected. EPA evaluated new instruments for N_2O measurement and discussed in the proposal that newer instruments evaluated since the time of the 2012–2016 rulemaking have the potential to provide more precise emissions measurement. EPA believed that it would be prudent to provide manufacturers with additional time to evaluate, procure, and install the new equipment in their test cells.[474] EPA proposed that beginning in MY 2017, manufacturers would be required to measure N_2O emissions to verify compliance with the standard. This approach would provide the manufacturers with two additional years of lead-time to evaluate, procure, and install N_2O measurement systems throughout their certification laboratories.

EPA is finalizing the additional lead-time for N_2O testing essentially as proposed. As discussed below, in response to comments, EPA is temporarily (for MYs 2017 and 2018) allowing manufacturers to continue to use compliance statements for test groups certified using carry-over data. EPA is also clarifying, in response to comments, that manufacturers will not be required to conduct in-use testing for vehicle test groups certified using a compliance statement.

EPA received several comments from manufacturers regarding N_2O testing. Manufacturers remain concerned that test equipment will not be available in time to provide accurate measurement for MY 2017 and some recommended that EPA re-evaluate N_2O testing as part of the mid-term review. The Alliance commented that there is currently no accurate measurement technology available that is suitable for high-volume testing and that laser based N_2O analysis is so new that most of the instruments are still in the development stages and hence are prototypes. The Alliance commented that it would take 4.5 years to install a new analyzer in a single test site and therefore testing would not be ready until MY 2019. Global Automakers commented that that the Non-Dispersive Infrared Analyzer (NDIR) and Fourier Transform Infrared (FTIR) bag analysis methods currently have repeatability, durability and/or practicality concerns. Hyundai and Volvo expressed a preference for bag measurement methods to minimize testing throughput and also noted that no new equipment is available for this type of testing.

In response, although EPA recognizes manufacturers' concerns about the

[473] See 76 FR 74993.

[474] "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.

challenges associated with the measurement of N_2O, we are confident that the improvements in N_2O measurement technology over the past few years, specifically with respect to the development of laser source based instruments, has provided an avenue for accurate low-level N_2O measurement.

At this time we are aware of four manufactures of laser source instruments, and we have evaluated the instruments from three of these manufacturers. Horiba's MEXA–1100QL and Sensors' LASAR systems have performed very well and are suitable for measurement of N_2O from light-duty passenger vehicles. We also note that the gas chromatograph-electron capture detector (GC–ECD) still remains a viable option for low level measurement of N_2O.[475]

Our evaluations of these N_2O measurement systems have shown how measurement technologies have evolved over time. While we have acknowledged the challenges associated with measurement using photoacoustic spectroscopy (PAS), non-dispersive infrared spectroscopy (NDIR), and Fourier transform infrared spectroscopy (FTIR); the laser source systems have been shown to be a marked improvement.

In an initial evaluation of existing N_2O measurement technologies, EPA found that interference from CO, CO_2, and H_2O was contributing positive error (high bias) for PAS, NDIR, and FTIR technologies. It was also thought that a small amount of error could be attributed to bag blending error. EPA's subsequent evaluations of laser source instruments have shown marked improvement in measurement accuracy and elimination of interference, leaving just a small amount of measurement error associated with EPA bag blend measurements, which is primarily due to blending error.[5] The Alliance points out that our N_2O measurements are slightly low, while NDIR measurements of CO and CO_2 are slightly high. The Alliance points to interference as the culprit. We would like to point out that our NDIR instruments have internal compensation detectors that internally correct for the effects of CO, CO_2, and H_2O interference on the measurement of CO and CO_2. Thus the error shown in these measurements is not due to interference effects, but rather to bag blend errors. These blending errors are also responsible for the slight underreporting of N_2O as measured by the laser instruments, keeping in mind that any associated interference would have biased the N_2O measurements high, not low.

With respect to timing, we do not see why it would take 4.5 years to properly install a new N_2O analyzer into a single test site. While we understand that some time is needed for manufacturers to determine which measurement technology to purchase, we would expect the time to evaluate, procure, and install one of these instruments to be more like one year, which is the timing EPA has experienced with acquiring these instruments at our National Vehicle and Fuels Emissions Laboratory.

The Alliance also recommended that the requirement to measure N_2O only be applied to new emission certification programs that are implemented after the establishment of proper N_2O measurement instrumentation and procedures. Manufacturers routinely use ''carryover'' emissions certification and durability data from a previous model year in lieu of repeating the same emission tests. The Alliance commented that assuming that N_2O measurement capabilities are not available until the MY 2017, manufacturers would be forced to rerun all of their emission durability and certification testing in one model year. This would be an unnecessary and unwarranted certification burden for that particular model year. EPA believes that this recommendation has merit, as it would allow for a more reasonable testing workload as manufacturers transition to N_2O measurement. Therefore, for MYs 2017–2018, EPA is requiring N_2O testing only for new emission certification programs and not in cases where the manufacturer is using carryover emissions data. In cases where manufacturers are using carry-over data in MY 2017–2018, the manufacturer may continue to provide a compliance statement in lieu of measured N_2O test data. Applying the new testing requirements in this way will allow manufacturers to spread out the new testing burden over a number of years. EPA believes this type of phase-in is appropriate. EPA will no longer accept compliance statements for any vehicle test groups starting with MY 2019.

The Alliance commented that N_2O testing should not be required for manufacturer in-use testing (IUVP and IUCP) for all model years and test groups that certify to the N_2O standards via a compliance statement. The Alliance commented that ''EPA should not hold the manufacturers accountable for measuring N_2O utilizing a method that will have been established subsequent to certification, nor should EPA hold a manufacturer responsible for meeting a standard for which accurate measurement methods were not available at the time of certification.'' EPA believes this recommendation is reasonable and is not requiring manufacturers to conduct in-use testing for the IUVP and IUCP programs for test groups certified using an N_2O compliance statement. This will further ease the testing burden in the initial years of the measurement program and allow manufacturers to focus on new certification testing. EPA notes, however, that manufacturers remain responsible for meeting the N_2O standard in-use and EPA maintains the discretion to conduct its own in-use N_2O testing of test groups certified using compliance statements.

EPA also received comments from the Global Automakers that because N_2O is a small fraction of overall GHGs and should remain small, and the testing equipment is expensive, EPA should allow the use of compliance statements until such time as there is evidence that N_2O emissions may be an issue. In response, EPA believes that it is important for manufacturers to demonstrate compliance with the emissions standard for N_2O through testing as soon as it is reasonable to do so to ensure that N_2O does not increase with the introduction of new technologies.

10. Test Procedures

In the proposal, EPA announced that it 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. EPA is adopting the proposed changes. As discussed in section IV of this Notice, NHTSA has taken 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 these changes, and the mechanisms by which these changes will be implemented. EPA is adopting this approach as appropriate after

[475] ''Data from the evaluation of instruments that measure Nitrous Oxide (N_2O),'' Memorandum from Chris Laroo to Docket EPA–HQ–OAR–2010–0799, March 19, 2012.

consideration of all comments on these issues.

These changes are 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 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 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.[476] 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).[477]

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 1970s, 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 D.C. 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

[476] 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.

[477] 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.

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 required a test procedure adjustment. CAS did not contest that the coast down method and the prior alternative method achieved comparable results.

The D.C. 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 (D.C. 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 believes 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 believes it is appropriate to consider the impact of a CAFE procedure change in this broader context.

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. EPA considers the fuel economy results to be ''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 received a limited number of comments on the proposed changes to the CAFE procedures discussed above. One commenter noted that there are various statutory limitations on the CAFE program as compared to the GHG program, including the limitations discussed above on the CAFE test procedure for passenger cars. The commenter noted that EPA's proposal was a major change from the position EPA and NHTSA took in the MY2012–2016 rulemaking. EPA recognizes that the interpretation and approach discussed above are a major change from the prior interpretation of the statutory limitations on testing and calculation procedures for passenger cars. However there has been a significant change in circumstances that justifies this change in interpretation. As discussed above, EPA is changing its interpretation of when a procedure produces results comparable to the 1975 test procedure based on the effect of a coordinated and harmonized GHG and CAFE program. Because of the National Program, the changes to the CAFE procedures would not 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 have a real world impact on the fuel savings and other benefits of the National Program which would remain identical. Under these circumstances it is reasonable to interpret section 32904(c) as not restricting adoption of these changes in procedure for passenger automobiles.

Other commenters, largely from the motor vehicle industry, supported EPA's proposal to allow for fuel consumption improvements credits for 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, where these credits are comparable to the GHG emissions credits for these technology improvements. The commenters noted that the efficiency improvements are real, they will occur in the real world, and the change will further coordinate and harmonize the CAFE program and the GHG program. EPA agrees with these points, and they support EPA's analysis discussed above.

The discussion above focuses primarily 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 has taken 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 generally impact fuel economy). The allowance of off-cycle credits and hybrid credits for full size pickup trucks has been considered in setting the CAFE standards for passenger car and light-trucks.

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

Air conditioning (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.

In this final rule, EPA is allowing manufacturers 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 will 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.1, and III.B.10, EPA, in coordination with NHTSA, is also allowing manufacturers to include fuel consumption reductions resulting from the use of A/C efficiency improvements in their CAFE compliance calculations. Manufacturers will be able to generate ''fuel consumption improvement values'' essentially equivalent to EPA CO_2 credits, for improved fuel efficiency, for use in the CAFE program. The changes to the CAFE program to incorporate A/C efficiency improvements are discussed below in section III.C.1.b.

As in the MY's 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 A/C-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 MY's 2012–2016 final rule, EPA also included projections of A/C credit generation in determining the appropriate level of the standards.[478]

In the time since the analyses supporting the MY's 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.[479] As discussed in more detail in Chapter 5 of the Joint TSD, 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.[480] Together

[478] See Section II.F above and Section IV below for more information on the use of such credits in the CAFE program.

[479] The A/C-related emission inventories presented in this paragraph are discussed in Chapter 4 of the RIA.

[480] 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

these leakage emissions are equivalent to CO_2 emissions of 13.8 g/mi for cars and 17.2 g/mi for trucks (see Section 5.1.2 of the Joint TSD). (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.[481] Chapter 5 of the Joint TSD (see Section 5.5.2.2) 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 standards by using credits generated from incorporating A/C GHG-reducing technologies is a key factor in meeting that goal.[482] 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.C and III.F 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 Significant New Alternatives Policy (SNAP) program, as discussed below, especially if systems are also designed to minimize leakage and thus avoid opportunities for owners to recharge the system with less-expensive—but higher GWP—refrigerant.[483] 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 and in the proposal for this one, EPA is finalizing 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 will be highly cost-effective and technologically feasible for light-duty vehicles in the 2017–2025 timeframe. EPA is maintaining most of the existing framework for quantifying, generating, and using A/C Leakage Credits and Efficiency Credits. EPA expects that most manufacturers will choose to use these A/C credit provisions, although some may choose not to do so. Consistent with the 2012–2016 final rule, the standard reflects this projected widespread penetration of A/C control technology.

The following table summarizes the maximum credits that EPA is making available in the overall A/C program.

TABLE III—13—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 MY's 2012–2016 final rule). In the MY's 2012–2016 rule, the total average car and total average truck credits accounted for the difference between the GHG and CAFE standards.

TABLE III—14—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

(AR4). At this time, the 100-year time frame values in the 1995 IPCC Second Assessment Report (SAR) are used in the official U.S. GHG inventory submission to the United Nations Framework Convention on Climate Change (UNFCCC) per the reporting requirements under that international convention. The UNFCCC recently agreed on revisions to the national GHG inventory reporting requirements, and will begin using the 100-year GWP values from AR4 for inventory submissions in the future.

481 Indirect emissions are additional CO_2 emitted due to the load of the A/C system on the engine.

482 The recent GHG standards for medium and heavy duty vehicles included separate standards for A/C leakage, rather than a credit based approach. EPA did so because the quantity of these leakage emissions is small relative to CO_2 emissions from driving and moving freight, so that a credit does not create sufficient incentive to adopt leakage controls. 76 FR 57118; 75 FR 74211. EPA also did not adopt standards to control A/C leakage from vocational vehicles, and did not adopt standards to control indirect emissions from any medium or heavy duty vehicle for reasons explained at 75 FR 74211 and 74212.

483 Refrigerant emissions during service, maintenance, repair, and disposal are also addressed by the CAA Title VI stratospheric ozone program, as described below.

TABLE III—14—PROJECTED AVERAGE CREDITS—Continued

	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
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 MY's 2017–2025 GHG standards, but not exceeding a 20% penetration rate increase in any given year, until the maximum credits are achieved by MY 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. However, 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 installed outside of the redesign cycle, as so could be done more rapidly, 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 MY 2021 (as shown in Table III–14 above).

The progression of the average credits (relative to the maximum) also defines the relative year-on-year costs as described in Chapter 5 of the Joint TSD. The costs are apportioned by the ratio of the average credit in any given year to the maximum credit. This is nearly equivalent to apportioning 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 MY's 2012–2016 rule, apportioning to the credits provides a more realistic and smoother year-on-year sequencing of costs.[484]

In this section, we discuss the A/C leakage credit program. The A/C efficiency credit program is discussed in Section II.F and in Chapter 5 of the Joint TSD. EPA sought 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. We respond to comments received below, in Section II.F, in the Joint TSD, and in the Response to Comments document.

a. Air Conditioning Leakage (''Direct'') Emissions and Credits

i. Quantifying A/C Leakage Credits for Today's Refrigerant

As previously discussed, EPA is finalizing the proposed leakage credit program, with minor modifications. There was broad support among commenters from the auto and refrigerant supply industries, as well as from other commenters, for the proposed leakage credit program.

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 associates each available leakage-reduction technology with associated leakage credit value, which will 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, February 2012 version), which in turn was based on results from the cooperative ''IMAC'' study.[485] EPA has incorporated several minor modifications that SAE made to the J2727 method, but these do not affect the credit values for the technologies. Chapter 5 of the joint TSD includes a full discussion of why EPA is continuing to use the design-based ''menu'' approach to quantifying Leakage Credits, including definitions of each of the technologies associated with the values in the menu, and commenters supported continuation of the menu approach as well.

In addition to the above ''menu'' for vehicles using the current high-GWP refrigerant (HFC–134a), EPA also continues 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 will significantly reduce the climate-change concern about HFC–134a refrigerant leakage by reducing the direct climate impacts. Thus, the credit a manufacturer can generate by using an alternative refrigerant 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 automotive 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.[486] (In addition, two new potential refrigerants, AC–5 and AC–6, are being researched and have GWPs less than that of HFC–134a.) Both HFC–152a and CO_2 are produced

[484] 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 rule.

[485] 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.

[486] 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 time frame values in the 1995 IPCC Second Assessment Report (SAR) are used in the official U.S. GHG inventory submission to the United Nations Framework Convention on Climate Change (UNFCCC) per the reporting requirements under that international convention. The UNFCCC recently agreed on revisions to the national GHG inventory reporting requirements, and will begin using the 100-year GWP values from AR4 for inventory submissions in the future.

commercially in large amounts and thus the supply of refrigerant is not a significant factor preventing their use.[487] HFC–152a has been shown to be comparable to HFC–134a with respect to cooling performance and fuel use in A/C systems.[488]

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 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 inappropriate, 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 this type of substitution. 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 Clean Air Act Title VI regulations.[489]

For alternative refrigerant systems, EPA is finalizing as proposed a provision that adds to the existing credit calculation approach for alternative-refrigerant systems 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. This ''high leak disincentive'' provision will encourage manufacturers to continue to use low-leak components that are in typical use today even with low-GWP alternative refrigerants. We believe that this will help ensure that refrigerant leakage will remain low, avoiding opportunities for vehicle owners to recharge a depleted system 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 p. 660 of 1991, 76 FR 17509; March 29, 2011).[490] In EPA's disincentive provision, manufacturers can 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. Specifically, the disincentive will be avoided when leakage components in a new alternative refrigerant system, as quantified in the leakage credit menu, maintain a target level of leakage reduction typical of today's systems, accounting for the fact that designing larger systems that are charged with larger volumes of refrigerant for low leakage is relatively more challenging than for smaller systems.

EPA received a number of comments on this proposed provision. A number of automobile manufacturers and a chemical manufacturer, in particular, raised concerns that the high-leak disincentive was potentially reducing the credits available under the MY's 2012–2016 rules. These commenters said that this would complicate their ability to comply and would penalize early adopters of low GWP refrigerants. Further, some automobile manufacturers stated that they were already making efforts to prevent the replacement of a low GWP alternative refrigerant, such as HFO–1234yf, with the less expensive, high GWP refrigerant HFC–134a. Some commenters stated that there are fittings unique to HFO–1234yf on the air conditioning system that would not allow someone to add HFC–134a into a car designed to use HFO–1234yf. Other commenters stated that it was not fair to penalize automobile manufacturers for activities taken by others who would refill with HFC–134a an A/C system containing HFO–1234yf. ICCT supported such an anti-leak credit, but believed that full credit should be given only where manufacturers demonstrate designs that cause the system to fail operating when recharged with higher GWP refrigerants.

In response to these comments, EPA has maintained as proposed the general approach of a credit deduction to discourage high leak rates for systems designed for use of an alternative, low GWP refrigerant. However, the final rule allows greater flexibility so that the disincentive would only occur if a manufacturer eliminates a significant number of leakage-reduction technologies that are in broad use today. Thus, if a manufacturer takes reasonable care to reduce leaks and thus reduce the opportunity for the illegal top-off or charging of refrigerants not designed for use with low-GWP A/C systems, the manufacturer will be able to take full advantage of the credits for using a low-GWP alternative refrigerant. EPA discusses the final criteria for avoiding the disincentive in Chapter 5.1.2.3.2.5 of the Joint TSD.

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.

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 air-conditioning systems (MAC Directive[491]) aims at reducing emissions of specific fluorinated greenhouse gases in the air-conditioning systems fitted to passenger cars (vehicles under EU

[487] 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.*

[488] 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.

[489] See appendix D to 40 CFR part 82, subpart G.

[490] 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.

[491] 2006/40/EC.

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 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 calls with new car models starting 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 (see 76 FR 17494–17496, 17507; March 29, 2011).

There are some drawbacks to the use of HFO–1234yf. Some vehicle technological changes, such as the addition of an internal heat exchanger in the A/C system and associated packaging issues, may be necessary in order to transition to HFO–1234yf. Also, some vehicle manufacturers may require changes to the refrigerant charging and storage facilities at their vehicle assembly plants to accommodate the use of 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.[492] By comparison, recent reported costs for HFC–134a range from about $4.50 to $10 per pound.[493] 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. (We do not include potential costs for manufacturing facility changes to accommodate a new refrigerant; some may incur such costs, some may not. Commenters did not provide specific data relating to such costs).

Manufacturers have seriously considered other alternative refrigerants in recent years. One of these, HFC–152a, has a GWP of 124.[494] HFC–152a is produced commercially in large amounts.[495] HFC–152a has been shown to be comparable to HFC–134a with respect to cooling performance and fuel use in A/C systems.[496] HFC–152a is flammable, listed as A2 by ASHRAE.[497] 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). Alternatively, CO_2 can be used as a refrigerant. It has a GWP of 1, and is widely available commercially.[498] The SNAP program has listed R–744 as acceptable for motor vehicle A/C systems. (June 6, 2012; 77 FR 33315). Air conditioning systems using CO_2 would require different designs than other refrigerants, primarily due to the higher operating pressures that are required. Research 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.[499] 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, 2011, 76 FR 17488; and March 26, 2012, 77 FR 17344). 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. EPA has also recently issued a final rule allowing use of R–744 as a refrigerant in new motor vehicle A/C systems subject to use conditions for motor vehicle A/C systems (June 6, 2012; 77 FR 33315). The SNAP rules for all three alternative refrigerants HFC–152a and HFO–1234yf require meeting safety requirements of the industry standard SAE J639. With HFO–1234yf and HFC–152a, 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. Similarly, for CO_2, EPA requires manufacturers to keep records of the tests they perform to ensure that MVAC systems are designed with devices to avoid concentrations in excess of the limits in the final rule.

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

[492] Automotive News, April 18, 2011.21.

[493] [generate docket memo from this site: *www.r-134a.com*.]

[494] IPCC 4th Assessment Report.

[495] 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.]

[496] 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.*

[497] 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).

[498] The U.S. has one of the largest industrial quality CO_2 production facilities in the world (Gale Group, 2011).

[499] ''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.*

(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.[500] EPA has found this 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.[501]

EPA addresses potential toxicity issues with the use of CO_2 as a refrigerant in automotive A/C systems in the final SNAP rule mentioned above. CO_2 has a workplace exposure limit of 5000 ppm on an 8-hour time-weighted average, a short-term exposure limit (STEL) of 3% over a 15-minute time-weighted average, and a ceiling limit of 4.0% CO_2 at any time.[502] 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 also is not considered a 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 for use of all three low-GWP alternative refrigerants in new vehicles only, we expect that manufacturers would introduce cars using alternative refrigerants during complete vehicle redesigns or when introducing new models.[503] This need for complete vehicle redesign limits the potential pace of a transition from HFC–134a to alternative refrigerants. In meetings with EPA and in their public comments, 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–14.

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, 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. The expected mass production of HFO–1234yf has been delayed until later this year. As a result, the European Union has delayed the requirement for newly approved types of vehicles to be filled with a refrigerant with GWP less than 150 by one year until December 31,

[500] 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).

[501] EPA received a supplemental petition from the Institute for Sustainable Governance, The Environmental Investigation Agency, and the National Resources Defense Council to find unacceptable HFC–134a for other uses in April, 2012.

[502] 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%).

[503] Some suppliers and manufacturers have informed us that some vehicles may be able to upgrade A/C systems to use HFO–1234yf 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 between redesign years may be feasible for only a select few models.

2012.[504] The producers of HFO–1234yf have indicated that they plan to construct a new facility in the 2014 timeframe. 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–1234yf as early as MY 2013.[505] According to a commenter, some automobile manufacturers expect to begin using HFO–1234yf on some models in 2013. As of spring of 2012, EPA is aware of at least two manufacturers already producing vehicles using HFO–1234yf—GM and Subaru. 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 these manufacturers 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–14 shows that, starting from MY 2017, EPA projects that 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. These projections are for analytical purposes, and, as described above, this final rule does not in any way require that the auto and refrigerant supply industries transition to alternative refrigerants, or to do so according to any specified timeline.

(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.

EPA is basing this final rule on the current status of refrigerants, where there are no U.S. regulatory requirements for manufacturers to eliminate the use of HFC–134a for newly manufactured vehicles. Thus, the agency expects that the market penetration of alternatives will proceed based on supply and demand and the strong incentives in this final rule. Given the combination of clear interest from automobile manufacturers in switching to an alternative refrigerant, the interest from the manufacturers of the alternative refrigerant HFO–1234yf 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 will 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 alternative refrigerants will be in the U.S., nor how quickly that transition will occur in the absence of requirements or strong incentives. (Some commenters stated that EPA should not require a phase-out of HFC–134a. This action is beyond the scope of this final rule; such comments will be appropriate for a future NPRM on that subject.

There are other factors 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.

In February, the Secretary of State Hillary Rodham Clinton and Administrator Lisa Jackson announced the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, a new initiative seeking to realize benefits by addressing black carbon, HFCs, and methane.

2. Incentives for Electric Vehicles, Plug-in Hybrid Electric Vehicles, Fuel Cell Vehicles, and Dedicated and Dual Fuel Compressed Natural Gas Vehicles

EPA is finalizing temporary regulatory incentives for electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), fuel cell vehicles (FCVs), and dedicated and dual fuel compressed natural gas (CNG) vehicles. This section is divided into four subsections: (a) Introductory context, (b) summary overview of the public comments on this topic, (c) a detailed topic-by-topic discussion of what EPA proposed, major public comments on that proposal, EPA's response to comments, and EPA's final decision, and (d) the projected impact of the temporary regulatory incentives on GHG emissions reductions.

[504] April 18, 2012 Note to the Attention of the Members of the Technical Committee on Motor Vehicles, ''The supply shortage of an essential component in mobile air conditioning systems and its impact to the application of Directive 2006/40/EC in the automotive industry''. Philippe Jean, Chairman of the Technical Committee—Motor Vehicles, European Commission Enterprise and Industry Directorate-General.

[505] General Motors Press Release, July 23, 2010. ''GM First to Market Greenhouse Gas-Friendly Air Conditioning Refrigerant in U.S.''

a. Context

i. Agency Rationale for Temporary Regulatory Incentives

EPA believes that these temporary regulatory incentives are justified under CAA section 202 (a) as they promote the commercialization of technologies that have, or of technologies that can be critical facilitators of next-generation technologies that have, the potential to transform the light-duty vehicle sector by achieving zero or near-zero GHG emissions and oil consumption, but which face major near-term market barriers. However, providing temporary regulatory incentives for certain advanced technologies will decrease the overall GHG emissions reductions associated with the program in the near term. EPA believes it is worthwhile to forego modest additional emissions reductions in the near term in order to lay the foundation for the potential for much larger ''game-changing'' GHG emissions and oil reductions in the longer term.[506] EPA accounts for the higher real world GHG emissions and lower GHG emissions reductions associated with these temporary regulatory incentives in all of our regulatory analyses, e.g., in this section, in Section III.F, and in the Regulatory Impact Analysis.

ii. Light-Duty Vehicle Greenhouse Gas Emissions Standards for MYs 2012–2016

The light-duty vehicle greenhouse gas emissions standards for model years (MYs) 2012–2016 provide a regulatory incentive for EVs, FCVs, and for the electric portion of operation of PHEVs. See generally 75 FR 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 the use of a 0 grams per mile (g/mi) 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 EV/PHEV/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 upstream (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, an eGRID2007 national average power plant GHG emissions factor, and multiplicative factors to account for electricity grid transmission losses and pre-power plant feedstock GHG related emissions.[507] The accounting for a hydrogen fuel cell vehicle would be done in a comparable manner.

The 0 g/mi compliance value decreases the GHG emissions reductions associated with the MYs 2012–2016 standards compared to the same standards and a compliance value that accounts for the upstream GHG emissions associated with these vehicles, compared to conventional vehicles. It is impossible to know the precise number of vehicles that will utilize this approach 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 g/mi during the MYs 2012–2016 timeframe. This likely maximum bounding 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 g/mi.

iii. Proposed Approach for MYs 2017–2025

EPA proposed the following approach for EVs, PHEVs, and FCVs.[508] For MYs 2017–2021, EPA proposed two incentives: allowing all EVs, PHEVs (electric operation), and FCVs to use an uncapped GHG emissions compliance value of 0 g/mi; and to use a multiplier for these vehicles which would allow each of these vehicles to ''count'' as more than one vehicle in a manufacturer's compliance calculation. The proposed multipliers varied by model year and by vehicle type, the maximum proposed multiplier being 2.0 for EVs and FCVs in MYs 2017–2019, and the lowest proposed multiplier being 1.3 for PHEVs in MY 2021.

For MYs 2022–2025, EPA proposed the 0 g/mi GHG emissions compliance treatment for EVs, PHEVs (electric operation), and FCVs up to a per-company cumulative production threshold for those model years. EPA proposed a two-tier, per-company cap based on cumulative production in prior years. Thus, 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 manufacturers would have a proposed cumulative production cap of 200,000 EV/PHEV/FCVs in MYs 2022–2025. EPA did not propose multipliers for these later model years. See 76 FR 75012–013.

b. Overview of Comments

EPA received many comments in response to these proposals. Almost exclusively, automakers supported these kinds of regulatory incentives for a wide range of advanced technologies, and many automakers preferred larger and/or longer-lasting incentives than those that EPA proposed. On the other hand, environmental public interest groups generally opposed the proposed incentives either out of concern for reduced emissions reductions, or to have a program which is technology-neutral. Electric vehicle advocacy organizations supported incentives for EVs and PHEVs, while natural gas advocacy stakeholders supported adding incentives for dedicated and dual fuel CNG vehicles. Proponents of other fuels often opposed incentives for electric and natural gas vehicles. Representative comments will be addressed in the topic-by-topic discussion below. For a more comprehensive treatment of comments on this topic, see the separate EPA Response to Comments document.

c. Final Rule for Light-Duty Vehicle Greenhouse Gas Emissions Standards for MYs 2017–2025

i. Appropriateness of Regulatory Incentives

Every automaker that commented on this topic supported some type of regulatory incentives for advanced technologies. Honda's comment is illustrative: ''Alternative fuel vehicles and advanced technologies face unique challenges in coming to market: developing appropriate infrastructure and overcoming initial consumer resistance to new, unfamiliar technologies. Incentives that are limited in time and appropriately phased-out

[506] EPA has adopted this strategy in previous mobile source rulemakings, such as its Tier 2 Light-Duty Vehicle, 2007 Heavy-Duty Highway, and Tier 4 Nonroad Diesel rulemakings.

[507] See 40 CFR 600.113–12(m).

[508] These proposals were consistent with the discussion in the August 2011 Supplemental Notice of Intent. 76 FR 48758.

can help accelerate the introduction of these vehicles.'' Nissan also strongly supported regulatory incentives: ''[G]overnment incentives and support are essential to ensuring manufacturer investment and consumer adoption of these technologies * * *. Without the incentives and continued focus on tailpipe emissions when calculating GHG emissions * * * consumers will be slower to adopt these advanced technologies and continue to rely on traditional internal combustion vehicles, which will result in higher overall greenhouse gas emissions long term. It is not until consumers adopt these technologies that the United States can realize the benefits of these transformational, 'game changing' vehicle technologies.'' Tesla made a direct link between the proposal and the business case for EV investment: ''Tesla notes that incentives such as credit multipliers not only serve to accelerate the commercialization and widespread adoption of advanced technology vehicles like EVs, they provide support for the businesses seeking to introduce such technology * * *. GHG and CAFE credits earned from the production and sales of EVs like the Model S will allow Tesla to generate revenue for more rapid EV development and production. This will, in turn, speed the introduction of the next generation of EVs at higher volumes and lower price points.'' Another dozen or so automakers also supported temporary regulatory incentives, as did three organizations that advocate for EV issues: Edison Electric Institute, Electric Drive Transportation Association, and Securing America's Energy Future. The latter supported ''incentives to help promote the adoption of electric drive vehicles. Further, we believe the incentive is justified because of the critical contribution that the technology employed in the qualifying vehicles can make in improving our economic and national security. For the vehicles to achieve their potential, however, they will need incentives of sufficient size and duration for the vehicles to achieve scale, reduce costs, and penetrate the mainstream market.'' Pew Charitable Trusts supported ''[i]ncentives designed to spur deployment of electric and hybrid vehicle technologies in the U.S. light duty fleet [to] provide a clear path for auto manufacturers to invest in research, development, and production, which can improve the competitiveness of U.S. manufacturing and enhance exports to nations with growing demand.''

On the other hand, several commenters expressed opposition to the proposed regulatory incentives. The American Petroleum Institute stated: ''Regulatory agencies should not be in the business of promoting investments and innovations in government-selected technologies applied to government-selected vehicle categories. Regulators should instead set broad, performance-based targets that reward innovation directed at achieving outcomes, not the implementation of specific technologies. The market, via consumer choice, should then be allowed to select the winners and losers.'' The Union of Concerned Scientists ''strongly opposed these incentives during the 2012–2016 rulemaking on the grounds that they do not reflect real emissions reductions and thus erode the benefits of the National Program and that there are other, more effective ways of accelerating the market for electric cars (e.g., the California ZEV program, federal tax credits, loan guarantees, and other state and local incentives). We continue to oppose them here for the same reasons, and express grave concern that they, like many auto industry incentives over the years, will again be extended and continue to undermine the goals of the program they serve.'' The International Council on Clean Transportation commented that ''[w]hile the ICCT strongly supports development of electric and fuel cell vehicles, one of our core principles is that efficiency and greenhouse gas emission standards should be technology neutral.'' The Institute for Policy Integrity, New York University School of Law, argued that ''subsidization of new technology should be neutral with respect to greenhouse gas emissions * * *. By giving inflated regulatory incentives to a certain type of technology rather than allowing manufacturers to find the most efficient and effective solution, EPA will disincentivize other forms of technology that may be more cost-effective at reducing greenhouse gas emissions.'' The Center for Biological Diversity stated that any incentives beyond actual emissions reductions ''are inappropriate'' and ''[w]hile we believe that credits may have provided a valuable incentive for electric vehicles during the 2012–2016 rulemaking to encourage this relatively new technology, such concerns are now misplaced. The 2017–2025 rulemaking years no longer constitute a start-up period for these vehicles.''

EPA is adopting temporary regulatory incentives for MYs 2017–2025 similar to those proposed. Critics of the proposal tended to emphasize three primary arguments: that regulatory incentives are not technology neutral and therefore pick ''winners and losers'' among the advanced technologies, that they reduce the GHG benefits of the program, and that they are no longer needed for technologies such as EVs. EPA believes that the issue of technology neutrality is a much more complex issue than some commenters suggest. Given that internal combustion engines and petroleum-based fuels have dominated the U.S. light-duty vehicle market for 100 years, with massive sunk investments, there are major barriers for new vehicle technologies and fuels to be able to gain the opportunity to compete on any type of level playing field. In this context, temporary regulatory incentives do not so much ''pick winners and losers'' (an inefficient or unattractive technology is not going to achieve long-term success based on temporary incentives) as to give new technologies more of an opportunity to compete with the established technologies. The agency recognizes that the temporary regulatory incentives will reduce the short-term benefits of the program, but as noted above believes that it is worth a limited short-term loss of benefits to increase the potential for far-greater game-changing benefits in the longer run. EPA also believes that temporary regulatory incentives may help bring some technologies to market more quickly than in the absence of incentives. Finally, EPA disagrees that such incentives are no longer needed. Although it is true that several EVs and PHEVs are now on the U.S. market, sales of EVs and PHEVs amounted to less than 0.2% of all sales in 2011.[509] On the other hand, EPA believes there must be limits on the use of the incentives, and the Agency is adopting temporary regulatory incentives that we believe balance our objectives of achieving GHG emissions reductions and promoting game-changing technologies.

ii. Incentive Multipliers for EV/PHEV/FCVs for MYs 2017–2021

An incentive multiplier allows a vehicle to ''count'' as more than one vehicle in the manufacturer's compliance calculation.[510] As noted

[509] Total 2011 U.S. light-duty vehicle sales were 12.8 million (see *http://online.wsj.com/article/SB10001424052970203513604577140440852581080.html*, last accessed on July 10, 2012). Total 2011 U.S. EV/PHEV sales were less than 20,000 (see *http://www.plugincars.com/nissan-leaf-sales-trump-chevy-volt-2011-111308.html*, last accessed July 10, 2012, for total Leaf EV plus Volt PHEV sales of 17,345).

[510] In the extremely unlikely case where an advanced technology vehicle might have an overall GHG emissions compliance value that is higher than its compliance target, the manufacturer can choose not to use the multiplier.

above, EPA proposed incentive multipliers for three technologies—EVs, PHEVs, and hydrogen FCVs—that have the potential to achieve game-changing GHG emissions reductions in the future if the electricity and hydrogen used by these vehicles are produced from low-GHG emissions feedstocks or from fossil fuels with carbon capture and sequestration.[511] Although the Agency rejected an incentive multiplier in the MYs 2012–2016 final rule, we proposed a multiplier for MYs 2017–2021 because, while advanced technologies were not necessary for compliance in MYs 2012–2016, we project that they will be necessary, for some manufacturers, to comply with the GHG standards in the MYs 2022–2025 timeframe, and we believe that an incentive multiplier for MYs 2017–2021 can promote the initial commercialization of these advanced technologies that need to be available in later years. Table III–15 lists the incentive multipliers that EPA proposed. EPA also sought comment on whether there should be a single, fixed incentive multiplier for all PHEVs (as proposed) or whether the PHEV incentive 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.

TABLE III—15—EV, FCV, AND PHEV INCENTIVE MULTIPLIERS FOR MYS 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

Overall, public comments about the incentive multipliers for EV/PHEV/FCVs mirrored the general comments on regulatory incentives. Every automaker supported the concept of a multiplier for these vehicles, though some automakers wanted the multiplier to go beyond 2021 (Mitsubishi and Tesla supported incentive multipliers through 2025) and others wanted higher multipliers for some technologies (Mercedes-Benz USA suggested a multiplier of 4.0 for FCVs). The United Auto Workers also supported the multiplier, as did the EV advocacy stakeholders (the Electric Drive Transportation Association also supported extension to 2025). Some environmental organizations explicitly opposed the multipliers, such as the Union of Concerned Scientists and Center for Biological Diversity. The Union of Concerned Scientists was ''particularly disappointed by the agency's proposal on incentive multipliers, given its intellectual inconsistency with an EPA determination on the very same issue made only a year and a half earlier'' when EPA stated that ''the multiplier, in combination with the zero grams/mile compliance value, would be excessive.''[512] Several other environmental groups did not state an explicit position on the multipliers, though expressed general opposition to regulatory incentives. The multipliers for EV/PHEV/FCVs were also opposed by a wide range of non-electricity fuel advocacy groups, as well as by several state governmental agencies. The Alliance of Automobile Manufacturers was the only commenter to address the issue of a single versus a variable multiplier for PHEVs, and it supported a single, fixed multiplier for all PHEVs arguing that a variable multiplier could have unintended consequences by encouraging the use of battery capacity or power that might not be demanded by consumers.

EPA is finalizing the multipliers for EV/PHEV/FCVs as proposed. Consistent with the general rationale just discussed, EPA believes it has struck a reasonable balance in finalizing the multipliers shown in Table III–15 for MYs 2017–2021. EPA believes that it is both reasonable and appropriate to accept some short-term loss of emissions benefits in the short run to increase the potential for far-greater game-changing benefits in the longer run. The agency believes that these multipliers may help bring some technologies to market more quickly than in the absence of incentives. EPA disagrees with the comment by the Union of Concerned Scientists of ''intellectual inconsistency'' with the MYs 2012–2016 standards in that EPA did not project that advanced technologies like EVs and PHEVs were necessary to meet the MY 2016 standards so that no further incentive was needed. In contrast, EPA projects here that, for some manufacturers, EVs and PHEVs are in fact projected for meeting the much more stringent MY 2025 standards. As EPA stated in the proposal, providing multipliers for MYs 2017–2021 can lay the foundation for commercialization of these technologies that can then contribute toward compliance with standards in MYs 2022–2025. 76 FR 75012. On the other hand, EPA disagrees with those commenters that support higher multipliers and/or multipliers of longer duration, as we believe that such incentives could lead to a significant reduction in program GHG savings, particularly if EV/PHEV/FCV sales increase significantly after MY 2021. In addition, the Agency agrees with the Alliance of Automobile Manufacturers about the possible unintended consequences of a variable multiplier, and is finalizing a fixed multiplier for all PHEVs that meet the eligibility requirements below.

iii. PHEV Eligibility Requirements for Incentive Multiplier

EPA proposed that, in order for a PHEV to be eligible for the multiplier discussed in the previous section, the PHEV 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 over the EPA highway cycle. See 76 FR 75012.

EPA received only a few comments on this issue. Both the Alliance of Automobile Manufacturers and Ford supported the 10.2 mile all-electric or equivalent all-electric range eligibility requirement. The only commenter to suggest an alternative approach was Securing America's Future Energy, which recommended that the PHEV eligibility requirement be a minimum battery energy storage capacity of 4 kilowatt-hours, maintaining that this would be simpler to administer and consistent with the current minimum battery capacity for the federal income tax credit for PHEVs.

EPA is finalizing, as proposed, the PHEV multiplier eligibility requirement of 10.2 miles all-electric or equivalent all-electric range. EPA agrees that a 4 kilowatt-hour minimum battery energy storage requirement would be a reasonable alternative, but generally prefers performance-based metrics over design-based metrics, unless there are compelling reasons to prefer the latter. This is because performance-based metrics typically allow maximum flexibility. In this instance, EPA believes that there are no such compelling reasons to prefer a design-based approach.

iv. Incentive Multiplier for Dedicated and Dual Fuel CNG Vehicles for MYs 2017–2021

EPA did not propose multipliers for CNG vehicles, but asked for comment on the merits of providing multipliers for dedicated and/or dual fuel CNG vehicles. See 76 FR 75013.

[511] EPA did not propose, but is finalizing, incentive multipliers for dedicated and dual fuel CNG vehicles. See Section III.C.2.c.iv below.

[512] 75 FR 25436.

A large majority of the public commenters on this topic supported providing regulatory incentives in this rule for both dedicated and dual fuel CNG vehicles.

Most natural gas advocacy groups supported both multipliers for CNG vehicles, as well as use of a ''0.15 divisor'' for GHG emissions compliance values for CNG vehicles. This value comes from EPCA, where it is used to calculate fuel economy for alternative fueled vehicles through MY 2019.[513] Use of this divisor would result in a much lower GHG emissions compliance value and hence a much bigger incentive and, advocates claimed, would allow GHG emissions compliance to be harmonized with a CAFE compliance approach that also uses the 0.15 divisor.

The joint America's Natural Gas Alliance/American Gas Association comment summarized the perspective of the natural gas advocates: ''While EPA proposes generous incentives for EVs and PHEVs because they represent 'potential for game-changing GHG emissions and oil savings in the long term,' both dedicated and dual fuel NGVs represent actual 'game changing GHG emissions and oil savings' right now that justify comparable incentives. Moreover, considering NGVs superior cost-benefit performance in reducing GHGs compared to EVs, EPA should consider an even larger multiplier incentive, perhaps equal to the incentive Congress mandated for NGVs based on their oil-displacement performance * * *. [A]ny GHG multiplier that is less than the fuel economy one essentially negates the Congressional mandate in AMFA to the extent of that difference, a result at odds with the very purpose of this joint rulemaking. We strongly encourage EPA to take into account the fuel economy goals of this joint program in crafting their GHG standards, and the fact that NGVs are more cost-effective than EVs in reducing GHGs should allow EPA to establish a GHG multiplier incentive equivalent to the Congressionally-mandated fuel economy incentive.'' This position was echoed by the American Clean Skies Foundation: ''All qualified alternative fuel vehicles, including EVs and NGVs, should qualify for these incentives which would use a multiplier to give extra credit for the emission reduction benefits of such vehicles in calculating each manufacturer's fleet averages * * *. Unlike the NHTSA rules, the EPA's new GHG standards contain additional EV-only incentives. These supplemental incentives arbitrarily and capriciously favor EVs over NGVs * * *. EPA's new rules would abolish the benefits NGVs gain under the NHTSA standards from the 0.15 'divisor' incentive.''

NGV America echoed these arguments, and also maintained that CNG vehicles can serve as a potential bridge to hydrogen FCVs: ''NGVs also likely will play an important role in facilitating the market penetration of fuel cell electric vehicles (FCEVs) * * *. [t]he development of NGVs—and particularly natural gas refueling infrastructure—has long been recognized as a key bridge technology on a 'path to hydrogen.' * * * Due to the chemical and physical similarities of these two gases, they share a number of technology synergies, so that the proliferation of NGVs and natural gas fueling infrastructure will facilitate and accelerate deployment of FCEVs. Indeed, the development of the NGV market serves to reduce or eliminate all four of the near-term market barriers to FCEV adoption identified by the Agencies: low-GHG fuel production and distribution, * * * fuel cost, * * * vehicle cost, and * * * consumer acceptance.'' VNG. Co also emphasized the bridge-to-hydrogen theme: ''It is critical for the Agencies to provide appropriate support for the natural gas-to-hydrogen path so that both NGVs and FCEVs will be a viable option for consumers and automakers from 2017 to 2025, as well as during the post-2025 period as emission and fuel economy standards become ever more stringent. Keeping this gaseous fuel pathway 'open' to automakers is particularly important given the Agencies' acknowledged and well-founded concerns over the consumer acceptance of EV technology due to cost as well as range and refueling issues. It is, simply, too soon to put all of the Nation's eggs in the EV basket—and it would be a clear mistake to overlook the gaseous fuel pathway just as the supplies and economics of natural gas in the US are undergoing a historic transformation. Ultimately, both EVs and FCEVs will be necessary to achieve long-term environmental and energy security goals, and NGVs will play an essential role in reducing ICE vehicle emissions as well as enabling the transition to hydrogen.''

Most automakers that commented on this issue also supported CNG incentive multipliers. Honda, which markets a dedicated Civic CNG vehicle, argued that: ''NGVs have similar environmental and energy security benefits compared to EVs and PHEVs, and their marketing challenges (infrastructure and consumer acceptance) are similar, as well. Honda supports the addition of dedicated NGVs to the group of dedicated vehicle multipliers (EVs and FCVs) and bi-fuel NGVs to the bi-fuel vehicle multipliers (PHEVs). A differential in the multiplier for dedicated and bi-fuel natural gas vehicles is fully justified because there is no guarantee that the latter will operate on natural gas all of the time.'' Chrysler stated: ''NGVs represent a significant opportunity to reduce greenhouse gas emissions and to improve energy independence * * *. However, several roadblocks exist to the widespread adoption of NGVs. These include limited vehicle availability and a lack of public fueling infrastructure * * *. Chrysler recommends that dedicated and ''extended range'' natural gas vehicles receive at least the same multipliers as electric vehicles, and that dual fuel NGVs receive at least the same multipliers as plug-in hybrid electric vehicles.'' Chrysler and the Vehicle Production Group were the two automakers who also supported the use of the 0.15 divisor for GHG emissions compliance, to harmonize with the use of the 0.15 divisor in CAFE compliance. A comment from Boyden Gray and Associates also supported the use of the 0.15 divisor for GHG emissions compliance.

Toyota was the one automaker that provided a different view: ''Toyota believes the primary consideration for including any technology in this provision should be its CO_2 reduction potential. The CAFE regulations already recognize the oil saving benefit of CNG vehicles by structuring the fuel economy calculations to provide a significant boost in their reported fuel economy. EPA's advanced technology provisions should be squarely focused on CO_2 benefits of a technology.''

The broad set of comments, briefly summarized above, on CNG incentives raises several relevant issues. EPA disagrees with those comments that suggest that CNG vehicles provide the same GHG emissions reductions as EVs. Table III–16 compares GHG emissions for three MY 2012 vehicles: a Honda Civic gasoline vehicle, the Honda Civic CNG vehicle, and the Nissan Leaf EV (the highest-selling EV in the US market). The tailpipe GHG emissions values for all three vehicles are taken directly from the EPA GHG emissions certification database. The upstream value for the Civic gasoline vehicle was calculated based on a gasoline upstream GHG emissions factor of 2478 grams

[513] See 49 U.S.C. 32905, which deems a gallon equivalent of gaseous fuel to contain only 0.15 gallon of fuel. This means that 1 gallon of alternative fuel is treated as 0.15 gallons of fuel, essentially increasing the fuel economy of a vehicle on alternative fuel by a factor of 6.67.

upstream GHG emissions per gallon.[514] The upstream value for the Civic CNG vehicle was projected based on natural gas extraction, processing and distribution emissions values in GREET, which are based in part on the 2011 EPA GHG emissions inventory.[515] The upstream values for the Leaf EV account for electricity feedstock, power plant, and distribution related GHG emissions, with the power plant and distribution data from EPA's eGRID2012 based on 2009 data.[516] Two upstream values are shown for the Leaf, the higher of which is based on U.S. national average electricity (which is relevant if EV sales are distributed proportionally throughout the U.S.), and the lower value is for California electricity (where initial EV sales have been much higher than average, and whose electricity GHG emissions are reasonably representative of some of the other areas on the east and west coasts where EV sales are higher than average). The ''average'' Leaf has an upstream GHG emissions profile somewhere between these two values.

TABLE III–16—TAILPIPE AND UPSTREAM GHG EMISSIONS COMPARISON—MY 2012 (GRAMS PER MILE) (VALUES IN PARENTHESES ARE RELATIVE TO CIVIC GASOLINE)

	Civic Gasoline	Civic CNG	Leaf EV
Tailpipe	207	163 (−21%)	0 (−100%)
Upstream	58	67	96 to 156 (CA and US)
Tailpipe + Upstream	265	230 (−13%)	96 to 156 (−64% to −41%)

The data in Table III–16 support several conclusions. First, CNG vehicles provide a reduction in tailpipe GHG emissions relative to gasoline vehicles. The data from the two Civics suggest that the tailpipe CNG benefit is approximately 20%, primarily due to natural gas' more favorable hydrogen-to-carbon ratio relative to gasoline. Second, based on the latest EPA data for natural gas extraction, processing, and distribution, upstream GHG emissions for a CNG vehicle are slightly higher than those for a comparable gasoline vehicle. Third, it is clear that the Leaf EV is superior to the Civic CNG in terms of both tailpipe only and tailpipe + upstream GHG emissions. Although the Leaf's GHG emissions advantage over the Civic CNG is largest in California and other cleaner-electricity states, the Leaf has demonstrably lower tailpipe + upstream GHG emissions even if EVs are assumed to operate on ''national average'' electricity.

From a vehicle tailpipe perspective, EVs are a game-changing technology. However, given the current electricity upstream emissions profile, as shown in Table III–16, the full potential for zero or near-zero GHG emissions from EVs will only be realized if and when the electricity sector is transformed so that upstream emissions are lower. Current trends, where lower-GHG natural gas is displacing higher-GHG coal use, will decrease EV upstream GHG emissions, which means that the comparison between the Civic CNG and Leaf EV in Table III–16 above will become more favorable for EVs over time as more electricity is produced with natural gas and less with coal. However, this is not the ultimate pathway for EVs to become a true game-changing technology from a GHG emissions perspective.

EPA agrees with the comment by Toyota that EPA should base its decision on this issue by focusing on GHG emissions performance. Based on the data above, EPA does not believe that CNG vehicles are a game-changing technology in terms of GHG emissions.

Comments raised two other factors relevant to the potential for CNG to be a game-changer with respect to GHG emissions. The first is the potential for the use of biomethane, or methane produced from non-fossil sources, that can yield very low lifecycle GHG emissions. EPA agrees that there will be some production of biomethane, but we believe that biomethane will remain a small part of the overall natural gas market for the foreseeable future, particularly given the remarkable drop in natural gas prices and the likelihood that natural gas prices in the US will remain at relatively low levels for the foreseeable future.

The second is the potential for CNG to be a bridge technology for the commercialization of hydrogen FCVs. EPA agrees that CNG investments have the potential to facilitate the introduction of hydrogen FCVs in several respects. Examples include:

• Innovations with on-board vehicle CNG fuel tanks could translate directly to improved on-board hydrogen fuel tanks, since the primary challenge with both is the safe and economic storage of sufficient gaseous fuel to provide reasonable vehicle range;[517]

• synergistic innovations in tube trailer designs could apply to the delivery of CNG and hydrogen to end users;[518]

• engineering innovations to improve the design of natural gas compressors

[514] This gasoline upstream GHG emissions factor is calculated from 21,546 grams upstream GHG emissions per million Btu (EPA value for future gasoline based on DOE's GREET model modified by EPA standards and data; see docket memo to MYs 2012–2016 rulemaking titled ''Calculation of Upstream Emissions for the GHG Vehicle Rule'') and multiplying by 0.115 million Btu per gallon of gasoline.

[515] The upstream value for the Civic CNG vehicle was based on data from DOE's GREET model that shows that CNG vehicle upstream GHG emissions are 28% higher than current gasoline vehicle upstream GHG emissions (see default estimates for target year 2015 using the GREET model developed by Argonne National Laboratory, ''GREET 1_2011'', available at *http://greet.es.anl.gov/*, last accessed July 10, 2012). Note that for this table, and to be consistent with analyses elsewhere in this document, the Civic gasoline vehicle upstream GHG emissions value has been revised to a slightly higher value as discussed in the previous footnote. Therefore, in the table the upstream GHG emissions value for the Civic CNG vehicle is 16%, not 28%, higher than that of the Civic gasoline vehicle.

[516] See EPA eGRID2012 at *http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html* for 2009 national average powerplant GHG emissions factor of 0.554 grams/watt-hour and 2009 California powerplant GHG emissions factor of 300 grams/watt-hour. These powerplant values were adjusted upward to account both for regional transmission/grid losses from eGRID2012 (6.5% national average) and regional feedstock-related GHG emissions from DOE/Argonne National Laboratory's GREET model (10% national average). The total national average electricity upstream GHG value for electricity delivered to a wall outlet is 0.654 grams/watt-hour, and the total California value is 0.405 grams/watt-hour.

[517] *Natural Gas and Hydrogen Infrastructure Opportunities Workshop October 18–19, 2011,* Argonne National Laboratory, February 21, 2012, page 18, *http://www.transportation.anl.gov/pdfs/AF/812.PDF* (last accessed August 10, 2012).

[518] *Hydrogen and Fuel Cell Manufacturing R&D Workshop August 11–12, 2011, http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/mfg2011_iv_newhouse.pdf* (last accessed August 10, 2012).

and/or dispensers that might translate to hydrogen compressors and/or dispensers;[519] and

• pipelines, including new fiber reinforced polymer (FRP) technology, to natural gas refueling stations could be used for hydrogen refueling, either by carrying hydrogen from central production facilities (while it is not considered feasible to transport pure hydrogen in pipelines designed for natural gas, one active research pathway is transporting natural gas/hydrogen blends and separating the fuels at the refueling station) or by providing the natural gas feedstock for on-site hydrogen production, such as steam methane reforming and combined heat, hydrogen and power (CHHP), at the refueling station.[520] So, although EPA does not consider the direct CNG vehicle pathway to be a potential GHG emissions game-changer, we do consider investments in CNG technology and refueling infrastructure to be a valuable, indirect step towards hydrogen FCVs, which can be a game-changer in terms of GHG emissions.

EPA also agrees with those commenters who argued that CNG vehicles share some of the market barriers faced by technologies for which EPA is providing temporary regulatory incentives; for example, higher vehicle cost, lower vehicle range, the need for new refueling infrastructure, and consumer acceptance. On the other hand, EPA also believes that CNG vehicles do not face the same magnitude of barriers with respect to overall consumer acceptance as EVs, which involve a completely different consumer refueling paradigm compared to both CNG and gasoline vehicles.

On the basis of the above discussion, EPA believes that it is appropriate to provide a temporary regulatory incentive for CNG vehicles, but not to the same extent as EVs, PHEVs, and FCVs. Based on the considerations just discussed, EPA consequently disagrees with comments that distinctions between CNG vehicles and those other advanced technology vehicles, for which EPA is providing temporary regulatory incentives, are arbitrary.

EPA is adopting an incentive multiplier, for both dedicated and dual fuel CNG vehicles, equal to the multipliers for PHEVs: 1.6 in MYs 2017–2019, 1.45 in MY 2020, and 1.3 in MY 2021. As discussed above, EPA believes these multipliers for CNG vehicles are justified because CNG vehicles and infrastructure indirectly support future commercialization of hydrogen FCVs, which are a potential game-changing GHG emissions technology, and because CNG vehicles face significant market barriers such as lack of fueling infrastructure, vehicle cost and range, and consumer acceptance. EPA is finalizing the same incentive multiplier for both dedicated and dual fuel CNG vehicles, rather than a higher multiplier for dedicated vehicles and a lower multiplier for dual fuel vehicles, because we believe that most owners of dual fuel CNG vehicles will use CNG fuel as much as possible. This is because, once a consumer has paid a premium to be able to use CNG fuel, and given the expectation that CNG fuel will continue to be much cheaper than gasoline, there will be a strong economic motivation for consumers to seek out and use CNG fuel. While the CNG incentive multipliers are equal to those for PHEVs, the effective value of the CNG multiplier to an automaker will be lower relative to most (and possibly all) PHEVs because the multipliers will be applied to the vehicles' respective tailpipe emissions, and most CNG vehicles will likely have lower tailpipe GHG emissions reductions (relative to the footprint-based CO_2 targets) than most PHEVs.

EPA is not adopting additional regulatory incentives for dedicated and dual fuel CNG vehicles beyond the incentive multipliers for MYs 2017–2021. EPA disagrees with those commenters that argued that EPA should provide the same ''0.15 divisor'' incentive for GHG emissions compliance that is used for the calculation of CAFE credits for alternative fuel vehicles. Congress provided the 0.15 divisor for CAFE compliance because a vehicle that operates on a nonpetroleum fuel (like CNG) consumes zero or near-zero petroleum, and petroleum conservation is a primary objective of the CAFE program. But, as shown above, the tailpipe GHG emissions from CNG vehicles, while approximately 20% lower than from comparable gasoline vehicles, are substantial and do not reflect game-changing GHG emissions performance. The primary focus of the GHG standards is GHG emissions. EPA is not persuaded that adopting the divisor is warranted from a GHG standpoint because there would be a significant reduction of GHG programmatic benefits that is not warranted by these vehicles. As discussed above, the fact that CNG technology can be a helpful, indirect step toward hydrogen FCVs does justify providing an incentive multiplier, but this same rationale is not sufficient to justify a far larger regulatory incentive. We also disagree with those commenters who argued that EPA must adopt the 0.15 divisor in order to not ''negate the Congressional mandate'' for CAFE credits. The Congressional mandate still applies for CAFE purposes. EPA's GHG program and NHTSA's CAFE program are harmonized in numerous ways, but there are a number of instances where the programs diverge with respect to incentives and flexibilities. See section I.B.4 above. Here, EPA believes that the paramount emission reduction goals of the CAA warrant the difference in approach.

v. 0 g/mi Compliance Treatment for EV/PHEV/FCVs with MYs 2022–2025 Per-Company Cap and Net Upstream GHG Emissions Compliance Beyond Cap

The tailpipe GHG emissions from EVs, from PHEVs operated on grid electricity, and from 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 criteria 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,[521] 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.[522] In the future, if there were a program to comprehensively address upstream GHG emissions, then the zero tailpipe levels from these vehicles have the potential to contribute to very large

[519] *Natural Gas and Hydrogen Infrastructure Opportunities Workshop October 18–19, 2011,* Argonne National Laboratory, February 21, 2012, page 7, *http://www.transportation.anl.gov/pdfs/AF/812.PDF* (last accessed August 10, 2012).

[520] *Natural Gas and Hydrogen Infrastructure Opportunities Workshop October 18–19, 2011,* Argonne National Laboratory, February 21, 2012, page 19, *http://www.transportation.anl.gov/pdfs/AF/812.PDF.*

[521] EPA has proposed a New Source Performance Standard for greenhouse gas emissions from new electricity generating units, see 77 FR 22392.

[522] There is significant regional variation with upstream GHG emissions associated with electricity production and distribution. Based on EPA's eGRID2012 database, comprised of 26 regions, the average 2009 power plant GHG emissions rates per kilowatt-hour for those regions with the highest GHG emissions rates are over 3 times higher than those with the lowest GHG emissions rates. See *http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html.*

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 MYs 2012–2016 rule see 75 FR 25434–438.

Original equipment manufacturers currently offer several EVs and PHEVs in the U.S. market. EVs on the market include the Nissan Leaf, Mitsubishi MIEV, Ford Focus EV, Tesla S, Honda Fit EV, and Coda Sedan. PHEVs on the market include the Chevrolet Volt, Toyota Prius PHEV, and Fisker Karma. Some of these models are available nationwide, others are available in selected markets. At this time, no original equipment manufacturer offers FCVs to the general public except for some limited demonstration programs.[523]

EVs and FCVs represent some of the most significant changes in automotive technology in the industry's history.[524] Although EVs face major consumer barriers such as significantly higher vehicle cost and lower range, EPA remains optimistic about consumer acceptance of EVs, PHEVs, and FCVs in the long run, but believes that near-term market acceptance is less certain. EVs have a completely different consumer refueling paradigm, which might appeal to some consumers and discourage other consumers. EVs also have attributes that could be attractive to 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.[525]

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. While conventional hybrids have now been on the U.S. market for over a decade, their market share hovers around 2 to 3 percent, 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. 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 providing incentives for these potential game-changing technologies today if we want to retain the possibility of achieving their 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.[526] On the other hand, vehicles using electricity and hydrogen emit no GHG emissions at the vehicle tailpipe, and therefore all GHG emissions associated with powering the vehicle are due to fuel production and distribution.[527] Depending on how the electricity and hydrogen fuels are produced, these fuels can have 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). As shown in Table III–16, today's Nissan Leaf EV would have an upstream GHG emissions value of 156 grams per mile based on national average electricity, and a value of 96 grams per mile based on the average electricity in California, one of the initial major 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 power plants, EPA believes it is appropriate to consider the incremental upstream GHG emissions associated with electricity production and distribution for the model years at issue in this rulemaking. 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.

As noted above, EPA proposed that, for MYs 2017–2021, all EVs, PHEVs (electric operation), and FCVs would have a GHG emissions compliance value of 0 grams per mile (g/mi). For MYs 2022–2025, EPA proposed a compliance value of 0 g/mi for EVs, PHEVs, and FCVs for that vehicle production below a per-company, cumulative production cap threshold for those four model years. The proposed cap had two tiers, consistent with the two-tier cap approach that was adopted in the rulemaking for MYs 2012–2016.[528] 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. The rationale for this two-tier approach was that it would provide an extra incentive to those automakers willing to take early leadership in commercializing EV/PHEV/FCVs. In other words, a manufacturer would be allowed to continue using a 0 g/mi compliance value for EV/PHEV/FCVs during MYs 2022–2025 until its per-company production cap was exceeded, at which point the manufacturer would begin calculating compliance using net upstream GHG emissions accounting. See 76 FR 75013. The agency also asked for comments on an alternative industry-wide cap design. This would place an industry-wide cumulative production cap of 2 million EV/PHEV/FCVs eligible for the 0 g/mi incentive in MYs 2022–2025. 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/

[523] 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).

[524] A PHEV is not such a big change since, if the owner so chooses, it can operate on gasoline.

[525] PHEVs and FCVs share many of these same challenges and opportunities.

[526] 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 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. See section III.G.5.

[527] 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 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.

[528] 75 FR 25436.

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). See 76 FR 75013.

For both the proposed per-company cap and the alternative industry-wide cap, EPA proposed that, for production beyond the cumulative vehicle production cap for a given manufacturer in MYs 2022–2025, 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. See Section III.C.2.c.vi below for the details of this methodology.

Finally, EPA also asked for comments on approaches for phasing in from a 0 g/mi 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 recognized in the proposal that the use of EVs, PHEVs, and FCVs in the 2017–2025 timeframe, in conjunction with both the incentive multiplier and the 0 g/mi compliance treatment, would decrease the overall GHG emissions reductions associated with the program as the upstream emissions associated with the generation and distribution of national average electricity are higher than the upstream emissions associated with production and distribution of gasoline. EPA accounted for this difference in projections of the overall program's impacts and benefits. In the proposal, EPA projected that, based on plausible assumptions about EV/PHEV/FCV sales, the decrease in GHG emissions reductions due to the temporary regulatory incentives would likely be on the order of 5% or so.[529] EPA has updated that analysis in Section III.C.2.d below and in the Regulatory Impact Analysis.

EPA received a large number of comments on the topic of compliance treatment for EV/PHEV/FCVs. Two commenters, the Northeast States for Coordinated Air Use Management and the National Association of Clean Air Agencies, supported the proposal. But the great bulk of commenters opposed the proposed treatment, with opponents approximately split on whether the proposed EV/PHEV/FCV incentives were too much or too little.

The most addressed issue was the proposed 0 g/mi compliance treatment. Almost all automakers strongly supported 0 g/mi as the most appropriate compliance value for EV/PHEV/FCVs and that upstream emissions should never be factored into vehicle GHG emissions compliance values. The Alliance of Automobile Manufacturers summarized many of the themes that were repeated by most automakers: ''Automakers should not be required to account for utility GHG emissions * * *. Clearly automakers have no control over the feedstocks that power plants use to create electricity nor do we have control over the conversion or transportation processes, or where and when a vehicle owner recharges a vehicle. * * * [m]aking vehicle manufacturers responsible for emissions over which they have no control is contrary to the Clean Air Act. * * * [t]he attribution of upstream emissions impacts to grid-powered vehicles alone would be arbitrary, capricious and an abuse of discretion * * *. If Americans agree that programs to address upstream GHG emissions are appropriate, then such programs should be put in place through appropriate regulation of electricity generators, not by imposing additional burdens on vehicle manufacturers.'' Nissan echoed many of these same themes: ''The proposal to focus on tailpipe emissions is consistent with the policy objective of fostering electric vehicles and with the fact that automobile manufacturers only control tailpipe emissions and have no control over the fuel source for electric power * * *. Not only is EPA's proposal to measure EVs as zero grams per mile the best policy decision to promote EV deployment, it is also legally required * * *. Section 202 [of the Clean Air Act] gives EPA discretion to incentivize new technologies, but Section 202 does not give EPA the authority to consider non-vehicle related emissions when setting compliance standards. Doing so would disrupt the careful structure of the CAA * * *. Specifically, Title I of the CAA regulates stationary sources, while Title II of the CAA regulated mobile sources.'' Several other automakers made similar arguments. The United Auto Workers ''believes that zero grams per mile are the most faithful representation of the tailpipe pollution for a vehicle that in many cases has no tailpipe. Accordingly, while the UAW believes that the proposed caps for zero gram per mile treatment by the EPA for model years 2022–2025 are likely adequate to avoid assigning upstream emissions to large numbers of these vehicles, we urge the EPA to reconsider its stance that the emissions of electricity producers should be assigned to the products that use electricity. The proper place to measure and regulate these emissions is of course where the electricity is produced and the grid system that distributes electricity.'' Electric vehicle advocates also echoed these same themes, and the Edison Electric Institute argued that 0 g/mi ''is not an 'incentive' but a recognition of actual EV emissions which are 0.0 g/mile when measured at the tailpipe.''

Two automakers opposed the use of 0 g/mi. Honda ''believes that EPA should separate incentives and credits from the measurement of emissions. Honda believes that without accounting for the upstream emissions of all fuels, inaccurate comparisons between technologies will take place * * *. EPA's regulations need to be comprehensive and transparent. By zeroing out the upstream emissions, EPA is conflating incentives and credits with proper emissions accounting.'' EcoMotors International ''encourages EPA to drop the 0 g/mile tailpipe compliance value.'' Environmental advocacy groups also opposed the 0 g/mi compliance treatment. The Natural Resources Defense Council claimed that 0 g/mi ''undermines'' the pollution and technology benefits of the program. Along with other environmental groups, the American Council for an Energy Efficient Economy also opposed 0 g/mi, but added that ''[m]ost important, however, is that a zero-upstream treatment of plug-in vehicles not be continued indefinitely, and that full upstream accounting be applied to these vehicles by a date certain. EPA's proposed treatment of EVs largely accomplishes this, so we strongly support that aspect of the proposal.'' The American Petroleum Institute argued that ''[i]gnoring the significant contribution of (and extensive compilation of published literature on) upstream CO_2 emissions from electricity generation, defies principles of transparency and sound science and distorts the market for developing transportation fuel alternatives. It incentivizes the electrification of the vehicle fleet with a pre-defined specific and costly set of technologies whose future potential is not measured with the same well-to-wheels methodology against that of advanced biofuels or other carbon mitigation strategies.'' Organizations advocating fuels other than electricity also opposed the use of 0 g/mi.

EPA received many fewer comments on the proposed cap on the number of vehicles that would be eligible for the 0 g/mi compliance treatment in MYs 2022–2025. The specific questions here are (1) whether the cap should be a per-company cap where individual

[529] 76 FR 75015.

companies would have greater advance certainty, but there would be greater uncertainty with the overall environmental outcome, or an industry-wide cap, where there would be greater environmental certainty regarding the maximum number of vehicles that would be eligible for the 0 g/mi treatment, but where individual manufactures would not know their effective per-company caps until some point in the future, and (2) the production/sales threshold for the cap. The joint Sierra Club/Environment America/Safe Climate Campaign/Clean Air Council comment recommended ''a floating industry wide cap for number of EV sales eligible for zero emissions treatment in 2022–2025 be set at 1 million minus cumulative sales in 2017–2021 rather than the 2 million vehicle cap in the proposed rule.'' The American Council for an Energy Efficient Economy recommended that ''in the 2017–2025 period, the number of such EVs should be capped at 2 million.'' The Natural Resources Defense Council ''recommends that EPA adopt an industry-wide cap following the structure described in the NPRM as the alternative to the proposed manufacturer-specific cap. NRDC recommends the industry-wide cap because it ensures the environmental benefits of the program. If set appropriately * * * the industry-wide cap could ensure that no more than 5 percent of the program GHG reductions are lost. NRDC recommends that the industry-wide cap be set based on cumulative plug-in electric vehicles produced beginning in 2012 because even these early volumes will help pave the way for electric vehicle production cost reductions and greater market acceptance * * *. [T]he post 2021 cap of no more than 2 million vehicles would be lowered by the cumulative sales that occurred before 2022 to reflect the technology advancement in the early years of the program.''

Nissan and BMW were the only individual automakers to comment on this question. Nissan stated that: ''[a]ny regulatory cap should be industry based in order to encourage investment in electric powertrains now for use in the coming model years, and the cap should not reserve any volume for manufacturers selling zero electric vehicles in MYs 2019–2021 * * *. The purpose of the proposed incentives is to encourage manufacturer investment in potentially game-changing technologies now to accelerate their adoption rate. Adopting an industry-wide cap will serve that purpose.'' On the other hand, BMW ''prefers company-based cap. * * * [as it provides] clear planning certainty in the whole time period of the regulation * * * [while the industry-wide cap provides a] big advantage for [high] volume manufacturer.'' The Association of Global Automakers stated that ''[i]f EPA decides to adopt company-specific caps, we recommend that it adopt a simple linear function based on vehicle sales levels to establish the caps, rather than using the proposed two-step approach.'' No other individual automaker addressed this issue. EPA recognizes that almost every automaker supported the permanent adoption of the 0 g/mi compliance treatment, and under that approach the concept of caps is meaningless. Finally, the Electric Drive Transportation Association stated that: ''[a]n industry-wide cap is especially problematic, because each manufacturer's cap would depend on that manufacturer's relative share of the market, not its absolute sales volume; a cap based on relative share is very difficult for a manufacturer to predict, because it is tied to decisions made by other manufacturers.''

No commenters suggested any alternatives to basing EV/PHEV/FCV GHG emissions compliance values, for production beyond the cumulative vehicle production cap for a given manufacturer in MY 2022 and later, on the full net increase in upstream GHG emissions relative to that of a comparable gasoline vehicle.

The agency received one comment on the question of whether the transition from a 0 g/mi compliance treatment to a full net increase in upstream GHG emissions, for production beyond the cumulative vehicle production cap in MY 2022 and later. Nissan stated that ''[t]he interim period between a zero grams per mile compliance value and full net increase in upstream emissions value should be equal to the number of vehicles each manufacturer can assign a zero grams per mile compliance value for MYs 2022–2025, and the interim period compliance value should be one-half of the net increase.''

EPA is finalizing, as proposed, the 0 g/mi compliance treatment for EV/PHEV/FCVs with a per-company vehicle production cap in MYs 2022–2025 and net upstream GHG emissions compliance beyond the cap. As the above summary shows, there were strong public comments, on both sides, on the proposed approach for the compliance treatment for EV/PHEV/FCVs, beginning with 0 g/mi and transitioning to a full net increase in GHG upstream emissions if and when a manufacturer exceeds its vehicle production cap threshold. But there was no new information or rationales provided to EPA that changes the Agency's perspective on these matters. EPA disagrees with those commenters who believe that compliance values for vehicle GHG emissions standards under section 202(a) cannot take fuel-related upstream GHG emissions into account, and that it is ''arbitrary and capricious'' to do so and ''contrary'' to the Clean Air Act. As EPA explained when discussing this issue in the MYs 2012–2016 light duty vehicle GHG rulemaking, ''EPA is not directly regulating upstream GHG emissions from stationary sources, but instead is deciding how much value to assign to a motor vehicle for purposes of compliance calculations with the motor vehicle standard. While the logical place to start is the emissions level measured under the test procedure, section 202(a)(1) does not require that EPA limit itself to only that level.'' 75 FR 25437. Furthermore, there is a reasoned basis for accounting for upstream GHG emissions here because, as shown in Table III–16 above, upstream GHG emissions attributable to increased electricity production to operate EVs or PHEVs currently exceed the upstream GHG emissions attributable to gasoline vehicles. EPA thus believes that although section 202(a)(1) of the Clean Air Act does not require the inclusion of upstream GHG emissions in these regulations, the discretion afforded under this provision allows EPA to consider upstream GHG emissions, particularly when such emissions from new technologies are higher than those from conventional vehicles. On the other hand, EPA also disagrees with those commenters who claim that, by allowing a 0 g/mi compliance treatment, the Agency is ''ignoring'' upstream emissions and ''not being transparent.'' The agency has discussed and quantified the upstream GHG emissions associated with EVs and PHEVs at length in the rulemaking analyses for both the MYs 2012–2016 rule and this rule. EPA also disagrees that the 0 g/mi compliance treatment ''undermines'' the program, as the Agency believes that it will likely lead to only a small percentage loss of overall program GHG emissions reductions (see Section III.C.2.d for these projections), while creating an important incentive for potentially enormous emissions reductions from these vehicles in the longer term. The broad discretion to set emissions standards under section 202(a)(1) includes authority to structure those standards in a way that provides an incentive to promote advances in emissions control technology, which includes discretion in how to structure a compliance regime so as to promote use of advanced technologies.

In summary, EPA continues to believe that finalizing the proposed compliance treatment for EV/PHEV/FCVs strikes a reasonable balance between promoting the commercialization of EV/PHEV/FCVs, which have the potential to achieve game-changing GHG emissions reductions in the future, and accounting for upstream emissions once such vehicles reach a reasonable threshold in the market. The mid-term evaluation will provide an opportunity to review the status of advanced vehicle technology commercialization, the status of upstream GHG emissions control programs, and other relevant factors.

EPA is also finalizing, as proposed, the per-company vehicle production caps for MYs 2022–2025. The cumulative per-company caps for MYs 2022–2025 are 600,000 EV/PHEV/FCVs for those manufacturers that produce a total of 300,000 or more EV/PHEV/FCVs in MYs 2019–2021, and 200,000 EV/PHEV/FCVs for all other manufacturers. The central tension in the design of a 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 maximum decrease in GHG emissions reductions. A per-company cap 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 g/mi compliance treatment and therefore the overall impact on GHG emissions. With an industry-wide cap, EPA would establish a finite limit on the total number of vehicles eligible for the 0 g/mi 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, automakers would have much less certainty and leadtime for compliance planning as they would not know their individual caps until some point in the future. Public comments on the relative merits of per-company and industry-wide caps were mixed. EPA has chosen to finalize the per-company cap because of the concern that the uncertainty faced by individual automakers about how they would fare under an industry-wide cap could, in effect, act as a disincentive to pursue advanced vehicle technology commercialization.

Finally, EPA is finalizing the full net upstream GHG emissions approach for the compliance treatment for EV/PHEV/FCVs beyond the per-company vehicle production threshold caps in MYs 2022–2025. EPA is not adopting any type of ''phase-in'', i.e., the compliance value will change from 0 g/mi to the full net upstream GHG emissions value once a manufacturer exceeds the cap. EPA believes that the levels of the per-company vehicle production caps in MYs 2017–2025 are high enough to provide a sufficient incentive such that any production beyond those caps should use the full net upstream GHG emissions accounting.

vi. Methodology for Determining Net Upstream GHG Emissions Compliance for EVs Beyond Cap

EPA proposed a specific methodology for calculating the net upstream GHG emissions compliance value for EVs (and the electric portion of PHEV operation). This methodology was based on four key inputs: (1) The vehicle electricity consumption over EPA city and highway compliance tests (under EPA test protocols, this accounts for the losses associated in vehicle charging as well), (2) an adjustment to account for electricity losses during electricity grid transmission, (3) a projected 2025 nationwide average electricity upstream GHG emissions rate of 0.574 grams/watt-hour at the power plant, which accounts for both power plant and feedstock GHG emissions, and (4) the upstream GHG emissions of a comparable gasoline vehicle meeting its MY 2025 GHG emissions target. See 76 FR 75014.

The 0.574 grams/watt-hour electricity upstream GHG emissions factor that EPA proposed was based on a nationwide average power plant value for 2025, based on simulations with the EPA Office of Atmospheric Programs' Integrated Planning Model (IPM), and a 1.06 multiplicative factor to account for additional upstream GHG emissions associated with feedstock extraction, transportation, and processing. EPA recognized in the proposal that there were other approaches for projecting a future upstream GHG emissions factor for EVs and PHEVs, and that EPA would be considering running the IPM model with more detailed vehicle and vehicle charging-specific assumptions to generate a more robust electricity upstream GHG emissions factor for EVs and PHEVs in the final rulemaking. Specifically, the Agency discussed its intention to account for the likely regional sales variation for initial EV/PHEV/FCVs, and the likely frequency of daytime and nighttime charging. EPA sought comment on whether there were additional factors that the Agency should try to include in the IPM modeling for the final rulemaking.

All of the relevant comments directly or indirectly supported a more sophisticated approach for determining the electricity upstream GHG emissions factor. Nissan noted that most of its initial Leaf sales have been in California and other states with lower-than-average electricity GHG emissions. It concluded: ''By accounting for upstream emissions using a national average, electric vehicle manufacturers would be penalized because their compliance standard will not be reflective of actual upstream emissions.'' Edison Electric Institute stated: ''[i]t is inappropriate for EPA, now in 2012, to calculate any upstream electricity GHG emissions rate for 2025, as there is no way that this value could reasonably approximate actual electric generating unit (EGU) emissions 13 years in the future * * *. Unless EPA dramatically changes its assumptions about the makeup of the generating fleet in 2025 to better reflect current and expected regulations, any additional IPM runs—even those using updated vehicle and charging assumptions—will be equally unable to provide an upstream electricity GHG emissions rate that has any relationship to actual emissions in 2025. If EPA does decide to conduct additional IPM runs for the final rule, the Agency must do more than update vehicle and charging assumptions * * *. In 2011, California residents purchased more than 60 percent of the Nissan Leafs and about 30 percent of the Chevrolet Volts sold in the U.S. * * *. The Agency would be better served by waiting until MY 2021 to estimate upstream GHG electricity emissions, using actual emissions data and the most up-to-date information about the EGU generating fleet. EPA easily could conduct this analysis concurrently with the planned midterm evaluation of the vehicle standards necessary to support NHTSA's required, separate rulemaking to establish CAFE standards for MY 2022–2025.''

The Electric Drive Transportation Association (EDTA) argued that ''[t]his national average—or any national average for that matter—fails to take into account the wide variation in actual 'upstream emissions' among different regions, demographic groups, and vehicle types. The fundamental point is that *average* GHG emissions from electricity generation are not necessarily representative of the *incremental* emissions resulting from the charging of a particular vehicle or vehicle model. The additional emissions associated with charging a particular vehicle or vehicle model will depend on many factors. First, any estimate of upstream emissions would need to take into account the geographic distribution of the users of the vehicles, since the electricity generation mix varies considerably by region. In addition, it would need to take into account the expected driving habits and charging habits of those users, which could vary significantly for different vehicle models. It also would need to take into account a host of capital investment and operational decisions made by electric utilities and grid operators, including decisions about the electricity generation mix for both base load and peak load that are made on a daily basis in managing the grid, and over time, in planning the energy inventory of a service territory.'' Ford stated that it supported the EDTA comment. The American Petroleum Institute stated: ''API concurs with the EPA's observation that there is significant regional as well as temporal variation in the fuels and equipment used for electric power generation. Consequently, a more robust analysis and representation of upstream electricity GHG emissions that incorporates this regional and temporal variability is preferable if the ultimate objective is to reflect real-world fuel usage patterns.'' Referring to the 1.06 multiplicative factor that EPA used to account for feedstock-related GHG emissions, API stated: ''Using the most recent version of GREET (version 1_2011) yields an adjustment factor of 9.2% for the average US electricity mix in calendar year 2020.'' The Natural Resources Defense Council (NRDC) noted that ''there are several factors to consider including marginal versus average power plant emissions rates, regional variability and how to project emission rates for vehicles that are charging over many years. NRDC provided comments in the 2012–2016 GHG proposed rule along these lines and we recognize that on-going analysis could be appropriate to most accurately quantify electric vehicle emission rates for real-world operation.''

EPA agrees with the commenters that developing an appropriate electricity upstream GHG emissions factor for vehicles that will be sold in MYs 2022–2025, and be on the road out to 2040 or even 2050, is a challenging task, due to the many assumptions that must be made to reflect relevant variables. EPA continues to believe that the IPM model is the best tool for making such long-term projections, as it is a long-term capacity expansion and production costing model for analyzing the U.S. electric power sector. EPA has used IPM for most electricity sector analysis for the last 15 years, including for several major EPA power sector regulatory initiatives. While continuing to use the IPM model, EPA has made several refinements in the approach that we are adopting for estimating the electricity upstream GHG emissions for vehicles sold in MYs 2022–2025 subsequent to the proposal. One, we are using a newer IPM version (version 4.10) that is harmonized with new EPA stationary source emissions controls (such as the Mercury and Air Toxics Standards and the Cross-State Air Pollution Rule) and reflects recent economic conditions such as lower natural gas prices and lower electricity demand growth. This newer IPM version should address many of the concerns expressed by the Edison Electric Institute that use of IPM will necessarily overestimate future electricity GHG emissions. Two, as we suggested in the proposal and as supported by public comments, EPA changed from a ''national average'' electricity GHG emissions factor to one that projects the average electricity GHG emissions factor for the additional electricity demand represented by the EVs and PHEVs that EPA projects will be sold in MYs 2022–2025 and on the road in calendar year 2030. Three, rather than assuming that EVs and PHEVs would be distributed proportionally throughout the U.S., EPA distributed EV and PHEV sales into the 32 IPM regions based on the distribution of hybrid vehicle sales in 2006–2009 (e.g., much higher per capita sales in California, lower per capita sales in Montana). Four, EPA assumed that EVs and PHEVs would charge 25 percent of the time on-peak and 75 percent of the time off-peak, which is consistent with early vehicle charging data from the DOE ''EV Project.''[530] The cumulative effect of these changes is that IPM projects that about 80 percent of the additional electricity needed to reflect the extra demand by EVs and PHEVs in 2030 will come from natural gas, with 14 percent from coal, and 6 percent from wind and other feedstocks (66.3% of this average power plant GHG emissions factor originates from natural gas combustion emissions, 33.4% from coal combustion emissions, and 0.3% from combustion emissions of other feedstocks such as landfill gas petroleum coke, and oil). This is a lower-GHG mix of feedstocks than the mix that was projected for the national average approach in the proposal. Using this approach, the average power plant electricity GHG emissions factor is projected by IPM to be 0.445 grams/watt-hour.

Since the proposal, EPA has also re-evaluated the appropriate multiplicative factor to account for the feedstock-related GHG emissions upstream of the power plant. This is necessary for three reasons: The feedstock mix in the new approach is very different than the national average feedstock mix assumed in the proposal (i.e., natural gas represents a much higher fraction of the projected 2030 feedstock mix under the new approach), there are more recent data on the upstream GHG emissions associated with natural gas production that were not reflected in the 1.06 feedstock factor that was used in the proposal, and EPA recently promulgated a New Source Performance Standard (NSPS) for natural gas operations beginning in 2015.[531] EPA is now using a projected multiplicative factor of 1.20 for feedstock-related GHG emissions for the additional electricity necessary to support EVs and PHEVs in 2030. This factor is derived from application of Argonne National Laboratory's GREET model, which was used to estimate GHG emissions that occur upstream of the power plant emissions (for example, the emissions associated with the extraction, processing and transportation of power plant feedstocks). EPA used the GREET default values for different feedstocks with one exception. EPA adjusted a default GREET value for upstream methane emissions associated with natural gas-fired power plants to account for the impact of the recently promulgated NSPS for natural gas operations.[532] The NSPS will result in a 95 percent reduction of uncontrolled VOC emissions (causing a corresponding reduction in methane

[530] *http://www.theevproject.com/downloads/documents/45.%20Battery%20Electric%20Vehicle%20Driving%20and%20Charging%20Behavior%20Observed%20Early%20in%20The%20EV%20Project%20(April%202012).pdf*, last accessed July 10, 2012.

[531] EPA signed the final rule on 4/17/12; publication of the official version in the **Federal Register** is forthcoming. For internet version of final rule, see *http://www.epa.gov/airquality/oilandgas/pdfs/20120417finalrule.pdf*.

[532] EPA utilized GREET 1_2011, available at *http://greet.es.anl.gov/* (last accessed July 10, 2012). EPA revised the default emissions estimate of about 481 g CH_4 per mmBtu of natural gas for electricity generation to 458 g CH_4 per mmBtu (see ''NG'' worksheet, C156).

emissions) due to requirements for flaring and reduced emissions completions and workovers for hydraulically fractured wells. This adjustment to the one GREET model default value had a minimal impact on the total life cycle emissions from natural gas electricity generation because these completion and workovers are only a few of many emissions sources included in natural gas emissions totals, and because the GREET emission values for these activities already accounted for state regulatory efforts and industry best practices. Expressing the results of the GREET modeling effort in terms of multiplicative factors of life cycle GHG emissions mass per power plant GHG emissions mass for each feedstock, coal has a feedstock multiplier of 1.05 and natural gas has a feedstock multiplier of 1.28. The emissions from the other feedstocks are low enough, less than 0.3 percent, to ignore the feedstock multipliers (effectively assigning a value of 1.0). Weighting these feedstock multipliers by the IPM run GHG emissions percentages (33.4 percent natural gas, 66.3 percent coal, 0.3 percent other feedstocks) yields an overall feedstock multiplier of 1.20.

The overall electricity upstream GHG emissions factor, for the additional electricity needed to reflect the extra demand by EVs and PHEVs in 2030, is the product of the 0.445 grams/watt-hour power plant value and the 1.20 factor for feedstock-related emissions, or 0.534 grams/watt-hour. This is somewhat lower than the 0.574 grams/watt-hour value that was used in the proposal.

Below is an example of the 4-step methodology in today's final rule for calculating the GHG emissions compliance value for vehicle production in excess of the cumulative production cap for an individual automaker for MYs 2022–2025, for an EV that has the same electricity consumption, 238 watt-hours/mile, as the 2012 Nissan Leaf:

- A measured 2-cycle vehicle electricity consumption of 238 watt-hours/mile over the EPA city and highway tests
- Adjusting this watt-hours/mile value upward to account for electricity losses during electricity transmission (dividing 238 watt-hours/mile by 0.935 to account for grid/transmission losses yields a value of 255 watt-hours/mile)
- Multiplying the adjusted watt-hours/mile value by a 2030 EV/PHEV electricity upstream GHG emissions rate of 0.534 grams/watt-hour at the power plant (255 watt-hours/mile multiplied by 0.534 grams GHG/watt-hour yields 136 grams/mile)
- Subtracting the upstream GHG emissions of a comparable midsize gasoline vehicle of 41 grams/mile [533] to reflect a full net increase in upstream GHG emissions (136 grams/mile for the EV minus 41 grams/mile for the gasoline vehicle yields a net increase and EV compliance value of 95 grams/mile).[534]

The full accounting methodology for FCVs and the portion of PHEV operation on grid electricity would use this same approach. The final regulations adopt EPA's proposed method to determine the compliance value for PHEVs, and EPA will develop a similar methodology for FCVs if and when the need arises based on the fuel production and distribution GHG emissions associated with hydrogen production for various feedstocks and processes.[535]

The final issue raised by the Edison Electric Institute was that it would be better for EPA to wait until the midterm evaluation to adopt an electricity upstream GHG emissions factor. EPA disagrees with this comment. EPA believes it is critical to provide the automobile manufacturers, for their long-term compliance planning, a value that we expect to be used for compliance purposes in MYs 2022–2025, for those manufacturers who exceed their vehicle production caps for EVs and PHEVs. We understand that there are many factors that could lead to an electricity upstream GHG emissions factor for EVs and PHEVs that may be higher or lower, such as future regulations, market forces, regional distribution of EV/PHEV sales, and vehicle charging patterns. EPA will continue to evaluate these factors, including in the mid-term evaluation, and will address these issues there.

vii. Should Other Technologies Be Eligible for Incentives?

The proposal included temporary regulatory incentives for three technologies: EVs, PHEVs, and FCVs. Sections III.C.2.c.ii and III.C.2.c.v discuss the final incentives for EVs, PHEVs, and FCVs. EPA also solicited comment on whether incentives should be provided for CNG vehicles, and Section III.C.2.c.iv discusses the final incentives for those vehicles. The Agency also received comments recommending that other technologies receive regulatory incentives.

The Alliance of Automobile Manufacturers, Association of Global Automakers, and Ford recommended that incentive multipliers be available for manufacturers of liquefied petroleum gas (LPG) vehicles. EPA is not adopting incentive multipliers for LPG vehicles because the Agency does not believe that LPG vehicles promote the commercialization of technologies that have, or technologies whose commercialization can be critical facilitators of next-generation technologies that have, the potential to transform the light-duty vehicle sector by achieving zero or near-zero GHG emissions and oil consumption.

Toyota suggested that conventional hybrid electric vehicles should receive incentive multipliers, if, as is the case, CNG vehicles receive such multipliers. EPA is not adopting incentive multipliers for conventional hybrid vehicles. Although the Agency agrees with Toyota that conventional hybrids share many of the same electric drive components of EVs and PHEVs (e.g., batteries, motors, controllers), with respect to consumer acceptance and barriers to utilization, the Agency believes that conventional hybrids are much more similar to gasoline vehicles than they are to EVs, in that all of the propulsion energy comes from gasoline, vehicle range is improved, and hybrids need no new refueling infrastructure. As such there is not the same degree of market barriers inhibiting increased use of this technology.

Volkswagen also recommended incentives for ''advanced technology compression ignition engines,'' or what are more commonly referred to as advanced diesel engines. EPA is not adopting an incentive multiplier for advanced diesel vehicles because the Agency does not believe that advanced diesel vehicles promote the commercialization of technologies that have, or technologies whose commercialization can be critical facilitators of next-generation technologies that have, the potential to transform the light-duty vehicle sector by achieving zero or near-zero GHG emissions and oil consumption, nor do advanced diesels face significant barriers with respect to consumer acceptance, relative to EV/PHEV/FCVs and CNG vehicles.

[533] A midsize gasoline vehicle with a footprint of 46 square feet would have a MY 2025 GHG target of about 147 grams/mile; dividing 8887 grams CO2/gallon of gasoline by 147 grams/mile yields an equivalent fuel economy level of 60.5 mpg; and dividing 2478 grams upstream GHG/gallon of gasoline by 60.5 mpg yields a midsize gasoline vehicle upstream GHG value of 41 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 MY2012–2016 rulemaking titled ''Calculation of Upstream Emissions for the GHG Vehicle Rule'') and multiplying by 0.115 million Btu/gallon of gasoline.

[534] Manufacturers can utilize alternate calculation methodologies if shown to yield equivalent or superior results and if approved in advance by the Administrator.

[535] 40 CFR 600.113–12(m).

Finally, the Agency received many comments related to a broad set of issues related to biofuels.

The Clean Fuels Development Coalition, Growth Energy, the 25x'25 Alliance (and partners), Volkswagen, and the Association of Global Automakers recommended that EPA provide GHG emissions incentives to automakers that produce vehicles capable of operating on biofuels, such as ethanol and biodiesel, beyond MY 2015 (when incentives under the light-duty vehicle GHG program currently expire) and/or gasoline/biofuels blends. EPA recognizes that the use of certain biofuels has the potential to reduce lifecycle GHG emissions. EPA also recognizes that other programs already either require the increasing use of renewable fuels in the transportation sector or provide incentives for vehicle manufacturers to produce vehicles capable of operating on more than one fuel. In that context, EPA believes it is not appropriate to adopt incentive multipliers, or the 0.15 divisor, in this rule for manufacturers of biofuel-capable vehicles. The tailpipe GHG emissions of biofuel-capable vehicles when operated on biofuels are typically slightly lower than GHG emissions from conventional vehicles, and those GHG emissions performance-based reductions would be accounted for in EPA compliance calculations based on the actual use of biofuels. On the other hand, biofuels-capable vehicles are typically no more expensive than conventional vehicles, they may or may not use a biofuel (since they can operate on conventional fuel), and they do not face significant consumer acceptance barriers since they can, and most often are, operated on fuels with high gasoline content. As noted above, one purpose of the incentive multipliers for vehicles such as EVs, PHEVs, FCVs, and CNG vehicles is to address barriers to the increased use in the marketplace of those vehicles and their fuels. The factors above indicate there are not similar barriers for the increased production of biofuel-capable vehicles. As such, there is not a similar basis for adopting incentive multipliers for biofuel-capable vehicles.

The 25x'25 Alliance (and partners) specifically recommended that EPA adopt a ''0.15 multiplier'' for CO_2 emissions compliance ''in order to preserve existing statutory incentives for alternative fuels'' under the CAFE program. As discussed above when the same issue arose with respect to CNG vehicles, EPA disagrees with this comment. Congress provided the 0.15 divisor for CAFE compliance because a vehicle that operates on a nonpetroleum fuel (like E85) consumes zero or near-zero petroleum, and petroleum conservation is a primary objective of the CAFE program. The primary focus of the GHG standards is GHG emissions. EPA believes that compliance must be based on demonstrated GHG emissions performance, not on a 0.15 incentive. We also disagree that EPA must adopt the 0.15 incentive in order to ''preserve existing statutory incentives'' for CAFE credits. EPA's GHG program and NHTSA's CAFE program are harmonized in numerous ways, but compliance with one program does not imply compliance with the other. There are a number of instances where the programs diverge with respect to incentives and flexibilities. See section I.B.4 above. Here, EPA believes that the paramount emission reduction goals of the CAA warrant the difference in approach.

Several commenters, including Growth Energy and Plant Oil Powered Diesel Fuel Systems, pointed out that cellulose-based ethanol and other renewable fuels have the potential to yield large lifecycle GHG emissions benefits due to the CO_2 uptake during plant growth, and recommended that such fuels be given credits to reflect the upstream GHG emissions benefits. The use of low-GHG biofuels is already required under the Renewable Fuel Standard (RFS) program, which has been in place since 2006 and is designed to achieve GHG emissions benefits through the required use of renewable transportation fuels that have better lifecycle GHG emissions performance than the gasoline or diesel fuel that they displace. EPA has already quantified the GHG emissions benefits associated with the RFS program. Providing an additional incentive in the MYs 2017–2025 GHG program, which is focused on vehicle tailpipe emissions and not lifecycle emissions, would not achieve any greater use of renewable fuels than is already required under the RFS program, and thus would not achieve any greater emissions reductions from the use of such fuel. Thus, providing an additional incentive would only lead to a reduction in the emissions benefits of the MYs 2017–2025 light-duty vehicle GHG emissions program. Given that renewable fuel use is already required by and accounted for under the RFS program, it therefore would be inappropriate to provide additional incentives in the MYs 2017–2025 program.[536]

A related comment from Growth Energy, the 25x'25 Alliance (and partners), the National Corn Growers Association, and the Minnesota Department of Commerce was that, by not providing incentives for ethanol or biofuel vehicles, the proposal was ''inconsistent'' with the RFS, and, as stated by Growth Energy, ''will make the volumetric biofuels requirements of Title II in EISA unachievable.'' EPA disagrees with these comments. There is nothing inconsistent between the MYs 2017–2025 GHG program and the RFS program. The MYs 2017–2025 GHG program is designed to achieve GHG emission reductions from vehicle operation as measured at the tailpipe. The RFS program is a standalone program designed to increase the use of renewable fuels and to achieve GHG emission reductions primarily through upstream emission reductions. The RFS program can be achieved independent of the vehicle GHG standards. The RFS program does not mandate any particular type of fuel (or vehicle) and relies on market forces to determine the most cost-effective approaches for meeting the RFS program's volume requirements. Achievement of the RFS volume mandates is largely based on decisions that will be made by the fuel industries about what renewable fuels to produce and how to distribute and market them. The RFS program already contains mechanisms to create market incentives to facilitate such increases. No additional incentives for vehicle manufacturers are needed to do so.

Furthermore, there have been CAFE incentives for automakers that produce ethanol FFVs (and other dual fuel vehicles) for many years (see 75 FR 25432–33), and CAFE incentives will remain in place. Although the GHG emissions incentive under the light-duty vehicle GHG rule, designed to be equivalent to the CAFE incentive, will end in MY 2015, automakers can achieve lower GHG emissions compliance values for ethanol FFVs based on lower tailpipe GHG emissions when operating on E85 and a weighting of E85 and gasoline emissions performance based on actual E85 use, an option that EPA is finalizing. (See Section III.C.4 for more detail on the methodology for calculating GHG emissions from ethanol FFVs.) There are approximately 10 million ethanol FFVs on the road in the U.S. today (far more than any other incentivized technology),

[536] The plant oil-based fuel produced by POP Diesel is not currently identified as an acceptable renewable fuel under the RFS program. EPA is currently considering the company's petition seeking approval of its product under the RFS program. The RFS program established by Congress is the appropriate mechanism for evaluating the full lifecycle emissions impact of this type of biofuel use, rather than a program focused principally on vehicle tailpipe emissions.

and automakers produced approximately 2 million ethanol FFVs in MY 2011 alone. Although the great majority of ethanol FFVs currently use gasoline, EPA believes that automakers will continue to produce ethanol FFVs, as more consumers begin to fuel their ethanol FFVs with E85 fuel. Given the long history of federal incentives for ethanol FFVs, and the fact that ethanol FFVs can achieve small GHG emissions credits after the GHG emissions incentives expire, the Agency believes that there is no need to provide additional incentives for ethanol FFVs in this rulemaking, beyond those already provided.

viii. Applicability of Credits for EV/PHEV/FCVs

In the proposal, EPA did not propose any restrictions on the use of GHG emissions credits for those vehicles eligible for the 0 g/mi GHG emissions compliance incentive. The Natural Resources Defense Council commented that ''if the agencies proceed with their proposed 0 g/mi treatment, other incentives, such as off-cycle credits, should not be available for the portion of an advanced vehicle's driving range that is powered by grid electricity or off-board hydrogen. No vehicles should be allowed to have negative emissions.'' EPA is finalizing, as proposed and consistent with the MYs 2012–2016 program, no restrictions on the use of GHG emissions credits for those vehicles eligible for the 0 g/mi GHG emissions compliance treatment, i.e., EV/PHEV/FCVs can earn air conditioner efficiency, air conditioner refrigerant, and off-cycle credits. EPA will be accounting for these credits at the manufacturer fleet level, not at the individual vehicle model level, though we accept the point by NRDC that, in effect, if one were to assess the actual credits earned on a per vehicle basis, the overall compliance value would appear to be negative for this limited set of vehicles. Because of the relatively small number of EV/PHEV/FCVs expected during MYs 2017–2025, EPA expects the fleetwide impact of these additional credits to be very small (see Table III–17), and EPA does not want to discourage improvements in air conditioner and other technologies for EV/PHEV/FCVs that provide real world GHG emissions benefits (including, in the case of air conditioner refrigerants, some of the most potent GHGs).

ix. Changes to MYs 2012–2016 Regulations

In the proposal, EPA sought 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. See 76 FR 75013. EPA received two comments on this topic. Within a broader context of reiterating its support for a 0 g/mi tailpipe-based compliance treatment for EVs, Nissan recommended that if a manufacturer reaches its vehicle production threshold for MYs 2012–2016, there be an ''interim period'' (for the same volume of vehicles that initially triggers the cap) where the non-0 g/mi compliance value be equal to one-half of the net increase. Alternatively, the Natural Resources Defense Council supported no change in the MYs 2012–2016 regulations. EPA is not adopting changes to the MYs 2012–2016 regulations as we believe that the incentives currently in place for MYs 2012–2016 provide a sufficient incentive.

x. Impact of Temporary Regulatory Incentives for EV/PHEVs on Projected GHG Emissions Reductions

In this section, EPA projects the potential impact on GHG emissions that will be associated with both the temporary incentive multiplier and the 0 g/mi compliance value for EV/PHEVs over the MYs 2017–2025 timeframe. Since it is impossible to know precisely how many vehicles will be sold in the MYs 2017–2025 timeframe that will utilize the proposed incentives, EPA provides projections for two scenarios: (1) the number of EV/PHEV sales in MYs 2017–2025 that EPA's OMEGA technology and cost model predicts for the most cost-effective way for the industry to meet the standards, and (2) an alternative scenario with a greater number of EV/PHEVs, based not only on compliance with the standards, but on other factors that could affect the market for EV/PHEVs as well.[537] For this analysis, EPA assumes that EVs and PHEVs each account for 50 percent of all EV/PHEVs.

TABLE III–17—PROJECTED IMPACT OF EV/PHEV INCENTIVES ON GHG EMISSIONS REDUCTIONS

Scenario	Cumulative EV/PHEV sales 2017–2025	Cumulative EV/PHEV sales 2022–2025	Cumulative decrease in GHG emissions reductions 2017–2025 [538]	Percentage decrease in GHG emissions reductions 2017–2025 [539]
EPA OMEGA model projection	1.5 million	1.1 million	56 MMT	2.7%
EPA alternative projection	2.8 million	2.0 million	101 MMT	5.0%

EPA projects that the cumulative GHG emissions savings of the MYs 2017–2025 standards, on a model year lifetime basis, is approximately 2 billion metric tons. Table III–17 projects that the likely decrease in cumulative GHG emissions reductions due to the EV/PHEV incentives for MYs 2017–2025 vehicles is in the range of 56 to 101 million metric tons, or 2.7 to 5.0 percent of overall program savings.

It is important to note that the above projections of the possible impact of the EV/PHEV incentives on the overall program GHG emissions reductions assumes that there would be no change to the standard even if the EV 0 g/mi incentive were not in effect, i.e., that EPA would promulgate exactly the same standard if the 0 g/mi compliance value were not allowed for any EV/PHEVs. Although EPA has not analyzed such a scenario, it is clear that not allowing a 0 g/mi compliance value would change the technology mix and cost projected for the standards.

Of course, either technology innovation or a future comprehensive program addressing upstream emissions

[537] These projections do not include any FCVs or CNG vehicles.

[538] 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 temporary incentive multiplier and no 0 gram per mile compliance value.

[539] 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 program.

of GHGs from the generation of electricity could decrease the loss of GHG reductions associated with the temporary regulatory incentives.

On the other hand, EPA also recognizes that EV/PHEV sales could be higher than projected, and that there are factors which could increase the appropriate electricity upstream GHG emissions factor in the future, such as greater use of high-power charging, and 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).

3. Incentives for Using Advanced ''Game-Changing'' Technologies in Full-Size Pickup Trucks

As explained in section II.C, the agencies recognize that the MY 2017–2025 standards will be challenging for large vehicles, including full-size pickup trucks that are often used for commercial purposes. In Section II.C, and in 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 advanced technology incentives that were proposed and are being adopted for full-size pickup trucks under both section 202(a) of the CAA and section 32904(c) of EPCA. These incentives are 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 proposed and is adopting per-vehicle credit provisions for manufacturers that hybridize a significant number of their full-size pickup trucks, or use other technologies that comparably reduce CO_2 emissions and fuel consumption. As described in sections II.F.3 and III.B.10, EPA and NHTSA are coordinating to allow manufacturers to include ''fuel consumption improvement values'' equivalent to EPA CO_2 credits in the CAFE program.[540] Comments on the need for and scope of these provisions are discussed in section II.F.3.

As was proposed, the agencies are defining a full-size pickup truck based on minimum bed size and hauling capability, as detailed in 86.1866–12(e) of the regulations being adopted. This definition is meant to ensure that the larger pickup trucks, which provide significant utility with respect to bed access and payload and towing capacities, are captured by the definition, while smaller pickup trucks with more limited capacities are not covered. A full-size pickup truck is defined as meeting requirements (1) and (2) below, as well as either requirement (3) or (4) below. Section II.F.3 includes a discussion of comments received on this definition.

(1) Bed Width—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, excluding any transitional arc, local protrusions, and depressions or pockets (dimension W202 in SAE Procedure J1100). An open cargo box means a cargo bed without a permanent roof or cover. Vehicles sold with detachable covers are considered ''open'' for the purposes of these criteria. And—

(2) Bed Length—The length of the open cargo box must be at least 60 inches, as measured at both the top of the body and at the bed floor (dimensions L506 and L505 in SAE Procedure J1100). And—

(3) Towing Capability—the gross combined weight rating (GCWR) minus the gross vehicle weight rating (GVWR) must be at least 5,000 pounds. Or—

(4) Payload Capability—the GVWR minus the curb weight (as defined in 40 CFR 86.1803) must be at least 1,700 pounds.

Full-size pickup trucks using mild hybrid technology will be eligible for a per-truck 10 g/mi CO_2 credit (equivalent to 0.0011 gal/mi for a gasoline-fueled truck) during MYs 2017–2021. Full-size pickup trucks using strong hybrid technology will be eligible for a per-truck 20 g/mi CO_2 credit (0.0023 gal/mi) during MYs 2017–2025. Eligibility for both the mild and strong hybrid credit is dependent on the manufacturer reaching the technology penetration thresholds discussed below.

Because of their importance in assigning credit amounts, the definitions of mild and strong hybrids for purposes of this credit program must be fair and unambiguous. The proposal included explicit criteria regarding a hybrid's percent efficiency in recovering braking energy (75% to qualify as a strong hybrid, 15% for a mild hybrid). EPA received a number of manufacturer comments on the proposed definitions. Some industry commenters objected to EPA's characterization of the credit provisions as applying to hybrid ''gasoline-electric'' vehicles. We agree that this would be an overly narrow characterization, and are clarifying that the provisions also apply to non-gasoline (including diesel-, ethanol-, and CNG-fueled) hybrids. Further extension to hybrids employing non-electric battery storage (including hydraulic-, capacitive-, and mechanical-energy storage) is complicated, however, by the difficulty in developing regulatory procedures for all conceivable energy-storage media. We believe that these technologies are not hampered in participating in the large truck credit program because manufacturers using them can take the alternative, performance-based pathway described below to gain the credits.

Ford, Toyota, and the Alliance of Automobile Manufacturers suggested improvements to the proposed procedure for determining whether hybrid technology is categorized as strong, mild, or having energy recovery too minimal to warrant credits. Most importantly, they argued that the proposed approach improperly integrated energy contributions over the entire city cycle FTP, thereby capturing more than just the intended recovered braking energy and creating an opportunity for gaming through tailoring of the direct addition of energy from the engine. They offered alternative procedures and corresponding recovered energy threshold levels based on energy input only during decelerations, with the recovery efficiency cutpoint between strong and mild hybrids correspondingly reduced from 75% to 40%. Chrysler maintained that a 75% energy recovery rate would be challenging for large pickups because of the need to design the braking system for maximum payload and trailer capability while maintaining drivability in the absence of loads. Chrysler's specific recommendation was for a cutpoint of 50% energy recovery rate. Ford and Toyota also suggested an additional metric for qualifying strong HEVs—that at least 10% of the total tractive energy during positive accelerations on the FTP must be from the electric drive with the engine off.

As discussed in detail in section 5.3.3 of the TSD, we have evaluated these

[540] Note that EPA's 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 program. Instead, EPA will convert the total CO_2 credits due to each incentive program from metric tons of CO_2 to a fleetwide CAFE improvement value.

concerns and the suggested changes and have concluded that the proposed metric remains adequate for our purposes, and furthermore has the advantage of being simpler and easier to measure than other metrics. However, based on the comments received from Chrysler and follow-up testing described in section 5.3.3 of the TSD, showing that the only large hybrid truck currently marketed would not satisfy the proposed 75% metric, we believe that 65% is a more appropriate threshold for defining strong hybrid energy recovery while remaining consistent with the overall goals of this incentive program, and so are adopting this threshold into the final regulations. We are retaining the proposed 15% threshold for mild hybrid energy recovery; commenters supported this threshold. Because there are other, non-hybrid, advanced technologies that can reduce pickup truck GHG emissions and fuel consumption at rates comparable to strong and mild hybrid technology, EPA is also adopting the proposed credit provisions for full-size pickup trucks that achieve emissions levels significantly below their applicable CO_2 targets. This performance-based credit will be 10 g/mi CO_2 (equivalent to 0.0011 gal/mi for the CAFE program) or 20 g/mi CO_2 (0.0023 gal/mi) for full-size pickups achieving 15% or 20%, respectively, better CO_2 than their footprint-based targets in a given model year. The basis for our choice of the 15 and 20% over-compliance minimums is explained in Section 5.3.4 of the TSD.

These performance-based credits have no specific technology or design requirements; automakers can use any technology or set of technologies as long as the vehicle's CO_2 performance is at least 15 or 20% below the vehicle's footprint-based target. However, a vehicle cannot receive both hybrid and performance-based credits, since that would be double-counting. In addition, 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 will also include any A/C-related credits generated by the vehicles.

The 10 g/mi performance-based credit will be available for MYs 2017 to 2021. In recognition of the nature of automotive redesign cycles, a vehicle model meeting the requirements in a model year will receive the credit in subsequent model years through 2021 unless its CO_2 level increases or its production level drops below the penetration threshold described below, even if the year-by-year reduction in standards levels causes the vehicle to fall below the 15% over-compliance threshold. Not doing so would reduce substantially the incentive to introduce advanced technology in earlier model years if the incentive wasn't available for the design cycle period. The 10 g/mi credit is not available after MY 2021 because the post-MY 2021 standards quickly overtake designs that were originally 15% over-compliant, making the awarding of credits to them inappropriate. The 20 g/mi CO_2 performance-based credit will be available for a maximum of 5 consecutive model years (the typical redesign cycle period) within the 2017 to 2025 model year period, provided the vehicle model's CO_2 level does not increase from the level determined in its first qualifying model year, and subject to the technology penetration requirement described below. A qualifying vehicle model that subsequently undergoes a major redesign can requalify for the credit for an additional period starting in the redesign model year, not to exceed 5 model years and not to extend beyond MY 2025.

Access to any of these large pickup truck credits requires that the technology be used on a minimum percentage of a manufacturer's full-size pickup trucks. These minimum percentages are set to encourage significant penetration of these technologies, leading to long-term market acceptance. Meeting the penetration threshold in one model year does not ensure credits in subsequent years; if the production level in a model year drops below the required threshold, the credit is not earned for that model year. The required penetration levels are:

- For strong hybrid credits: 10% in each model year 2017 through 2025.
- For mild hybrid credits: 20–30–55–70–80% in model years 2017–2018–2019–2020–2021, respectively.
- For ''20 percent better'' performance-based credits: 10% in each model year 2017 through 2025.
- For ''15 percent better'' performance-based credits: 15–20–28–35–40% in model years 2017–2018–2019–2020–2021, respectively.

These are identical to the proposed levels except that the levels for MY 2017 and 2018 vehicles using the mild hybrid credits, 20 and 30%, are lower than the proposed 30 and 40% levels, for reasons explained below.

EPA received a number of comments on the proposed minimum penetration thresholds, primarily from manufacturers arguing that they should be reduced or eliminated. These commenters felt that the requirements run counter to the agencies' goal of incentivizing technology introduction, because they add uncertainty over whether the investment in a technology, a commitment that is made years ahead of time, will reap the credits if a decline in sales causes the production level to fall short of the minimum in a model year. These commenters also noted that new technologies are often phased in at rates lower than the proposed minimum penetration rates in order to gauge consumer interest and acceptance. GM specifically objected to the proposed rapid ramp up of the mild hybrid penetration rate as not being aligned with historic rates of customer acceptance of new and/or advanced technologies. GM requested that the levels be instead cut in half to match those proposed for the ''15 percent better'' performance-based credits.

Our reason for setting ambitious market penetration thresholds remains—our goal is to create an incentive for manufacturers to commit to the large-scale application of hybrids and other advanced technologies in the challenging large truck sector and specifically that at least mild hybrid or comparable technology become a standard technology feature for large pickup trucks. Eliminating or greatly tempering the minimum penetration requirements might retain the incentive for niche applications but would lose any assurance of widespread ''game-changing'' technology introduction and substantial penetration. We do agree with comments that the ambitious penetration levels proposed for mild hybrid credits in the initial model years may be counter-productive, as launching a complex new technology on almost a third of first-year sales could be a risky business strategy in this highly competitive large truck market segment. As a result, we are scaling this requirement back to 20 and 30% in model years 2017 and 2018 (compared to the proposed levels of 30 and 40% in MY 2017 and 2018, respectively), to help facilitate the smooth introduction of mild hybrid technology. However, we are retaining the substantial penetration requirements that were proposed for later model years to maintain our focus on encouraging this technology to be more or less standard on large trucks. We note that a manufacturer which is unable to meet these penetration requirements may continue to generate credits through the 2021 model year for mild hybrid trucks under the performance-based credit option, assuming the less aggressive penetration threshold requirements for the performance-based credit provision are satisfied.

4. Treatment of Plug-In Hybrid Electric Vehicles, Dual Fuel Compressed Natural Gas Vehicles, and Ethanol Flexible Fuel Vehicles for GHG Emissions Compliance

This section describes the approaches for determining the compliance values for greenhouse gas (GHG) emissions and fuel economy for those vehicles that can use two different fuels, typically referred to as dual fuel vehicles under the CAFE program.[541] Three specific technologies are addressed: plug-in hybrid electric vehicles (PHEVs), dual fuel compressed natural gas (CNG) vehicles, and ethanol flexible fuel vehicles (FFVs).[542] Since the compliance approaches for GHG emissions and fuel economy vary across different time periods and across different technologies, the first part of this section addresses GHG emissions compliance and the second part of this section addresses fuel economy compliance (which likewise is administered by EPA pursuant to authority delegated under EPCA rather than under the Clean Air Act [543]).

a. Greenhouse Gas Emissions

EPA's underlying principle is to base GHG emissions 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 GHG emissions performance on the two different fuels. EPA is adopting an approach to do this on a technology-by-technology basis, and the sections below explain the rationale for choosing a particular approach for each vehicle technology.

i. 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 or diesel). Depending on how these vehicles are fueled and operated, PHEVs could operate exclusively on grid electricity, exclusively on the conventional fuel, or on a combination of both fuels. EPA can determine the CO_2 emissions performance when operated in charge depleting mode (when the battery is being used to provide grid electricity, either as the sole source of power or in combination with the engine) and in charge sustaining mode (when the battery is not providing grid electricity). 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 in these two modes.[544]

EPA proposed to use the Society of Automotive Engineers (SAE) cycle-specific fleet-based utility factor approach for PHEV compliance 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.[545] 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 have a full battery charge at the beginning of each day. Although this 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.[546] Three, PHEV drivers will retain driving profiles similar to those of past drivers on which the utility factors were based. Based on this utility factor approach, and individual PHEV-specific test data for charge depleting range and charge sustaining range, the cycle-specific utility factor methodology yields individual PHEV-specific values for projected average percent of operation in charge depleting and charge sustaining modes over both the city and highway test cycles. See 76 FR 75018.

EPA received a small number of comments on our proposed compliance treatment for PHEVs. The Alliance of Automobile Manufacturers, Fisker Automotive, the Electric Drive Transportation Association, and the American Council for an Energy-Efficient Economy (ACEEE) supported the use of the SAE utility factor methodology for PHEVs. The American Petroleum Institute (API) was the one commenter expressing several concerns, such as whether PHEVs and other dual fuel vehicles will always have a full tank of fuel at the beginning of each day, and whether the driving behavior of early adopters will be similar to those of the average drivers, on which the utility factor methodology is based. Securing America's Future Energy (SAFE) argued that the SAE-based utility factors would be too conservative for PHEVs, because PHEV buyers are more likely to be drivers who will maximize their electricity-to-gasoline use, due to various factors. SAFE also suggested that the agencies should continue to monitor the usage patterns of PHEVs and update the utility factor methodology if appropriate. ACEEE and API recommended that EPA use lower 5-cycle range values for all-electric (or equivalent all-electric) operation in the calculation of the utility factor, to better simulate the relative electric and conventional fuel operation in the real world. ACEEE also recommended that this rule use fleet based utility factors for compliance, rather than the individual based utility factors that are used for fuel economy and environment labels.

EPA is finalizing the PHEV compliance treatment as proposed, which was supported by most of the commenters who addressed this topic. While some of the comments suggest that the utility factors may be too high or favorable to PHEVs (since some PHEVs may not always have a fully charged battery each morning, and use of 2-cycle range in the calculations may not always be appropriate), other comments suggest that the utility factors may be too low or unfavorable to PHEVs (some PHEVs may be charged more than once per day, PHEVs may on average be driven fewer miles than the average

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[541] EPA is not making any changes to the tailpipe GHG emissions or fuel economy regulations for the compliance treatment for dedicated alternative fuel vehicles, i.e., those vehicles that operate on a single alternative fuel. For the GHG emissions compliance treatment for dedicated alternative fuel vehicles, see 75 FR 25434. For CAFE treatment for dedicated alternative vehicles, see 49 U.S.C. 32905.

[542] 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 would treat methanol vehicles in the same way as ethanol vehicles. EPA would treat B20-capable vehicles in the same way as ethanol FFVs. Other technologies that could use multiple fuels would be addressed on an as needed basis under 40 CFR 600.111–08(f), which allows EPA to prescribe special test procedures for vehicles (such as new, advanced, technologies) for which there are no applicable regulatory test procedures.

[543] See 49 U.S.C. 32904(a) and (c).

[544] PHEVs operated in all-electric mode have zero gram per mile tailpipe emissions. See Section III.C.2.c.v for the explanation of how and when the Agency will also account for the upstream fuel production and distribution GHG emissions associated with the use of grid electricity.

[545] 76 FR 39504–39505 and 40 CFR 600.116–12(b). For more detailed information on the development of this SAE utility factor approach, see *http://www.SAE.org*, specifically SAE J2841 "Utility Factor Definitions for Plug-In Hybrid Electric Vehicles Using Travel Survey Data," September 2010.

[546] It is also possible that some PHEV owners will charge their vehicles more than once per day.

vehicle, and PHEVs may be purchased by owners with driving patterns that allow them to optimize for maximum electricity use). No commenter suggested a specific alternative to the SAE utility factor methodology. Given the variables that could yield both higher and lower utility factors, EPA believes the SAE utility factor methodology is a reasonable approach to use at this time. EPA also agrees with SAFE that the agency should monitor PHEV usage patterns in the real world and use that data to refine the development of future utility factors if necessary. Finally, EPA notes that we are finalizing, as proposed, to use the fleet based utility factors, as suggested by ACEEE (see 40 CFR 600.116(b)(1)).

For example, based on the cycle-specific, fleet utility factors, the 2012 Chevrolet Volt PHEV, which has an all-electric range of 50 miles over EPA's 2-cycle tests, has a combined city/highway cycle utility factor of 0.69, meaning that the average Volt driver is projected to drive about 69 percent of miles on grid electricity and about 31 percent of miles on gasoline.

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 charge depleting operation (for all electric operation, either 0 g/mi 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; or a blended value for electric and gasoline/diesel operation) multiplied by the utility factor, and 2) the tailpipe CO_2 emissions value on gasoline/diesel multiplied by (1 minus the utility factor).

ii. Dual Fuel Compressed Natural Gas Vehicles

Current 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.[547] 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 MYs 2017–2025 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.[548]

EPA proposed a new approach for dual fuel CNG vehicle GHG emissions compliance based on the fleet-based utility factor approach described above for PHEVs, beginning in MY 2016. In the proposal, EPA suggested that, as with PHEVs, owners of dual fuel CNG vehicles would be expected to preferentially seek to refuel and operate on CNG fuel as much as possible, both because the owner would have to pay a higher vehicle price for the dual fuel capability, and because CNG fuel is considerably cheaper than gasoline on a per mile basis. EPA noted that there are some relevant differences between dual fuel CNG vehicles and PHEVs, some of which might strengthen the case for the use of utility factors and some of which might weaken the case, but in the aggregate EPA believed that the use of utility factors for dual fuel CNG vehicles was appropriate. Further, for dual fuel CNG vehicles in MYs 2012–2015, EPA also proposed to allow the option, at the manufacturer's discretion, to use the utility factor-based methodology. The rationale for providing this option was that, without it, some manufacturers are likely to reach the maximum allowable dual fuel vehicle GHG emissions credits for MYs 2012–2015 (which are consistent with the statutory CAFE credits) through their production of 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. Finally, EPA also asked for comments on the desirability of additional design or performance-based eligibility constraints for dual fuel CNG vehicles to be able to use the utility factor methodology.

Commenters expressed widespread support for the proposal. Natural gas advocacy groups (including America's Natural Gas Alliance/American Gas Association, American Public Gas Association, Clean Energy, Encana Natural Gas Inc., NGV America, and VNG.Co) supported the use of cycle-specific fleet-based utility factors for dual fuel CNG vehicles, supported the extension of this approach for MYs 2012–2015, and generally argued against any eligibility requirements for the application of utility factors for dual fuel CNG vehicles. One natural gas advocacy group, the American Clean Skies Foundation, recommended a fixed 95% utility factor so as not to ''require a case-by-case review.'' The Alliance of Automobile Manufacturers also supported the utility factor methodology, and for pulling it ahead to MYs 2012–2015, and proposed a work group to discuss possible eligibility requirements for dual fuel CNG vehicles. Chrysler also supported using utility factors beginning in MY 2012. In addition, several of the natural gas and automobile commenters asked EPA to consider a ''separate track'' for all dual fuel CNG vehicles (e.g., NGV America), or for ''extended range'' dual fuel CNG vehicles (e.g., Chrysler), in order to allow manufacturers of dual fuel CNG vehicles the option to benefit from the lower GHG emissions, which otherwise would not be possible for those manufacturers that have ''maxed out'' with ethanol FFV credits in the MYs 2012–2015 timeframe. The Natural Resources Defense Council (NRDC) also supported the use of utility factors, but was the one commenter to condition its support upon eligibility constraints. It suggested ''[t]he agencies should consider prioritizing a minimum requirement for natural gas-to-gasoline range of at least 80 percent on natural gas.'' Finally, as with PHEVs, the American Petroleum Institute was the only commenter to express some concerns with the use of utility factors for dual fuel CNG vehicles, but did not suggest an alternative approach.

EPA is finalizing, as proposed, the use of SAE fleet-based utility factors for dual fuel CNG vehicles, and is also finalizing some additional requirements in order for a dual fuel CNG vehicle to be able to use the utility factors. Dual fuel CNG vehicles must meet two requirements in order to use the utility factor approach. One, the vehicle must have a minimum natural gas range-to-gasoline range of 2.0. This is to ensure that there is a vehicle range incentive to encourage vehicle owners to seek to use CNG fuel as much as possible (for

[547] 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 compliance treatment, since they are not designed to allow the use of CNG only. There are no bi-fuel CNG vehicles sold in the US market, and EPA has no regulations in place for bi-fuel CNG vehicles.

[548] See 75 FR 25433–34. See also section III.C.2.c.iv above for the discussion of tailpipe GHG emissions from current CNG vehicles and of incentives for dedicated and dual fuel CNG vehicles. Based on data available to EPA, assuming equivalent energy efficiency on both gasoline and CNG, operation on CNG typically yields about 20% lower tailpipe CO_2 emissions than gasoline operation. Dual fuel CNG compliance values would be based on demonstrated emissions performance over EPA 2-cycle tests, so tailpipe CO_2 emission reductions from CNG operation, relative to gasoline, could be higher or lower than 20%.

example, if a vehicle had equal or greater range on gasoline than on natural gas, the agency is concerned that some owners would fuel more often on gasoline). While NRDC suggested a minimum natural gas range-to-gasoline range of 4.0, the agency believes that a ratio of 2.0, in concert with a (currently) much less expensive fuel, is very strong incentive to use natural gas fuel. Two, the vehicle must be designed such that gasoline can only be used when the CNG tank is empty, though EPA is permitting a de minimis exemption for those dual fuel vehicle designs where a very small amount of gasoline is used to initiate combustion before changing over to a much greater volume of natural gas to sustain combustion. With these eligibility requirements, EPA believes that there will be strong economic motivation for consumers to preferentially seek out and use CNG fuel in dual fuel CNG vehicles. Consumers will have paid a premium for this feature, and will have greater range on CNG. We also believe that the utility factor approach is the most reasonable approach for projecting the real world use of CNG and gasoline fuels in such dual fuel CNG vehicles. Any dual fuel CNG vehicles that do not meet the above eligibility requirements would use a utility factor of 0.50, the value that has been used in the past for dual fuel vehicles under the CAFE program.

As noted above, there was widespread public support from the commenters for the utility factor approach for dual fuel CNG vehicles. EPA is rejecting the one alternative approach that was suggested, the use of a fixed 95% utility factor, because it would allow a dual fuel CNG vehicle with a small CNG tank to benefit from a very large utility factor. Further, EPA is finalizing the option for manufacturers to begin using this approach in MY 2012, at the manufacturer's discretion. EPA agrees with the arguments from many commenters that, for those manufacturers who are already obtaining maximum dual fuel vehicle GHG emissions credits from the production of ethanol FFVs, there is effectively ''no room'' for additional GHG emissions credits from dual fuel CNG vehicles, even though these vehicles are likely to provide real world GHG emissions reductions. Allowing these manufacturers to use the utility factor approach, beginning in MY 2012, effectively provides the ''separate track'' that was requested by several commenters.

Table III–18 shows the utility factors that EPA is adopting, based on the SAE methodology, for use for dual fuel CNG vehicles that meet the eligibility requirements. A dual fuel CNG vehicle with a 150-mile 2-cycle CNG range would result in a compliance assumption of 92.5% percent operation on CNG and 7.5% operation on gasoline.[549] A dual fuel CNG vehicle with a driving range of less than 30 miles would use a utility factor of 0.50.

TABLE III–18—EPA UTILITY FACTORS FOR DUAL FUEL CNG VEHICLES AS A FUNCTION OF 2-CYCLE RANGE

CNG driving range (miles)	UF
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

iii. Ethanol Flexible Fuel Vehicles

Ethanol flexible fuel vehicles (FFVs) can operate on E85 (a blend of 85 percent ethanol and 15 percent gasoline, by volume), gasoline, or any blend of the two. There are many ethanol FFVs in the U.S. market today.[550]

In the final rulemaking for MYs 2012–2016, EPA promulgated regulations for MYs 2012–2015 ethanol FFVs that provide 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.[551] 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 where ethanol FFVs are assumed to be 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.[552] Since tailpipe GHG emissions from FFVs operated on E85 are typically slightly lower than those from gasoline operation, this methodology provides an opportunity for ethanol FFVs to earn GHG emissions credits, particularly if E85 use grows in the future.

EPA did not propose to make any changes to this methodology for MYs 2017–2025. In the proposal, the Agency laid out its 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 an ethanol FFV 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 to use E85 fuel. The data confirm that, on a national average basis in 2008, less than one percent of the fuel used in FFVs was E85.[553]

Most commenters who addressed FFVs that can operate on ethanol or other biofuels focused on the need for broader incentives, not the more narrow compliance issues like utility factors that are the focus of this preamble section.[554] The Renewable Fuels Association argued in favor of utility factors for ethanol FFVs, stating: ''EPA/NHTSA's rationale for allowing the use of these utility factors for some dual fuel

[549] 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 adopting for dual fuel CNG vehicles as well.

[550] While there are no B20-capable light-duty diesel vehicles in the U.S. market today, the compliance treatment for B20-capable vehicles in the future will be the same as for ethanol FFVs.

[551] 75 FR 25432–433.

[552] 75 FR 25433–434.

[553] 75 FR 14762 (March 26, 2010).

[554] For a discussion of why the Agency is not promulgating incentives for biofuel-capable vehicles like ethanol FFVs for model years beyond 2015, see Section III.C.2.c.vii.

vehicles but not for others is highly questionable. EPA and NHTSA state that PHEV and CNG vehicle owners paid a premium for their vehicles and thus will seek out and predominantly use alternative fuels more frequently than they will use gasoline. EPA/NHTSA also assume that alternative fuels used by PHEVs and CNGVs will be cheaper than gasoline on a per mile basis. These assumptions do not take into account that refueling access for these vehicles may be limited or unavailable (EPA/NHTSA also assume, without basis, that PHEV drivers will always recharge once per day). Further, the cost per mile for these fuels may actually prove to be higher than gasoline, and prices may fluctuate as demand increases. If theoretical utility factors are to be applied to PHEVs and CNGVs, they should also apply to FFVs and any other dual fueled vehicles.'' The Alliance of Automobile Manufacturers (AAM), Ford, and General Motors supported the concept of not using utility factors for ethanol FFVs, and instead basing FFV emissions values on a relative gasoline/E85 weighting based on national average E85 usage in FFVs (this would count all ethanol consumption beyond E10 and convert this volume of ethanol to E85). These automakers asked for ''early guidance'' so that automakers would have the relevant information for development of compliance plans, and want the guidance to reflect the expected ethanol volumes that will be necessary to comply with future Renewable Fuel Standard program volume requirements. The 25x'25 Alliance (and partners) recommended that the agency either adopt the utility factor methodology for FFVs or adopt the recommendation for gasoline/E85 weighting by AAM. The National Corn Growers Association argued that: ''[T]he concern for high relative cost of mid or high level ethanol blends does not seem to be justified in the term of the CAFE/GHG and RFS2 rules since at some point in the renewable fuel volume ramp-up of RFS2, market forces would result in competitive prices for ethanol and gasoline in order for the required volumes to be sold.''

EPA is finalizing its proposed approach of not using utility factors for ethanol FFVs and, instead, to base the relative weighting of gasoline and E85 emissions performance on the actual national average use of E85 in ethanol FFVs, consistent with the provisions in the MYs 2012–2016 standards final rulemaking.[555] EPA understands the request from manufacturers for early guidance regarding the relative weightings of gasoline and E85 usage in FFVs and that planning and manufacturing commitments for future production of FFVs may depend on knowing the future regulatory environment. EPA commits to providing early guidance to manufacturers well in advance of each model year. The agency disagrees with the objections raised by the Renewable Fuels Association with respect to the selective use of utility factors for various dual fuel vehicles. EPA continues to believe that it is appropriate to assume that owners of some types of dual fuel vehicles, such as PHEVs and CNG vehicles, will preferentially seek to use the alternative fuel when the vehicle is much more expensive to purchase and much less expensive to operate on the alternative fuel—why else would the consumer pay more for the vehicle if (s)he did not intend to use the cheaper fuel? Similarly, EPA believes it is appropriate to assume that ethanol FFVs will primarily use gasoline fuel, as there is no extra vehicle cost, E85 fuel is no cheaper and in fact usually more expensive per mile, and use of E85 reduces overall vehicle range since there is only one fuel tank (as opposed to PHEVs and dual fuel CNG vehicles which have two fuel storage devices and therefore the use of the alternative fuel raises overall vehicle range). Further, even with approximately 10 million ethanol FFVs in the U.S. car and light truck fleet, fuel use data demonstrate that ethanol FFVs only use E85 less than one percent of the time. EPA considers the comment from the Renewable Fuels Association about relative fuel prices to be without merit. While it is true that prices of all motor fuels can be volatile, CNG prices are approximately one-half those of gasoline[556] (and electricity prices, per mile, are even lower), and expected to remain low for the foreseeable future. Finally, our approach is responsive to comments from automakers, the 25x'25 Alliance, and the National Corn Growers Association, in that if actual use of E85 and other higher-ethanol blends increases, for example in response to future RFS requirements and/or due to more competitive pricing, then the regulations already allow automakers to apply a higher E85 weighting consistent with the greater use of the fuel, which in turn could allow ethanol FFVs to generate emissions credits if GHG emissions from E85 operation are lower than from gasoline operation.

b. 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.[557] 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.[558] 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.[559]

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 separately on both an alternative fuel and on a conventional fuel.

EPA proposed, for PHEVs, dual-fuel CNG vehicles, and FFVs, to apply the same fuel weighting approaches for CAFE purposes as we do for GHG emissions compliance. For PHEVs and dual-fuel CNG vehicles, the Agency proposed that fuel economy weightings would be determined using the SAE utility factor methodology, while for ethanol FFVs, manufacturers could

[555] The preamble to the 2012–2016 final rule stated: ''EPA plans to make this assigned fuel usage factor available through guidance prior to the start of MY 2016 and adjust it annually as necessary.'' 75 FR 25434, May 7, 2010.

[556] *http://www.afdc.energy.gov/afdc/pdfs/afpr_apr_12.pdf*

[557] 49 U.S.C. 32905.

[558] 49 U.S.C. 32906. NHTSA interprets section 32906(a) as not limiting the impact of duel fueled vehicles on CAFE calculations after MY2019.

[559] 49 U.S.C. 32904(a), (c).

choose to use a default based on 100% gasoline operation, can choose to base the fuel economy weightings on national average E85 and gasoline use, or can use manufacturer-specific data showing the percentage of miles that are driven on E85 vis-à-vis gasoline for that manufacturer's ethanol FFVs. EPA further proposed for model years 2020 and later 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. EPA sought comment on an alternative approach where we would not adopt the 0.15 divisor and petroleum equivalency factor for model years 2020 and later. Under this alternative approach, 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. See 76 FR 75019.

No commenters specifically addressed utility factors for CAFE beginning in MY 2020, though the general arguments for and against utility factors for CAFE compliance would be the same as those discussed above for GHG emissions compliance. With one exception, commenters supported the proposal to continue to use the 0.15 divisor for CAFE compliance beginning in MY 2020. Nissan summarized the most common argument for retaining the 0.15 divisor for CAFE compliance, stating that the 0.15 divisor ''is consistent with the purpose of the CAFE program—to reduce our country's dependence on foreign oil.'' The Alliance of Automobile Manufacturers argued that ''this approach will maintain consistency between dedicated and dual fuel vehicle calculations and will continue to encourage manufacturers to build vehicles capable of operating on fuels other than petroleum.'' There was also support for retaining the 0.15 divisor for the CAFE program from other automakers, natural gas advocacy groups, and ethanol/renewable fuel groups. The one comment against retaining the 0.15 divisor was the American Petroleum Institute. It argued: ''Section 32906 of the Energy Independence and Security Act of 2007 phased-out the maximum fuel economy credit attributable to dual fuel vehicles (except electric vehicles) that could be taken by manufacturers of those vehicles such that the credit was reduced from 1.2 mpg in model year 2014 (and previous model years) to 0.2 mpg in model year 2019 to '0 miles per gallon for model years after 2019.' Clearly, the EPA and NHTSA proposed treatment of model year 2020 and later dual fueled natural gas vehicles is overly generous and inconsistent with the intent and will of Congress. It should be set aside.''

EPA is finalizing the CAFE compliance treatment for MY 2020 and later, as proposed, with one change being the addition of eligibility requirements for dual fuel CNG vehicles to be able to use the utility factor approach. For the reasons discussed above for GHG emissions compliance, EPA is adopting the same approaches for weighting the fuel economy compliance values for dual fuel vehicles: using utility factors for PHEVs and dual fuel CNG vehicles (the latter must meet the eligibility requirements), and providing manufacturers the option of using national average E85 usage data, manufacturer-specific E85 usage data, or a 100% gasoline default value for ethanol FFVs. EPA is adopting the 0.15 divisor, and petroleum equivalency factor for PHEVs, for dual fuel vehicle CAFE compliance in MY 2020 and later, for two reasons. One, this approach is directionally consistent with the overall petroleum reduction goals of EPCA and the CAFE program, because it reflects the much lower or zero petroleum content of alternative fuels and continues to encourage manufacturers to build vehicles capable of operating on fuels other than petroleum. Two, the 0.15 divisor and petroleum equivalency factor (PEF) are used under EPCA to calculate CAFE compliance values for dedicated alternative fuel vehicles, and retaining this approach for dual fuel vehicles maintains consistency, for MY 2020 and later, between the approaches for dedicated alternative fuel vehicles and for the alternative fuel portion of dual fuel vehicle operation.

In response to the comment from the American Petroleum Institute, EPA recognizes that use of the 0.15 divisor, and petroleum equivalency factor for PHEVs, will continue to provide a large increase in CAFE compliance 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 MY 2020 and later methodology differs significantly in important ways from the special calculation provisions mandated by EPCA. Most importantly, the MY 2020 and later methodology reflects actual usage rates of the alternative fuel and does 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 MY 2020 and later methodology will be PHEVs and dual-fuel CNG vehicles, and not ethanol FFVs, while the primary source of benefit to manufacturers under the statutory provisions came from ethanol 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 petroleum conservation. In addition, as noted above, Congress maintained the 0.15 divisor in the calculation procedures for dedicated alternative fuel vehicles that result in increased fuel economy values. Finalizing the 0.15 divisor for dual fuel vehicles 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 MY 2020 and later methodology is quite different in effect from the specified provisions in 49 U.S.C. 32905, and is consistent with the calculation procedures for dedicated vehicles that use the same alternative fuel, EPA believes this methodology is an appropriate exercise of discretion under the general authority provided in 49 U.S.C. 32904.

Bosch and the Motor and Equipment Manufacturers Association commented that all types of alternative fuels, including biodiesel, be treated ''equivalently'' under the CAFE program. EPA agrees with these comments, and all dedicated alternative fuel vehicles will use the 0.15 divisor in CAFE calculations for MY 2020 and later. In addition, vehicles capable of operating on diesel containing at least 85% biodiesel (B85), will also use the 0.15 divisor in CAFE calculations for MY 2020 and later. While B85 may not be considered an alternative fuel under EPCA at this time, 20% biodiesel (B20) is recognized by Congress for purposes of section 32905, and B85 exhibits the same or better petroleum replacement benefits as the 85% alcohol blend alternative fuels currently used in FFVs. The American Council for an Energy-Efficient Economy, Encana Natural Gas, Inc., and NGV America recommended that utility factors be used for CAFE calculations prior to 2020. EPA is rejecting this recommendation, as EPCA requires the Agency to assume 50% use of the conventional fuel and 50% use of the alternative fuel for CAFE calculations through MY 2019. Finally, VNG.Co suggested that that agencies consider possible ways to provide CAFE credits, in the pre-2020 timeframe, for duel fuel CNG vehicles that have a CNG range of less than 200 miles. EPA is rejecting this recommendation as well, as the 200-mile minimum range requirement is required under 49 U.S.C. 32901(c).

5. Off-cycle Technology Credits

For MYs 2012–2016, EPA provided an option for manufacturers to generate credits by employing new and innovative technologies that achieve CO2 reductions which are not reflected on current 2-cycle test procedures. For this final rule, EPA, in coordination with NHTSA, is applying the off-cycle credits, and equivalent fuel consumption improvement values, to both the GHG and CAFE programs for MY 2017 and later. This 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, manufacturers may continue to use off-cycle credits for GHG compliance and begin to generate and use fuel consumption improvement values (essentially equivalent to EPA credits) for CAFE compliance. In addition, EPA, in coordination with NHTSA, is adopting a list of defined (i.e. default) values for identified off-cycle technologies that would apply unless the manufacturer demonstrates that a different value for its technologies is appropriate.

There are two key changes EPA is making to the proposal based on comments received. First, EPA is allowing the pre-defined list to be used starting in MY 2014, rather than the proposed starting point of MY 2017. This change does not apply to CAFE, where the off-cycle credits program does not begin until MY 2017. Second, EPA is not finalizing the proposed minimum penetration thresholds for technologies on the pre-defined list. For most of the listed technologies, the minimum threshold as proposed would have required manufacturers to use the listed technologies on at least 10 percent of their production before the manufacturer could begin generating credits based on the pre-defined list. All of the changes to the EPA off-cycle credit program for the GHG program are described in Section III.C.5.a–b below, and those for the CAFE program are described in Section III.C.5.c below.

a. Background on the Off-Cycle Credit Program Adopted in MY 2012–2016 GHG 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 procedures used to determine compliance with the fleet average standards (i.e., ''off-cycle'').[560] EPA established eligibility criteria requiring technologies to be innovative, relatively newly introduced in one or more vehicle models, but not yet implemented in widespread use in the light-duty fleet, and which provide novel approaches to reducing greenhouse gas emissions. The technologies must be used to achieve verifiable and demonstrable real-world GHG reductions.[561] 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. The optional off-cycle credit opportunity adopted in the MY 2012–2016 GHG rule is available through the 2016 model year.

In the MY 2012–2016 rule, 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 manufacturer must follow the 5-cycle procedures to demonstrate potential benefits and to quantify CO_2 gram per mile credits.

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 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 25438–40.

b. Changes to the Off-Cycle Credits Program

EPA has been encouraged by automakers' interest in developing innovative technologies which could be used to generate off-cycle credits. 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 will 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 encourages 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. EPA received a significant number of comments from manufacturers and suppliers supporting the continuation of the off-cycle program, and no opposition to doing so. For these reasons, EPA proposed and is finalizing extending the off-cycle credits program to 2017 and later model years.

In implementing the program, some manufacturers expressed concern prior to proposal that a drawback to using the program is uncertainty over which technologies may be eligible for off-cycle credits plus uncertainties resulting from a potentially cumbersome case-by-case approval process. See 76 FR 75021. As noted above, EPA eligibility criteria adopted in the MY 2012–2016 final rule require technologies to be new, innovative, and not in widespread use in order to qualify as a source of off-cycle credit generation. Also, the MY 2012–2016 final rule specifies that technologies must not be significantly

[560] 75 FR 25438–440.

[561] See 40 CFR section 1866.12(d); 75 FR 25438.

measurable on the 2-cycle test procedures. As discussed below, EPA is adopting the modifications it proposed to the technology 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 off-cycle 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 finalizing a new credit pathway that allows manufacturers to generate credits by using technologies listed on an EPA pre-defined and pre-approved technology list, and to do so starting with MY 2014. These credits will be verified and approved as part of certification with no prior approval process needed. We believe this new option significantly streamlines and simplifies the program for manufacturers choosing to use it and will provide manufacturers with certainty that credits may be generated through the use of pre-evaluated and approved technologies. For credits not based on the pre-defined list, EPA is finalizing as proposed a streamlined and better defined step-by-step process for demonstrating emissions reductions and for applying for credits under the existing credit pathways. EPA is finalizing these procedural changes to the existing case-by-case pathways effective for new credit applications for the MY 2012–2016 program as well as for MY 2017 and later for 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 finalizing the proposed provision allowing manufacturers to include fuel consumption reductions resulting from the use of off-cycle technologies in their CAFE compliance calculations. This provision would apply starting in MY 2017. Manufacturers may generate ‘‘fuel consumption improvement values’’ essentially equivalent to EPA credits, for use in the CAFE program. The changes to the CAFE program to incorporate off-cycle technologies are discussed below in section III.5.c.

i. Pre-Defined Credit List

As noted above, EPA proposed and is finalizing a list of off-cycle technologies from which manufacturers can select and by doing so automatically generate a pre-defined level of CO_2 credits. This provision will apply starting in MY 2014 and apply in each successive model year. Both technologies and credit values based on the list are established by rule. That is, there is no approval process associated with obtaining the credit. Prior to MY 2014, manufacturers must provide a demonstration of off-cycle emissions reductions in order to generate credits for off-cycle technologies, as is required under the program finalized in the MY 2012–2016 rule, including for those technologies on the list. Requirements for demonstrating off-cycle credits not based on the list are described below. EPA received several comments supporting EPA's proposal to establish a pre-defined and pre-approved technology list for the off-cycle program. Manufacturers supported the list as a necessary element to streamline and simplify the off-cycle program. EPA did not receive any comments against establishing a pre-defined list, but did receive comments on various aspects of the list, as discussed in this section and Section II.F.

EPA proposed that manufacturers could begin generating credits based on the pre-defined list beginning in MY 2017. EPA also solicited comment generally on ways to liberalize the pre-2017 MY procedures for obtaining off-cycle CO_2 credits, and proposed to change some of the criteria in the MY 2012–2016 rule for obtaining such credits. See 76 FR 75023, 75024. The agencies received several comments from manufacturers that the pre-defined list should also be available for use in MY 2012–2016. Commenters stated that: (1) These are real and measurable GHG and fuel consumption reductions and estimated benefits will equally apply to MY 2012–2016 vehicles as to MY 2017 and later vehicles, (2) since the credits for technologies on the list are based on conservative estimates, there is no reason to limit availability, (3) the reasons for streamlining and simplifying the off-cycle credits program apply equally to pre-MY 2017 model years, (4) allowing the list in MY 2012–2016 promotes earlier implementation of CO_2-reducing technology, and (5) requiring testing in the MY 2012–2016 time frame has the potential to create significant discrepancies and potential unfairness among manufacturers if EPA awards credits either higher or lower than the list value.

EPA agrees that the credits on the pre-defined list are based on conservative estimates of real world off-cycle CO_2 and fuel consumption benefits. Allowing manufacturers to pursue credits through the use of the pre-defined list provides a significantly streamlined pathway under the existing program, and therefore has the potential to encourage the earlier introduction of off-cycle technologies. Allowing manufacturers to use the list in pre-2017 model years also helps address concerns raised by manufacturers regarding uncertainty with the existing credit application and approval process, and potentially reduces the cost associated with the program by providing a pathway that does not include testing requirements. These reasons support applying the list prior to MY 2017.

EPA is allowing use of the credit list starting with MY 2014. For MY 2012–2013, it is too late for the provisions to have the desired effect of encouraging the use of off-cycle technologies on additional vehicle models (MY 2012 is almost complete and MY 2013 is underway). Allowing the pre-defined list to be used in these model years would effectively provide credits for actions manufacturers have already taken for reasons other than gaining off-cycle credits. For manufacturers not pursuing credits under the existing program, they would have already decided to forego potential off-cycle credits in these model years. Providing credits for MY 2012–2013 through the use of the list thus could be viewed as a windfall—providing credits for conduct which would occur anyway rather than creating an incentive to introduce new technologies. EPA therefore is not allowing the list to be used before MY 2014.

Extending the use of the pre-defined list to MYs 2014–2016 is not appropriate for the CAFE program. Although EPA included the off-cycle credit program when adopting the GHG emissions standards for these model years, see 76 FR 75022, NHTSA did not include an off-cycle credit program when adopting the CAFE standards for those model years. Fuel economy improvement values in the CAFE program, and associated comments, are discussed further in section III.5.c, below.

Table III–19 provides the list of the technologies and per vehicle credit levels included in the final rule for cars and light trucks. The manufacturer must demonstrate in the certification process that its technology meets the definition for the listed technology (see § 86.1869–12(d)(1)(iv)). EPA has made changes to some of the technologies and credit values on the list based on comments the agencies received. Section II.F of the preamble provides an overview of the technologies, credit values, and comments the agencies received on the proposed technology list. Chapter 5 of the joint TSD provides a further detailed description of how these technologies are defined and how the credit levels were derived. EPA continues to believe that these values reasonably estimate the amount of GHG improvement associated with use of the technology, albeit conservatively (in keeping with the list's function as providing default values, and providing assurance that the credits will not result in a loss of CO_2 benefits). EPA used a combination of available activity data from the MOVES model, vehicle and test data, and EPA's vehicle simulation tool described in Section II.F, to estimate these credit values. In particular, the vehicle simulation tool was used to determine the credit amount for electrical load reduction technologies (e.g. high efficiency exterior lighting, engine heat recovery, and solar roof panels) and active aerodynamic improvements.

TABLE III–19—OFF-CYCLE TECHNOLOGIES AND CREDITS FOR CARS AND LIGHT TRUCKS

Technology	Credit for cars g/mi	Credit for light trucks g/mi
High Efficiency Exterior Lighting (at 100W)	1.0	1.0
Waste Heat Recovery (at 100W; scalable)	0.7	0.7
Solar Roof Panels (for 75 W, battery charging only)	3.3	3.3
Solar Roof Panels (for 75 W, active cabin ventilation plus battery charging)	2.5	2.5
Active Aerodynamic Improvements (scalable)	0.6	1.0
Engine Idle Start-Stop w/heater circulation system	2.5	4.4
Engine Idle Start-Stop without/heater circulation system	1.5	2.9
Active Transmission Warm-Up	1.5	3.2
Active Engine Warm-Up	1.5	3.2
Solar/Thermal Control	Up to 3.0	Up to 4.3

As proposed, EPA is capping the amount of credits a manufacturer may generate using the above list to 10 g/mile per year on a combined car and truck fleet-wide average basis. As proposed, 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. In addition, the cap does not apply on a vehicle model basis, allowing manufacturers the flexibility to focus off-cycle technologies on certain vehicle models and to generate credits for that vehicle model in excess of 10 g/mile. (The vehicle is of course part of the manufacturer's fleet wide average, and further credits from the list could remain available so long as the manufacturer's fleetwide credits remained less than or equal to 10 g/mile.) EPA is finalizing a fleet-wide cap because the default credit values are based on limited data, and also because 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.

EPA received several comments regarding the 10 g/mile credit cap for the pre-defined technology list. Some manufacturers commented that the credit cap should be removed, primarily for the following reasons; (1) the credits on the list are based on conservative estimates of real-world reductions and industry should receive credits for all applications without requiring additional testing, and (2) the cap is counterproductive as it discourages the maximum adoption of the pre-defined off-cycle technologies (since there would be less incentive to introduce technologies that would take the manufacturer beyond the cap). NRDC and ICCT commented in support of the 10 g/mile credit cap because some uncertainty is inherent with using estimates rather than vehicle model specific test data. NRDC recommended that EPA fully evaluate the adequacy of the 10 g/mile cap level, given the uncertainties in real, verifiable emissions reductions, and to adopt a lower cap if necessary.

EPA has reviewed the level of credits being provided for listed technologies and the basis for those estimates, as discussed in section II.F, and EPA continues to believe that the 10 g/mile cap is appropriate. The cap balances the goal of providing a streamlined pathway to encourage significant introduction of innovative off-cycle technologies with the environmental risk from the uncertainty inherent with the estimated level of credits being provided. EPA believes that 10 g/mile is substantial relative to the overall emissions reduction obligation of manufacturers (for example, 10 g/mile represents over 11% of the difference between a fleet average of 250 g/mile and 163 g/mile), and that the cap will not be particularly limiting or deter manufacturers from introducing technology. Manufacturers would need to use several listed technologies across a very large portion of their fleet before they would reach the cap. Based on manufacturer comments regarding the proposed penetration thresholds, discussed below, manufacturers in general are not anticipating widespread adoption of these technologies, at least not in the early years of the program. Also, the cap is not an absolute limitation because manufacturers have the option of submitting data and applying for credits which would not be subject to the 10 g/mile credit limit. EPA thus believes credits generated beyond the 10 g/mile credit cap should be based on additional manufacturer-specific data.

In the NPRM, EPA discussed the possibility of adding technologies to the list based on data provided by manufacturers, and other available data, through future rulemaking. EPA received comments supporting revisiting the list annually, or from time to time as data become available, with one commenter recommending that the list be revisited and fully examined during the mid-term review. EPA received one comment objecting to providing additional credits without a rulemaking. EPA also received comment that the 10 g/mile cap discussed above should be revisited if the list is expanded in the future. EPA is not announcing a regular schedule to revisit the list, since it is unclear what the timing might be for other technologies to emerge with sufficient data supporting their consideration. However, EPA plans to monitor the emission reduction potential of off-cycle technologies in coordination with NHTSA. If the CO_2 reduction benefits of a technology have been established through manufacturer data and testing, or other available data, it would be appropriate to consider listing the technology and a conservative associated credit value. EPA agrees that any changes to the list would need to be done through a rulemaking (which would provide an opportunity for public comment), since the list is part of the regulation, so it would be the regulation itself that would change. EPA understands commenter interest in revisiting the issue of the credit cap in conjunction with revisiting the list, and expects the cap to be a topic for further consideration should a rulemaking be undertaken in the future and to be one of the issues the agencies examine during the mid-term review.

EPA also proposed 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 significant adoption by MY 2017 and later. This proposal was intended to support the programmatic objective of encouraging market penetration of the technologies. See 76 FR 75023. Under the proposed approach, 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 met or exceeded the percentage thresholds in order to receive the listed credit. EPA proposed to set the threshold at 10 percent of a manufacturer's overall combined car and light truck production for some technologies on the list.

EPA received several comments from manufacturers and suppliers recommending that EPA not adopt the proposed penetration thresholds. Commenters provided several reasons for not adopting thresholds, including; (1) actions to reduce emissions should be recognized on a per-vehicle-so-equipped basis, (2) thresholds unfairly withholds credit for actual, real-world emission reductions that are achieved in the early stages of technology roll-out, (3) the minimum threshold does not incentivize the introduction of these technologies, which typically require extensive development at significant cost. Instead, manufacturers may choose not to implement new technologies, or to delay introduction based on the fact that they cannot know with certainty if they will be able to meet the proposed penetration rates. Business cases for some of these new technologies will be based on the ability to achieve expected credit amounts, (4) it is common practice for new automotive technologies to be introduced on a single model, or even single configuration within a model. This low production trial period allows manufacturers to monitor technology performance and reliability, and to gauge consumer acceptance. Achieving a 10 percent market penetration can take a decade or more for certain technologies, (5) new, expensive technologies often are applied first on more expensive, lower volume models. This process has the salutary effect of lowering a manufacturer's risk, (6) a smaller penetration rate would create a correspondingly smaller credit, so we see no problem being created at lower penetration levels, and (7) EPA has failed to demonstrate a clear need for the minimum penetration restriction. EPA did not receive any comments in support of the proposed penetration thresholds.

EPA has decided not to adopt penetration thresholds as a condition for generation credits using the pre-defined list. EPA proposed the thresholds as a way to encourage the widespread adoption of off-cycle technologies by encouraging manufacturers to use the technologies on larger volume models. EPA believes that several points raised by the commenters are persuasive in demonstrating that a penetration threshold could have the opposite effect, dissuading manufacturers from introducing technologies. EPA agrees that in some cases manufacturers would proceed by introducing technologies on lower production volume vehicles in order to gain experience with them and to gauge market acceptance. EPA does not want to discourage this practice. The ability to generate additional credits by increasing the use of the technologies across their fleet will encourage manufacturers to bring off-cycle technologies into the mainstream. In addition, there is no loss of environmental benefits if the thresholds are not adopted.

ii. Technology Eligibility Criteria

As discussed above, EPA originally established the off-cycle credit program in the MY 2012–2016 program. EPA expects that the pre-defined list may become the primary pathway for off-cycle credit generation due to the streamlined process the list provides. However, the ability of manufacturers to generate credits beyond or in addition to those included in the pre-defined technology list based on manufacturer test data remains part of the off-cycle credits program under both the MYs 2012–2016 and MY 2017–2025 programs. EPA proposed and is finalizing several changes to the off-cycle credits pathway procedures originally established in the MY 2012–2016 rule.

As proposed, EPA is removing the criteria in the 2012–2016 rule that off-cycle technologies must be 'new, innovative, and not in widespread use.' EPA proposed to remove the criteria from the program because these terms are imprecise and have created implementation questions and uncertainty in the program. See 76 FR 75024. For example, under the criteria that technology must be ''new'' it has been 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. 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 received only supportive comments for these proposed changes to the eligibility criteria. EPA believes it is appropriate to provide credit opportunities for off-cycle technologies that achieve significant real world reductions beyond those measured under the two-cycle test without further making (somewhat subjective) judgments regarding the newness and innovativeness of the technology. Therefore, as proposed, EPA is implementing this program change for new MY 2012–2016 credits as well as for MY 2017–2025.

A further uncertainty in the MY2012–2016 rule was the requirement that off-cycle credits not be significantly measureable over the 2-cycle test. As noted at proposal, this left unclear whether technologies partially measureable over the 2-cycle test but generating significant additional CO_2 reductions in fact (as measured by the 5-cycle test for example) could generate off-cycle credits. 76 FR 75024. As proposed, EPA would provide off-cycle credits for any technologies that are added to a vehicle model that are demonstrated to provide significant off-cycle CO_2 reductions, like those on the list. EPA includes technologies providing small reductions on the 2-cycle tests but additional significant reductions off-cycle. Thus, as proposed, EPA is removing the ''not significantly measurable over the 2-cycle test'' criteria. The technology demonstration and step-by-step application process is described in detail below in section III.C.5.b.ii

As proposed, 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 (with the exception of stop start and active aerodynamic improvements whose credits are included in determining the appropriateness of the standards, and potential exception of high efficiency alternators, as discussed in section II.F.) Also, as proposed, technologies integral or inherent to the basic vehicle design including engine, transmission, mass reduction, passive aerodynamic design, and base tires will not be eligible for credits. For example, manufacturers may not generate off-cycle credits by moving to an eight-speed transmission. EPA continues to believe that it would be difficult to clearly establish an appropriate A/B test (i.e., testing with and without the technology) for technologies so integral to the basic vehicle design. EPA is limiting the off-cycle program to technologies that can be clearly identified as add-on technologies conducive to A/B testing. Further, EPA will not provide credits for a technology required to be used by Federal law, 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. 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. In addition, as discussed in II.F above, the agencies are not providing off-cycle credits potentially attributable to crash avoidance systems, safety critical systems, or technologies that may reduce the frequency of vehicle crashes.

EPA received a variety of comments on these aspects of the program. Environmental groups were concerned that there could be double counting of credits if a technology provided 2-cycle emissions reductions. As noted above, only emissions reductions above and beyond those provided over the 2-cycle test may be counted as off-cycle credits. The test data provided by manufacturers, either 5-cycle or through the public process described below, must be sufficient to allow EPA to determine an incremental off-cycle benefit that is significantly greater than the 2-cycle benefit.

Global Automakers commented that eligibility for off-cycle credits should not be limited to add-on technologies. They commented that although it may be that making a credible demonstration of benefits for some integral technologies will be difficult, that is no reason to deny manufacturers the opportunity to do so. If EPA finds such a demonstration to lack credibility, it would be able to deny the manufacturer's credit request. Ford similarly commented that EPA should work with manufacturers to develop methods to demonstrate integral technologies that cannot be turned off or disabled such as advanced combustion concepts, cam-less engines, variable compression ratio engines, air/hydraulic micro hybrids/launch assist devices, and advanced transmissions.

EPA continues to believe it is appropriate to not provide off-cycle credits for technologies that are integral to basic vehicle design. EPA continues to believe it would be very difficult to accurately parse out the off-cycle benefits for some integral technologies such as engine changes and transmission improvements. EPA is also concerned that certain fundamental vehicle design elements may inherently provide better CO_2 performance and fuel economy under certain off-cycle conditions than over the 2-cycle test. For example, a V–12 engine may provide improved performance over the USO6 test cycle. EPA believes it would be inappropriate to provide off-cycle credits in such circumstances, as these benefits are inherent to the vehicle design rather than to development in reaction to the off-cycle credit program. EPA views such credits as windfalls. The intent of the off-cycle provisions is to provide an incentive for CO_2 and fuel consumption reducing off-cycle technologies that would otherwise not be developed because they do not offer a significant 2-cycle benefit. Unlike off-cycle technologies that provide a small 2-cycle benefit and significant 5-cycle benefits, 2-cycle technologies that are fundamental to vehicle design would never generate additional 5-cycle reductions in reaction to the off-cycle credit program. These reductions would occur regardless, and thus are not appropriate for credits.

Global Automakers further commented on EPA's proposal that technologies included in the agencies' standard-setting analysis may not generate off-cycle credits (with the exception of active aerodynamic devices and engine stop-start systems). EPA states that allowing such credits for these technologies would amount to ''double-counting'' of benefits. Global Automakers comment that there may emerge by 2025 advanced levels for current technologies that are capable of achieving greater benefits than current systems. Global Automakers commented that if a manufacturer can demonstrate that an advanced version of one of the technologies that is included in the standard-setting analysis can achieve greater benefits than projected by the agencies, and those benefits are not captured with the current test procedure, there is no justification for excluding these technologies from the off-cycle credit program.

Similarly, MEMA commented that there will very likely be future technologies—in addition to stop/start and active aerodynamics—that could result in both significant on-cycle and off-cycle benefits. MEMA believes that these dual-benefit technologies should not be precluded from consideration. For example, for any of the technologies that are considered in setting the standard (in other words, baseline technologies for the program), there could come a time when an on-cycle technology may evolve and provide a significant off-cycle benefit.

In response to these comments, EPA remains concerned with double counting issues if the program were to allow credits for technologies that EPA has accounted for in establishing the level of the standards. As with 2-cycle technologies which are fundamental to vehicle design, EPA believes the use of these technologies will be driven by the standards. As noted above, the fundamental purpose of the off-cycle credit program is to provide incentive for manufacturers to develop new technologies that provide significantly greater emissions reductions off-cycle than over the 2-cycle test. Therefore, double counting and windfall credits issues remain a concern for technologies EPA already accounts for in establishing the standards and therefore expects manufacturers to use widely to meet the standards. For these reasons, as proposed, EPA is not allowing credits for technologies described in Chapter 3 of the TSD.[562]

As noted in the proposal, by removing the ''new, innovative, not widespread use'' criteria initially established in the MY 2012–2016 rule, EPA is also making clear that once approved, EPA does not intend to sunset a technology's credit eligibility or to 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. See 76 FR 75024. Manufacturers demonstrating through the EPA approval process that the technology is effective on additional vehicle models would be eligible for

[562] With the exception of stop start and active aerodynamics and the potential exception of high efficiency alternators, as discussed in section II.F.

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 received comments from manufacturers and suppliers in general support of not sunsetting the off-cycle credits program. EPA received comments from CBD that ''the concept of allowing credit for the installation of new and energy efficient technology that cannot be measured by existing testing mechanisms is sound, as long as the duration of the credit period is brief and provides no disincentive to the implementation of other available features.'' The commenter did not provide additional rationale as to why the credit period should be brief. For the reasons described above, EPA continues to believe that it is appropriate not to sunset credits for off-cycle technologies.

iii. Demonstrating Off-cycle Emissions Reductions

5-Cycle Testing

In those instances when a manufacturer is not using the default credit value provided by the pre-defined menu, EPA is retaining a two-tiered process for demonstrating the CO_2 reductions of off-cycle technologies, 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.

The 5-cycle test procedures remain the starting point for manufacturers to demonstrate off-cycle emissions reductions. The MY 2012–2016 rulemaking established general 5-cycle testing requirements and EPA is finalizing several provisions to delineate what EPA expects as part of a 5-cycle based demonstration. EPA has received and approved one off-cycle credit application from a single manufacturer under the 5-cycle testing approach. Manufacturers requested clarification on the amount of 5-cycle testing that would be needed to demonstrate off-cycle credits, and EPA is finalizing the following as part of the step-by-step methodology manufacturers would follow to seek approval of credits. EPA is also finalizing a specific requirement that all applications include an engineering analysis for how the technology provides off-cycle emissions reductions.

As proposed, EPA is specifying 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 test group. As proposed, manufacturers could bundle off-cycle technologies together for testing in order to reduce testing costs and to 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.[563]

EPA proposed that 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 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 in Section II.F. See 76 FR 75024–25. 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. EPA received comments from manufacturers that the additional 5-cycle testing would be burdensome and be unlikely to yield significantly different results. EPA also received comment that the use of the simulation tool should not be required, as it may not be appropriate for some applications. After reviewing the comments, EPA is not adopting an automatic triggering of the additional testing (i.e., the additional two sets of 5-cycle tests) and use of the vehicle simulation tool to verify credits. EPA agrees that there may be instances where additional test data is unnecessary. Instead, EPA will have the discretion to request additional testing in cases where the agency determines that the additional test would provide useful data in verifying credit levels. Further, EPA is not requiring manufacturers to use the EPA simulation tool, but EPA may use the simulation tool as a check to help verify the level of credits as part of the credit approval process. EPA is adopting the requirement for the initial three sets of 5-cycle testing as proposed. 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, and this process based on 5-cycle testing would not include a public review.

EPA received comments that in many cases technologies would reasonably be expected to have no impact on certain test cycles. For example, cold weather technologies would be expected to have no impact on the SCO3 cycle. In these cases, it would be wasteful to require multiple tests for cycles that are not relevant and have no impact on the credits determination. EPA agrees with these comments and will allow manufacturers to submit an engineering analysis demonstrating that the technology has no effect (either positive or negative) on emissions for one or more of the 5-cycle tests. If EPA concurs with the manufacturer's engineering analysis, the manufacturer must submit only one test result for that test cycle, either with or without the off-cycle technology. The value will be held constant and used for all of the 5-cycle weighting calculations. If EPA does not agree with the manufacturer's determination and believes that the test cycles are relevant, EPA may request that the manufacturer conduct the testing and provide the test data.

EPA also received comment from Center for Biological Diversity disagreeing with the agencies' suggestion that even more off-cycle credits should be allowed, without any rulemaking, if some unspecified data supports them. In response, EPA has specified in the final rule (and in fact, in the proposal (76 FR 75024/3)), the data needed under the 5-cycle approach. Manufacturers may generate credits beyond the conservative credit values provided on the pre-defined list only if they provide the required vehicle specific test data supporting the credit application. This is a case by case application process by a manufacturer, and this type of adjudicative process does not require a rulemaking procedure. As discussed below, EPA has included a public review and comment process in cases where manufacturers develop non 5-cycle demonstrations.

563 40 CFR 600.008(b)(3).

EPA believes this process will provide opportunity for public review and comment.

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. These provisions were established as part of the MY 2012–2016 program. See 75 FR 25440. No applications under these provisions have been received to date. EPA did not propose to make significant changes to this aspect of the program. If the specific technology being considered by the manufacturer does not demonstrate emissions reductions over the 5-cycle tests (i.e., the 5-cycle tests do not capture the specific real-world reductions of the technology), then an alternative approach may be developed by the manufacturer and submitted to EPA for evaluation and 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). Because these applications involve a public comment opportunity, the EPA review period would be longer than 60 days.

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–19 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, and traffic mitigation systems. EPA believes that data would need to be from instrumented vehicle studies and not through driver surveys where results may be influenced by the driver's failure to accurately recall their response behavior. Systems such as OnStar 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.

Several manufacturers expressed interested in credit opportunities based on eco driving modes and other driver interactive technologies, as discussed in Section II.F. The Alliance of Automobile Manufacturers commented that eco driving technologies are not sufficiently defined for the Alliance to propose specific credit definitions and criteria at this time, but the industry hopes that it can work with the agencies in the future to create off-cycle credits for these technologies. Commenters encouraged the agencies to consider alternative demonstration pathways and that they look forward to working with the agencies to develop new methodologies. Some manufacturers commented that the non 5-cycle credit pathway remains unclear. In response, EPA continues to believe that the data needed for demonstrating non 5-cycle technologies will likely be highly specific to the candidate technology and does not believe that it is practical to attempt to provide more specificity to the testing and data requirements at this time. EPA plans to work with manufacturers interested in pursuing credits under the non 5-cycle pathway. Upon request, EPA will informally review a manufacturer's planned methodology in coordination with NHTSA early in the process prior to the manufacturer undertaking testing and/or data gathering efforts in support of their application. This informal review would occur prior to the manufacturer submitting a formal application (and therefore would not include a public review process).

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 apply to technologies generating credits based on the pre-defined list as well as to those based on a manufacturer's demonstration.

Prior to proposal, manufacturers requested clarification of these provisions and guidance on how to demonstrate in-use performance. As discussed in the proposal, EPA is clarifying that off-cycle technologies are considered emissions related components and all in-use requirements apply including defect reporting, warranty, and recall. See 76 FR 75026. OBD requirements do not apply under either the MY 2012–2016 or MY 2017 and later program and EPA did not propose any OBD requirements 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 will be subject to EPA approval prior to credits being awarded.[564] EPA believes these provisions are important to ensure that promised emissions reductions and fuel economy benefit to the consumer are delivered in-use.

EPA received one comment requesting clarification regarding when

[564] Listed technologies are pre-approved assuming the manufacturer demonstrates durability.

durability testing must be conducted. The commenter recommended that manufacturers have the flexibility to conduct durability testing during the model year in which credits would be generated, rather than being required to submit the data before the beginning of the model year, since credits are not actually awarded by EPA to the manufacturer until the end of the model year. EPA believes this is a reasonable approach and is clarifying in the regulations that manufacturers may submit data during the model year in which credits would be generated (§ 86.1869–12). EPA will review the data as part of the end of year credit review and approval process. EPA notes that data submitted late in the model year may delay the end of year review and approval of credits.

v. Step-by-Step EPA Review Process

As proposed, EPA is finalizing a step-by-step process and timeline for reviewing credit applications and providing a decision to manufacturers. EPA proposed and is finalizing 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. As discussed above, starting in MY 2014, manufacturers may generate credits using a pre-defined technology 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 three sets of A/B 5-cycle testing as 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 engineering analysis of 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
- Required three sets of A/B 5-cycle test data
- 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
- For credits not based on 5-cycle testing, all of the above with the exception of 5-cycle data, plus 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

Step 3: EPA Review

Once EPA receives an application:

- EPA will review the application for completeness and within 30 days will notify the manufacturer if additional information or data is needed
- EPA will review the data and information provided to determine if the application supports the level of credits estimated by the 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 5-cycle based credits:
  - EPA may request additional sets of A/B 5-cycle test data where there is less than a three percent difference in A/B 5-cycle test results
  - EPA may conduct vehicle simulation tool analysis for candidate technology where there is less than a three percent difference in A/B 5-cycle test results
- For non 5-cycle based credits:
  - 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 5-cycle based credits, 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 non 5-cycle based 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)

EPA received one comment that it is unclear from the proposal language whether the approval process will be completed and credits will be available in the same year the automaker provides data and requests approval for new off-cycle technologies. In response, EPA clarifies that submitting an application for off-cycle technologies is viewed as independent from the certification application process and off-cycle applications are not required to be submitted prior to the beginning of the model year. EPA has laid out its expectations regarding the timing of its review of credit applications. The specific timing of when credits are awarded will depend on when the agency receives a complete application and has concluded its review. If a manufacturer submits an application late in the model year, the approval process might not be concluded until after the end of the model year. Credits would not be available for use by the manufacturer until the application process has been concluded and credits have been verified. However, manufacturers would generate credits for the model year that has concluded for each vehicle built with the off-cycle technology, as long as the application is submitted prior to the end of the model year.

c. Off-cycle Technology Fuel Consumption Improvement Values in the CAFE Program

As proposed, EPA in coordination with NHTSA, will allow manufacturers to generate fuel consumption improvement values equivalent to CO_2 off-cycle credits for use in the CAFE program. The CAFE improvement value for off-cycle improvements will 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 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 must 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.

TABLE III–20—FUEL CONSUMPTION IMPROVEMENT VALUES EQUIVALENT TO CO_2 OFF-CYCLE CREDITS

Technology	Credit for Cars gallons/mi	Credit for Light Trucks gallons/mi
High Efficiency Exterior Lighting (at 100W)	0.000113	0.000113
Waste Heat Recovery (per 100W; scalable)	0.000079	0.000079
Solar Roof Panels (for 75 W, battery charging only)	0.000372	0.000372
Solar Roof Panels (for 75 W, active cabin ventilation plus battery charging).	0.000282	0.000282
Active Aerodynamic Improvements (scalable)	0.000068	0.000113
Engine Idle Start-Stop w/heater circulation system	0.000282	0.000496
Engine Idle Start-Stop without/heater circulation system	0.000169	0.000327
Active Transmission Warm-Up	0.000169	0.000361
Active Engine Warm-Up	0.000169	0.000361
Solar/Thermal Control	Up to 0.000338	Up to 0.000484

Manufacturers commented in support of providing equivalent fuel consumption improvement values for off-cycle technologies under the CAFE program, supporting the harmonization of the GHG and CAFE programs to the maximum extent possible. EPA and NHTSA also received comments that fuel consumption improvement values based on the pre-defined list should be available for CAFE in the MY 2012–2016 program. As discussed above, EPA is allowing credits toward the GHG standards to be generated based on the list in MY 2014. EPA believes that this is appropriate because it is a modification to an existing off-cycle credits program, which reduces manufacturer testing associated with the program. In contrast, CAFE does not contain an off-cycle program for MY 2012–2016. NHTSA did not take such credits into account when adopting the CAFE standards for those model years. As such extending the credit program to the CAFE program for those model years would not be appropriate.

D. Technical Assessment of the CO_2 Standards

The CO_2 standards in this rule are 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.

As described in the proposal, EPA is taking the same basic approach in this rulemaking as that taken in the MYs 2012–2016 rulemaking and 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 final standards reflect this basic paradigm. In addition to fuel delivery, combustion, and aftertreatment technology, any aspect of the vehicle that affects the consumption of energy must also be considered. For example, the efficiency of the transmission system, which transmits mechanical energy from the engine to the wheels, and the rolling resistance of the tires both have major impacts on the amount of energy that is consumed while operating the vehicle. The braking system, the aerodynamics of the vehicle, and the efficiency of accessories, such as the air conditioner, also affect energy consumption. The mass of the vehicle also has a significant impact on its energy consumption.[565]

In evaluating vehicle efficiency, EPA's analysis preserves all existing vehicle utility. That is, in evaluating available technologies and potential compliance pathways, we preserve vehicle utility and thus do not consider fundamental changes in vehicles' utility.[566] 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).

[565] Like other vehicular greenhouse gas control technologies, the agencies' joint analysis of mass reduction is discussed in TSD 3.

[566] 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 RIA Chapter 1.

Manufacturers may decide to alter the utility of the vehicles which they sell, but this would not be a consequence of the rule but rather a matter of automaker choice.

The Center for Biological Diversity commented that ''[t]he Agencies have selected standards that value purported consumer choice and the continued production of every vehicle in its current form over the need to conserve energy: as soon as increased fuel efficiency begins to affect any attribute of any existing vehicle, stringency increases cease. That is clearly impermissible and contrary to Congressional purpose.'' (CBD Comments p. 4). The commenter is mistaken. In evaluating the costs of the rule, the agencies have included costs to preserve vehicle utility but certainly have not ''ceased * * * increases in stringency'' in the face of those costs. Indeed, were the commenter correct, the standards for cars and trucks would not increase in stringency each model year. Moreover, ''if CBD is advocating a radical reshifting of domestic fleet composition (such as requiring U.S. consumers to purchase much smaller vehicles and requiring U.S. consumers to purchase vehicles with manual transmissions), it is sufficient to say that standards forcing such a result are not compelled under section 202(a), where reasonable preservation of consumer choice remains a pertinent factor for EPA to consider in balancing the relevant statutory factors.'' 75 FR 25467 (May 7, 2010). The agencies' approach also makes evident common sense. If vehicles subject to these standards lack the utility that consumers desire, the vehicles will not be purchased and the ultimate goals of decreased GHG emissions and energy conservation will be derogated rather than furthered. See also *International Harvester* v. *EPA,* 478 F. 2d 615, 640 (D.C. Cir. 1973) (EPA required to consider issues of basic demand for passenger vehicles in making technical feasibility and lead time determinations). Consequently, EPA believes this comment to be misplaced and incorrect.

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 advanced 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 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 24 and 27 bar BMEP engines with cooled EGR, which offer the potential to move gasoline combustion efficiency closer 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, tire 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 final standards. Vehicle manufacturers typically develop many different models based on a limited number of vehicle platforms. The platform typically consists of a common set of vehicle architecture and structural components.[567] 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.[568] 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.[569] 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 final rule affects nine years of vehicle production, model years 2017–2025.[570] Given the 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 final rule 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 final rule. An example is the advanced 24 and 27 bar BMEP, cooled EGR engines. Although a number of demonstration projects have been completed, these engines are not yet in production vehicles today, and a further research and development period is required (as discussed in Chapter 3 of the joint TSD).

EPA's technical assessment of the final 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 promulgated standards. The technical assessment of these alternative standards in relation to the final standards 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 reduce GHGs beyond current levels. Finally, we consider the challenge for manufacturers to design

[567] Examples of shared vehicle platforms include the Ford Taurus and Ford Explorer, or the Chrysler Sebring/200 and Dodge Journey.

[568] See TSD Chapter 3; see also 75 FR 25467 (May 7, 2010).

[569] TSD 3 discusses redesign schedules in greater detail.

[570] In absence of additional EPA action, the MY 2025 standard would continue indefinitely for later model years.

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.

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, as in the MYs 2012–2016 rulemaking, EPA is again using a computerized program called the Optimization Model for reducing Emissions of Greenhouse gases from Automobiles (OMEGA). No comments were received on the use of the OMEGA model. Broadly, OMEGA starts with a description of the future vehicle fleet (i.e. the 'reference fleet'; see section II.B above),[571] 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 to capture the important differences in vehicle utility and engine design among future vehicles with sales of roughly 15–17 million units annually in the MYs 2017–2025 timeframe. The model is then provided with a list of technologies, or packages of technologies, which are applicable to various types of vehicles, along with the technologies' cost and effectiveness, and an upper limit for the percentage of vehicle sales that can receive each technology during the redesign cycle or cycles 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. Although OMEGA can apply technologies that reduce GHG emissions related to air conditioning efficiency improvements and reduction of refrigerant leakage this task is currently handled outside of the OMEGA model. A/C improvements are relatively cost-effective, and we reasonably project that they would always be added to vehicles by the model. We thus simply added projected A/C improvements into the results at the projected penetration levels. The model can also be set to account for the various final compliance flexibilities (and to accommodate compliance flexibilities in general) and was set to account for some of the off-cycle and full size pickup credits.

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 that are likely to be applied by manufacturers to comply with the standards. 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.0 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 of the final standards in relation to the alternative standards of greater and lesser stringency which we analyzed. Further technical detail on all of these issues can be found in EPA's Regulatory Impact Analysis.

1. How did EPA develop reference and control fleets for evaluating standards?

In order to calculate the impacts of this final rule, it is necessary to project the GHG emissions characteristics of the future vehicle fleet absent the final regulation. As discussed in Preamble I, for this final rulemaking, EPA has analyzed the costs and benefits of the standards using two different scenarios of the baseline fleet and future fleet projections. EPA is presenting its primary analysis of the standards using essentially the same baseline/future fleet projection that was used in the NPRM (i.e., based on the MY 2008 baseline fleet, AEO2011 interim projection of future fleet sales volume, and the future fleet forecast conducted by CSM).[572] EPA also conducted an alternative analysis of the standards based on MY2010 based fleet projection using a 2010 baseline fleet, an updated AEO 2012 (early release) projections of the future fleet sales volumes, and an alternative forecast of the future fleet mix projections to 2025 conducted by LMC Automotive (formerly J.D. Powers Automotive). EPA is presenting the 2008 baseline fleet and CSM future fleet forecast for its primary analysis based on a number of factors as described in Section I.C of the preamble. A detailed sensitivity analysis of the standards using the MY 2010 based fleet projection is contained in EPA RIA Chapter 10.

EPA and NHTSA develop this projection of the future vehicle fleet using a three step process. (1) Develop a set of detailed vehicle characteristics and sales for a specific model year (in this case, 2008). 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.[573] (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 final 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 (which assume that the MY 2016 standards are maintained indefinitely) and the 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 final standards. Further, each agency evaluates its own final and MY 2016 standards; neither NHTSA nor

[571] Note that we worked with two "baseline" fleets in this analysis—the 2008 based fleet projection and the 2010 based fleet projection—and used the 2008 based fleet projection to analyze our primary case (i.e., the final standards). For alternative standards and sensitivities, as discussed later in this section and in Chapter 10 of EPA's RIA, we have presented results for the 2010 based fleet projections.

[572] As explained in detail in section 1.3.1 and 1.3.2.1 of the joint TSD, there are minor changes from proposal in the 2008 MY fleet-based reference fleet. Namely, there are minor corrections to some of the footprint data used, which on average, slightly reduced the footprint of the fleet. In aggregate, incorporating these changes resulted in practically no change from the proposal.

[573] 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 final rule.

EPA evaluated the other agency's standard in this final rule.[574] The models employed by the two agencies are distinct due to the differences in the statutory requirements of the two agencies (as discussed in Section I of the preamble).

The use of MY 2008 vehicles [575] 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 reasonable for this final rule.[576] With regard to the issue of which models are included, we note that the designs of 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 confidential descriptions of these vehicle designs provided by manufacturers 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 duty 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

In this final rule, EPA is assuming, based on the following rationale and as in the proposal, that in the absence of more stringent GHG and CAFE standards, the reference case fleet in MY 2017–2025 would have fleetwide GHG emissions performance equal to that necessary to meet the MY 2016 standards.

One critical factor supporting the final approach is that AEO2012 Early Release projects relatively stable gasoline prices over the next 13 years. The average actual price in the U.S. for the first four months of 2012 for regular gasoline was $3.68 per gallon [577] with prices approaching $4.00 in March and April.[578] The AEO2012 Early Release reference case projects the regular gasoline price to be $3.87 per gallon in 2025, only slightly higher than the price for the first four months of 2012.[579] Accordingly, the reference fleet for MYs 2017–2025 reflects constant GHG emission standards (i.e. the MY 2016 standards continuing to apply in each of those model years), and gasoline prices only slightly higher than today's gasoline prices.

As discussed at proposal, these are reasonable assumptions to make for a reference case. See 76 FR 75030–31. EPA has reviewed the historical record for similar periods when there were relatively stable fuel economy standards and gasoline prices. EPA maintains, and publishes every year, the authoritative reference on new light-duty vehicle CO_2 emissions and fuel economy.[580] This report contains very detailed data from MYs 1975–2011. There was an extended 18-year period from 1986 through 2003 during which CAFE standards were essentially unchanged,[581] and gasoline prices were relatively stable and remained below $1.50 per gallon for almost the entire period. The 1975–1985 and 2004–2011 timeframes are not relevant in this regard due to either rising gasoline prices, rising CAFE standards, or both. Thus, the 1986–2003 timeframe is analogous 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 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 (i.e., non-footprint based) 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.[582]

Since the MYs 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 CAFE standards.[583] Thus, the historical evidence and the footprint-based design of the MY 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.[584] NHTSA (for the proposal) 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 market driven perspective, while there is considerable evidence that many consumers now care more about fuel economy than in past decades, the MY 2016 compliance level is projected to be several mpg higher than that being achieved in the market today.[585] On the other hand, some manufacturers have already announced plans to introduce technology well beyond that required by

[574] While the MY 2012–2016 standards are largely similar, some important differences remain. See 75 FR 25342

[575] While this discussion focuses on MY 2008 vehicles, the same concepts apply the MY 2010 based fleet projection.

[576] See section I.C concerning the selection of MY 2008 as an appropriate baseline.

[577] In 2012 dollars. As 2012 is not yet complete, we are not relating this value to 2010 dollars. See RIA 1 for additional details on the conversion between dollar years.

[578] *http://www.eia.gov/petroleum/gasdiesel/* and click on ''full history'' for weekly regular gasoline prices through May 7, 2012, last accessed on May 8, 2012.

[579] *http://www.eia.gov/forecasts/aeo/er/* last accessed on May 8, 2012.

[580] Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 through 2011, March 2012, available at *www.epa.gov/otaq/fetrends.htm*.

[581] There are no EPA LD GHG emissions regulations prior to MY 2012.

[582] See Regulatory Impact Analysis, Chapter 3.

[583] With the notable exception of manufacturers who only market electric vehicles or other limited product lines.

[584] 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.

[585] The average, fleetwide ''laboratory'' or ''unadjusted'' fuel economy value for MY 2011 is 28.6 mpg (see Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2011, March 2012, available at *www.epa.gov/otaq/fetrends.htm*), 6 mpg less than the 34–35 mpg levels necessary to meet the EPA GHG and NHTSA CAFE levels in MY 2016.

the MY 2016 GHG standards.[586] 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 (e.g., some manufacturers may have made public statements about higher mpg levels in the future in part because of the expectation of higher future standards).

While EPA exclusively assumed a ''flat'' baseline in the proposal, NHTSA used a flat baseline for its primary analysis, but assumed an ''increasing'' baseline (i.e., a market-driven fuel economy improvement in MYs 2017–2025 beyond the projected 34.1 mpg fleetwide CAFE level in MY 2016) in a sensitivity analysis. The agencies received five comments on this topic. The American Council for an Energy-Efficient Economy stated ''[t]here is little historical basis for a scenario in which there is a sustained increase in fuel economy in the absence of increases in standards. Public interest in fuel economy does shift with fuel prices, but even that interest typically has followed from large, rapid changes in price and has been short-lived. The fuel prices on which the various agency analyses are largely based are EIA projections and do not contain dramatic increases in price.'' The Environmental Defense Fund ''supports EPA's proposal to assume the reference case fleet in MY 2017–2025 would have fleet wide GHG emissions performance no better than that projected to be necessary to meet the MY 2016 standards. Because EPA is using AEO2011 fuel price forecasts, which project relatively stable fuel prices over the next 15 years, it is reasonable to assume that manufacturers will not over comply with the 2016 standards and/or consumers will not demand fuel economy greater than the 2016 standard.'' The International Council on Clean Transportation argued that ''[t]he proposed 2017–2025 standards follow aggressive increases in standards from 2011 through 2016. Further, the change to a footprint-based standard means that all manufacturers must increase the efficiency of their vehicles to comply, even manufacturers of primarily smaller vehicles. Thus, the 2012–2016 standards have already driven the market beyond the level of efficiency it would have demanded in the absence of standards.'' The Natural Resources Defense Council and joint Sierra Club/Environment America/Safe Climate Campaign/Clean Air Council comment echoed these arguments.

In sum, all five comments on this topic supported EPA's exclusive use of a flat baseline, and no comments supported a sensitivity case with an increasing baseline.

Based on the above data-driven rationale for a flat baseline, along with the fact that all of the public comments on this topic support a flat baseline, EPA reaffirms the reasonableness of its assumption in the proposal that, in the absence of more stringent standards, the greenhouse gas emissions performance of MY 2017–2025 vehicles would remain at MY 2016 levels, and therefore has used a ''flat'' baseline for the analysis in this final rulemaking.

Based on this assessment, the EPA My 2008 based reference case fleet is estimated through the target curves defined in the MY 2016 rulemaking applied to the projected MYs 2017–2025 fleet.[587] As in the MYs 2012–2016 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. Emission Control Scenarios Modeled

For the emission control scenario (i.e. scenarios where there are standards for MYs 2017–2025 which differ from the MY 2016 standards), EPA modeled the final standard curves discussed in Section III.B, as well as the alternative scenarios discussed in III.D.6.d. Certain flexibilities are also accounted for in the analysis. Air conditioning credits (both leakage and efficiency) discussed in section III.C.1 and III.D.2 are included in the cost and technology analysis described below. Full size pick-up truck HEV credits are also modeled in this final rule analysis. See 76 FR 75082 (noting that modeling for the final rule might include these credits.) The compliance value of 0 g/mile for EVs and the electric portion of PHEVs are also included. In a change from the proposal, we have also included some off-cycle credits (start-stop systems and active aerodynamic improvements) in the cost assessment as these technologies' two-cycle benefits were already assumed in EPA's list of technology packages (i.e. the technology packages modeled by OMEGA). See 76 FR 75022 and section III.C.5 above.[588] However, advanced technology multipliers through MY 2021, intermediate volume manufacturer provisions, flexible fuel, and carry forward/back credits are not included explicitly in the cost analysis. These flexibilities will offer the manufacturers more compliance options and lower compliance costs. Moreover, the overall cost analysis includes small volume manufacturers in the fleet, while in actuality, these companies would likely have company specific standards (see section III.B.5). Thus, in these respects EPA is utilizing a conservative costing methodology.

EPA notes that the stringency of the final standards reflects use of air conditioning improvements and use of the 2-cycle values for the stop-start and active aerodynamic off-cycle technologies. These technologies are highly cost effective, and the improvements in GHG emissions attributable to use of these technologies can be reliably quantified.[589] The standards do not directly reflect use of the credits related to use of advanced technologies on full size pickup trucks, notwithstanding that EPA believes that there is sufficient information to reflect and quantify use of these credits in its cost and feasibility modeling. The reason the standards do not reflect use of these advanced technology credits is the same reason EPA is establishing the provisions as incentives: use of advanced technologies in large pickup trucks may face issues of consumer acceptance of both the extra cost and of the technologies themselves. Consequently, EPA has made a reasonable policy choice to encourage penetration of these technologies into the large pickup truck sector rather than to adopt standards premised on aggressive penetration rates of these technologies. See 76 FR 75082.

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 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

[586] For example, Hyundai has made a public commitment to achieve 50 mpg by 2025. See also section III.D.8 below documenting those vehicles either achieving their post-MY 2016 targets, or which could do so with the use of A/C credits.

[587] 75 FR 25686.

[588] The off-cycle technologies not part of EPA's technology packages are not included in the analysis.

[589] See generally TSD 3 and 5.

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–21. While there were no comments on this topic, EPA has updated these groupings from those used in the proposal. The new groupings provide a more accurate mapping of vehicle technologies to vehicle platforms.

TABLE III–21—VEHICLE GROUPINGS [a]

Vehicle description	Vehicle type	Vehicle class
Auto Subcompact I3 DOHC 4v	1	Small car.
Auto Subcompact I4 SOHC/DOHC 2v/4v		
Auto Subcompact Electric		
Auto Compact SOHC 2v	2	Standard car.
Auto Compact SOHC/DOHC 4v		
Auto Midsize SOHC/DOHC 4v		
Pickup Small DOHC 4v		
Auto Subcompact I5 SOHC 4v	3	Standard car.
Auto Subcompact V6 SOHC/DOHC 4v		
Auto Subcompact I4 SOHC/DOHC 4v turbo/supercharged		
Auto Compact Rotary		
Auto Compact I5 DOHC 4v		
Auto Compact V6 SOHC/DOHC 4v		
Auto Compact I4 SOHC/DOHC 4v turbo/supercharged		
Auto Midsize V6 SOHC/DOHC 4v		
Auto Midsize I4 SOHC/DOHC 4v tubo/supercharged		
Auto Large V6 SOHC/DOHC 4v		
Auto Midsize I4 SOHC 4v tubo/supercharged		
Auto Subcompact V6 SOHC 3v	4	Standard car.
Auto Compact V6 OHV 2v		
Auto Midsize V6 SOHC 2v		
Auto Midsize V6 OHV 2v		
Auto Large V6 OHV 2v		
Auto Subcompact V8 DOHC 4v	5	Large car.
Auto Compact V10 DOHC 4v		
Auto Compact V8 DOHC 4v turbo/supercharged		
Auto Compact V8 DOHC 4v/5v		
Auto Compact V6 DOHC 4v		
Auto Compact V5 DOHC 4v turbo/supercharged		
Auto Midsize V12 DOHC 4v		
Auto Midsize V10 DOHC 4v		
Auto Midsize V8 DOHC 4v/5v		
Auto Midsize V8 SOHC 4v		
Auto Midsize V6 DOHC 4v		
Auto Midsize V7 DOHC 4v		
Auto Large V16 DOHC 4v turbo/supercharged		
Auto Large V12 SOHC 4v turbo/supercharged		
Auto Large V12 DOHC 4v		
Auto Large V10 DOHC 4v		
Auto Large V8 DOHC 4v turbo/supercharged		
Auto Large V8 DOHC 2v/4v		
Auto Large V8 SOHC 4v		
Auto Subcompact V10 OHV 2v	6	Large car.
Auto Subcompact V8 SOHC 3v		
Auto Midsize V8 SOHC 3v turbo/supercharged		
Auto Midsize V8 SOHC 3v		
Auto Midsize V8 OHV 2v		
Auto Large V12 SOHC 3v turbo/supercharged		
Auto Large V8 SOHC 3v turbo/supercharged		
Auto Large V8 SOHC 2v		
Auto Large V8 OHV 2v/4v		
SUV Small I4 DOHC 4v	7	Small MPV.
SUV Midsize SOHC/DOHC 4v		
SUV Large DOHC 4v		
Minivan I4 DOHC 4v		
SUV Small I4 DOHC 4v turbo/supercharged	8	Large MPV.
SUV Midsize V6 SOHC/DOHC 4v		
SUV Midsize I4 SOHC/DOHC 4v turbo/supercharged		
SUV Large V6 SOHC/DOHC 4v		
SUV Large I5 DOHC 2v		
SUV Large I4 DOHC 4v turbo/supercharged		
SUV Midsize V6 SOHC 2v	9	Large MPV.
SUV Large V6 SOHC 2v		
SUV Small V6 OHV 2v	10	Large MPV.
SUV Midsize V6 OHV 2v		
SUV Large V6 OHV 2v		

TABLE III–21—VEHICLE GROUPINGS [a]—Continued

Vehicle description	Vehicle type	Vehicle class
Minivan V6 OHV 2v		
Cargo Van V6 OHV 2v		
SUV Large V10 DOHC 4v turbo/supercharged	11	Truck.
SUV Large V8 DOHC 4v turbo/supercharged		
SUV Large V8 SOHC/DOHC 4v		
SUV Large V6 DOHC 4v turbo/supercharged		
SUV Large V8 SOHC 3v turbo/supercharged	12	Truck.
SUV Large V8 SOHC 2v/3v		
SUV Large V8 OHV 2v		
Cargo Van V10 SOHC 2v		
Cargo Van V8 SOHC/OHV 2v		
Pickup Large DOHC 4v	13	Small MPV.
Pickup Small V6 SOHC 4v	14	Large MPV.
Pickup Small I5 DOHC 2v		
Pickup Large V6 DOHC 2v/4v		
Pickup Large I5 DOHC 2v		
Pickup Small V6 SOHC 2v	15	Large MPV.
Pickup Small V6 OHV 2v		
Pickup Large V6 SOHC 2v		
Pickup Large V6 OHV 2v		
Pickup Large V8 DOHC 4v	16	Truck.
Pickup Large V8 SOHC 2v	17	Truck.
Pickup Large V8 SOHC/DOHC 3v turbo/supercharged	18	Truck.
Pickup Large V8 SOHC 3v		
Pickup Large V8 OHV 2v	19	Truck.

[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.

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 Joint TSD and in Section II.D of this preamble. The work on technology cost and effectiveness also includes maximum penetration rates, or ''phase-in caps'' for the OMEGA model. These caps are an important input to OMEGA that capture the agencies' analysis of the rate at which technologies can be added to the fleet (see Chapter 3.4.2 of the 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 (A/C) refrigerant.

EPA expects all manufacturers will choose to use A/C improvement credit opportunities as a strategy for complying with the CO_2 standards, and has set the stringency of the proposed and final standards accordingly (see section III.C.1). EPA estimates that the average level of the credits earned will increase from 2017 (13 g/mile) to 2021 (21 g/mile) as more vehicles in the fleet convert to use of the new alternative refrigerant.[590] By 2021, we project that 100% of the MY 2021 fleet will be using alternative refrigerants, and that credit usage will remain constant on a car and truck fleet 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 joint TSD. A more in-depth discussion of feasibility and availability of low GWP alternative refrigerants can be found in Section III.C.1 of the Preamble.

TABLE III–22—TOTAL COSTS FOR A/C TECHNOLOGIES RELATED TO ALTERNATIVE REFRIGERANTS

[Costs in 2010 dollars]

Technology	2017	2021	2025
Car:			
Leakage reduction (continued from the 2012–2016 rule)	$3	$3	$3
Low GWP refrigerant	17	58	50
Low GWP refrigerant hardware	4	17	16
Total	23	77	68
Truck:			
Leakage reduction (continued from the 2012–2016 rule)	1	3	3
Low GWP refrigerant	0	58	50
Low GWP refrigerant hardware	0	17	16
Total	1	77	68
Fleet:			
Total	24	77	68

[590] See table in III.B.

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 MYs 2012–2016 final rule. The penetration of A/C improvements and costs for this final rule can be found in Chapter 5 of the 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.

As in the proposal, EPA built unique technology packages for each of 19 ''vehicle types,'' which, as in the MYs 2012–2016 rule and the proposal, provides sufficient resolution to represent the technology of the entire fleet at varying levels of stringency.[591] 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), valvetrain configuration (DOHC, SOHC, OHV), and 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 six classes of vehicles: Small car, Standard car, Large car, Small MPV, Large MPV and Truck.[592] We believe that these six vehicle classes, along with engine cylinder count and valvetrain configuration, provide adequate representation for the cost basis associated with most technology application. A detailed table showing the 19 vehicle types, their baseline packages and their descriptions is contained in Table III–21 and in Chapter 1 of EPA's RIA.

Within each of the 19 vehicle types, multiple technology packages were created with increasing technology content and resulting increases in effectiveness. As stated earlier, with few exceptions, each technology package is meant to provide the same driver-perceived performance and utility as the baseline package. Note that we refer throughout this discussion of package building to 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 1,300 vehicle models. In this discussion, when we refer to ''baseline'' packages we refer to the ''baseline'' configuration of the given vehicle type. So, we have 19 baseline packages in the context of building packages. Each of those 19 baseline packages is comprised of 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. We describe this in more detail in Chapter 1 of EPA's RIA.

To develop a set of packages as OMEGA inputs, EPA builds packages consisting of every feasible combination of technology available, subject to constraints.[593] For the 2025MY, this ''master-set'' of packages consists of roughly 2,500 possible packages of technologies for each of 19 vehicle types, or roughly 47,000 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 complex 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,[594] 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 valve trains, 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 joint TSD as well as in Chapter 1 of EPA's RIA.

Table III–23 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 Joint TSD and in Chapter 1.2 of EPA's RIA). Table III–23 includes technology costs for a V6 dual overhead cam midsize 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 Joint TSD. Note that these costs are not package costs but, rather, individual technology costs. We present package costs for the V6 midsize car in Table III–24, below.

As discussed in II.D, we received relatively few detailed comments on technology cost and effectiveness, with the primary comments from NADA and

[591] Note that the 19 vehicle types have been significantly modified for this final rule relative to the proposal. These changes allow more accurate placement of vehicles into the appropriate vehicle types, such as towing and non-towing vehicles. See Chapter 1 of EPA's final RIA for more detail on the new vehicle types.

[592] Note that, for this final rule and representing an update since the proposal, EPA has used vehicle class designations that are consistent with those in the lumped parameter model used for effectiveness determinations. As such, the 19 vehicle types are mapped into vehicle classes with different names although the proposal's names and the final rule's names are essentially identical in meaning. This semantic change is meant to reduce confusion and to more closely tie the cost elements of our modeling with the effectiveness elements.

[593] 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.

[594] 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%)).

ICCT. At a high level, the changes made since the proposal discussed in Section II.D of this preamble. More detailed discussion of technology cost and effectiveness is presented in Chapter 3 of the Joint TSD.

TABLE III–23—TOTAL COSTS OF SELECT TECHNOLOGIES FOR V6 MIDSIZE CAR AND V8 LARGE PICKUP TRUCK

[2010 dollars]

Vehicle class & base engine	Technology	2017 MY	2021 MY	2025 MY
Midsize/Standard car	Dual cam phasing on V6	$205	$178	$168
V6 DOHC	Dual cam phasing on I4 (used when downsized to I4 DOHC)	95	83	78
4 valves/cylinder	Stoichiometric gasoline direct injection on V6	417	362	340
Port fuel injected	Stoichiometric gasoline direct injection on I4 (used when downsized).	277	240	226
4 speed auto trans	18-bar BMEP with downsize from V6 DOHC to I4 DOHC	248	161	169
	24-bar BMEP with downsize from V6 DOHC to I4 DOHC	510	449	383
	Cooled EGR on I-configuration (used when downsized)	305	288	249
	Advanced diesel	2965	2572	2420
	8 speed dual clutch transmission (wet)	47	45	39
	High efficiency gearbox	251	227	202
	Aerodynamic treatments (active, Aero2)	213	199	176
	Stop-start (12 Volt)	401	338	308
	P2 hybrid electric technology [a]	3,847	3,230	2,861
	Plug-in hybrid technology with 20 mile range [a]	13,148	9,950	8,145
	Electric vehicle technology with 75 mile range [a]	17,684	13,232	9,795
Large pickup truck	Dual cam phasing on V6 (used when downsized to V6 DOHC)	205	178	168
V8 OHV	Stoichiometric gasoline direct injection on V8	501	435	409
2 valves/cylinder	Stoichiometric gasoline direct injection on V6 (used when downsized).	417	362	340
Port fuel injected				
4 speed auto trans				
	18-bar BMEP with downsize from V8 OHV to V6 DOHC	1,339	1,151	1,080
	24-bar BMEP with downsize from V8 OHV to V6 DOHC	1,781	1,636	1,441
	Cooled EGR on V-configuration	305	288	249
	Advanced diesel	4,154	3,605	3,392
	8 speed automatic transmission	62	54	50
	High efficiency gearbox	251	227	202
	Aerodynamic treatments (active, Aero2)	213	199	176
	Stop-start (12 Volt)	498	420	383
	P2 hybrid electric technology [a]	4,575	3,851	3,399

[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 Joint TSD for more details).

As detailed in Chapter 1 of EPA's RIA, this master-set of packages is then ranked according to technology application ranking factors (TARFs) to eliminate packages that are not as cost-effective as others.[595]

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 purchasers of new vehicles 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).[596] 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:

[595] The Technology Application Ranking Factor (TARF) is discussed further in III.D.4. More detail on the TARF can be found in the OMEGA model supporting documentation (see EPA–420–B–10–042).

[596] 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.

$$CostEffManuf_t = \frac{\Delta TechCost - \Delta FS}{\Delta CO_2 x\ VMT_{regulatory}}$$

Where:

$CostEffManuf_t$ = Manufacturer-Based Cost Effectiveness (in dollars per kilogram CO_2),

$\Delta TechCost$ = Difference in marked up cost of the technology (dollars),

ΔFS = 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

ΔCO_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.[597] For this final rulemaking, we have additionally incorporated the off-cycle and hybrid credits into the TARF equations.[598] As the calculation is from the manufacturers' perspective, the credit value is considered as additional CO_2 savings when the model calculates the TARF.[599]

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 final rule, but a measure of the private cost, (i.e., a measure of the vehicle purchaser's willingness to pay more for a vehicle with higher fuel efficiency). Since vehicle operators pay the full price of fuel, including taxes, they value fuel costs or savings at this level, and OMEGA presumes that manufacturers will consider this when choosing among the technology options.[600]

The values of manufacturer-based net cost-effectiveness for specific technologies will vary from vehicle to vehicle, often substantially. This occurs for three reasons. First, the technology cost, change in ownership fuel costs, 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 are 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 RIA contains further detail on the values of manufacturer-based net cost-effectiveness for the various technology packages.

The result of this TARF ranking process is a ''ranked-set'' of over 700 packages for use as OMEGA inputs, or roughly 40 per vehicle type. EPA prepares a ranked-set of packages for any MY in which OMEGA is run,[601] 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).[602] 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 hybrid-electric, plug-in hybrid-electric and battery-electric technologies. Note that plug-in hybrid and electric vehicle packages are only modeled for the non-towing vehicle types, in order to better maintain utility (see RIA chapter 1). In the proposal, we requested comment on this approach and whether we should consider plug-in hybrids for towing vehicle types. We did not receive any comments on this topic and have maintained the same approach in the final rule as used in the proposal.

Table III–24 presents the cost and effectiveness values from a 2025MY ranked-set of packages used in the OMEGA model for EPA's vehicle type 3, a midsize or standard 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 RIA.

TABLE III–24—CO_2 REDUCING TECHNOLOGY VEHICLE PACKAGES USED IN OMEGA FOR A V6 MIDSIZE CAR EFFECTIVENESS AND COSTS IN THE 2025MY

[Costs in 2010 dollars]

Tech Pkg #	Engine & vehicle technologies	Mass Rdxn applied (percent)	Cost	Effectiveness (percent)
3.0000	Auto 4VDV6	base	$0	0.0

597 OMEGA model documentation. EPA–420–B–10–042.

598 As noted previously, selected off-cycle credits were included in the cost analysis. Thus, their usage was also included in the TARF (technology selection algorithm), so that the model could consider both the two cycle and off-cycle effectiveness when choosing technologies.

599 Of the off-cycle credits on the menu, only stop start and the active aerodynamics are considered when analyzing costs of complying with the standards the final analysis. We have done this because of their relatively high expected penetration rates.

600 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 making vehicle purchases and ranking technology choices, respectively. For this final rule, this factor was not included in our determination of manufacturer-based net cost-effectiveness in the analyses.

601 Note that a ranked-set of package is regenerated for any year for which OMEGA is run due to the changes in costs and maximum penetration rates. EPA's RIA chapter 3 contains more details on the OMEGA modeling and Joint TSD Chapter 3 has more detail on both costs changes over time and the maximum penetration limits of certain technologies used in the agencies modeling.

602 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–24—CO_2 REDUCING TECHNOLOGY VEHICLE PACKAGES USED IN OMEGA FOR A V6 MIDSIZE CAR EFFECTIVENESS AND COSTS IN THE 2025MY—Continued

[Costs in 2010 dollars]

Tech Pkg #	Engine & vehicle technologies	Mass Rdxn applied (percent)	Cost	Effectiveness (percent)
3.0131	Auto 4VDV6 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero1 +LRRT1 +HEG +DCP +WR5% +6sp.	5	822	29.8
3.0195	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero1 +LRRT1 +HEG +DCP +GDI +TDS18 +WR5% +6sp.	5	1,070	36.8
3.0196	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS18 +WR5% +6sp.	5	1,287	40.4
3.0388	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS18 +WR5% +8sp.	5	1,402	42.3
3.0772	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS18 +WR10% +8sp.	10	1,519	43.9
3.1156	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS18 +WR15% +8sp.	15	1,745	45.5
3.0804	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS24 +WR10% +8sp.	10	1,733	45.7
3.0836	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS24 +EGR +WR10% +8sp.	10	1,982	47.7
3.1220	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS24 +EGR +WR15% +8sp.	15	2,209	49.2
3.2004	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +TDS18 +WR10% +8sp.	10	2,722	50.2
3.1604	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +TDS24 +EGR +WR20% +8sp.	20	2,506	50.7
3.1612	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +SS +TDS24 +EGR +WR20% +8sp.	20	2,814	51.2
3.2196	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +TDS18 +WR15% +8sp.	15	2,948	51.4
3.1628	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC2 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +SS +SAX +TDS24 +EGR +WR20% +8sp.	20	2,896	51.5
3.2204	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +SAX +TDS18 +WR15% +8sp.	15	3,030	51.8
3.2020	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +TDS24 +WR10% +8sp.	10	2,936	51.9
3.2396	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +SAX +TDS18 +WR20% +8sp.	20	3,327	53.0
3.2400	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +MHEV +SAX +TDS18 +WR20% +8sp.	20	3,461	53.4
3.2220	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +SAX +TDS24 +WR15% +8sp.	15	3,245	53.4
3.2036	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +TDS24 +EGR +WR10% +8sp.	10	3,185	53.6
3.2228	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +TDS24 +EGR +WR15% +8sp.	15	3,412	54.7
3.2236	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +SAX +TDS24 +EGR +WR15% +8sp.	15	3,494	55.1
3.2428	Auto 4VDI4 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +GDI +MHEV +SAX +TDS24 +EGR +WR20% +8sp.	20	3,791	56.2
3.1680	Auto 4VDV6 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +HEV +SAX +ATKCS +WR20% +8sp.	20	5,156	57.3
3.2465	Auto 4VDV6 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +ATKCS +REEV20 +WR20% +8sp.	20	11,047	74.3
3.2466	Auto 4VDV6 +EFR2 +ASL2 +LDB +IACC1 +EPS +Aero2 +LRRT2 +HEG +DCP +DVVL +GDI +ATKCS +REEV40 +WR20% +8sp.	20	13,534	83.8
3.2467	+IACC1 +EPS +Aero2 +LRRT2 +EV75 mile +WR20% +0sp	20	11,451	100.0
3.2468	+IACC1 +EPS +Aero2 +LRRT2 +EV100 mile +WR20% +0sp	20	13,376	100.0
3.2469	+IACC1 +EPS +Aero2 +LRRT2 +EV150 mile +WR20% +0sp	20	18,306	100.0

6sp = 6sp transmission (DCT-wet for vehicle type 3); 8sp = 8 speed DCT-wet; 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; MHEV = Mild HEV; 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 joint TSD.

Note that MHEV, HEV, REEV and EV technologies include both the cost and effectiveness of IACC2 within the electrification technology, so IACC2 is not independently listed in the package description.

Note that the level of weight reduction actually applied to a given vehicle is controlled within OMEGA based on safety constraints.

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 explained above, EPA used 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 model documentation,[603] makes the model publically available on its Web site,[604] and has subjected the model to peer review.[605]

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 described above, which tells the model which set of technologies can be applied to that vehicle. 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, or to a vehicle that already has this equipment. The development of the required data regarding the reference fleet is described in Section II.B and 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, effectiveness, and any credit value that they accrue during the compliance process. As noted previously, accounting for credit value is a change from the proposal, and allows EPA to more accurately reflect compliance related impacts of technology usage in its cost assessment. This information was described above as well as in Chapter 3 of the Joint TSD and Chapter 1 of EPA's 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 (reference case) standards, and the MY 2021 and MY 2025 control case standards as well as the alternative standards described later in this chapter. The results for intermediate years are interpolated as described in Chapter 5 of the EPA RIA. 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/mile of A/C credit in MY 2016. Thus, the MY 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 21 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 baseline 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 MY 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 required a 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 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 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 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 to which each technology package's incremental effectiveness and incremental cost is affected by the technology already

[603] 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)

[604] *http://www.epa.gov/oms/climate/models.htm*

[605] EPA–420–R–09–016, September 2009.

present on the baseline vehicle. Termed the technology effectiveness basis (TEB) and cost effectiveness basis (CEB), respectively, the values are calculated in this step using the equations shown in EPA RIA chapter 3. For this final rulemaking, we also account for the credit values using a factor termed other effectiveness basis (OEB).

As described in Section III.D.3 above, technology packages are applied to groups of vehicles which generally represent a single vehicle platform and which are equipped with a single engine size (e.g., compact cars with four cylinder engine produced by Ford). These groupings are described in Table III–21. 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 final rule allows for averaging across a manufacturer's cars and trucks, the model determines the CO_2 emission standard applicable to each manufacturer's car and truck sales from the two sets of coefficients describing the piecewise linear standard functions for cars and trucks (i.e. the respective car and truck curves) in the inputs, and creates a combined car-truck standard for that manufacturer. This combined standard considers the difference in lifetime VMT of cars and trucks, as indicated in the final regulations which govern credit trading between these two vehicle classes (which reflect the final MYs 2012–2016 rules on this point).

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 standard.

5. Projected Compliance Costs and Technology Penetrations

The following tables present the projected incremental costs and technology penetrations for the final program. The most significant differences between the proposal analysis and the final rulemaking analysis presented below include:

- *Cost-impacts of the off-cycle, strong, and mild hybrid full size pickup provisions:* In the proposal, although we included these credits in our assessment of program impacts, we did not include these credits in the cost analysis. For this final rulemaking, we include these credits as further described in EPA RIA chapter 3.[606] As discussed in III.C.5, while manufacturers were also given the opportunity to use these credits from the off-cycle menu under the reference MY 2016 standards, in all cases, these additional compliance options lead to reductions in costs.
- *Mild hybrid technology:* As described in Chapter 3 of the TSD, we did not model a mild hybrid technology in the proposal. Between proposal and final rulemaking, new technical information has become available for this technology, and the mild hybrid technology has been included in the assessment. In combination with the off-cycle credits, this technology has the potential to be a highly cost-effective compliance option, and leads to cost reductions in this analysis.
- *Updated safety coefficients:* As a result of the safety analysis described in Section II.G, the amount of mass reduction applied to the fleet was modified in order to show a compliance path and cost-assessment that is safety neutral. This led to a smaller application of mass reduction compared to the proposal. This change slightly increased the costs relative to the proposal since mass reduction is a relative cost effective technology at the levels we are estimating it will be implemented.

As a result, the projected MY 2025 compliance costs are slightly less than those projected in the proposal (despite the increased cost from less mass reduction). These changes do not change the agency's overall assessment of the appropriateness of the standards we are adopting. As will be discussed later in this section, the proposal analysis using the MY 2008 based fleet projection, the final rulemaking results using the MY 2008 based fleet projection, and the final rulemaking analysis using the MY 2010 based fleet projection, all support EPA's assessment of the appropriateness of the standards.

Analysis results in the remainder of this section are for the MY 2008 based fleet projection only. EPA has additionally replicated many of the analyses discussed in this chapter using the MY 2010 based fleet projection (EPA RIA chapter 10). As noted, the differences in costs, benefits, and technology penetrations between results of the two fleet projections are relatively minor, and do not alter EPA's judgment of the appropriateness of the final standards.

Overall projected per vehicle cost increases relative to the reference fleet (i.e. the MY 2008 based fleet complying with the MY 2016 standard) are $766 in MY 2021 and $1836 in MY 2025. Captured in these costs, 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, 31 percent of the MY 2025 fleet is projected to have strong P2 hybrid or mild hybrid technology (5% P2, 26% MHEV) as compared to 5% in the 2016 reference case (5% P2, 0% MHEV). Similarly, 2% 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 for the industry as a whole—this does not mean that other potential technology penetrations and pathways are not possible. In fact, it is likely that each firm will plot their own future course to compliance. For example, while we show relatively low levels of EV and PHEV technologies, several firms have announced plans to aggressively pursue EV and PHEV technologies and thus the actual

[606] Of the many off-cycle credits on the menu, only stop start and active aerodynamics are included in this analysis. As we explained at proposal, EPA has sufficient information on these technologies' effectiveness, cost, and availability to reliably model them, and also has adjusted the stringency of the standard based on their 2-cycle effectiveness to reflect their use. See 76 FR 75022. This is not the case for the remaining ''menu'' off-cycle technologies where EPA has virtually no information on costs. *Id.* at 75022–023. At proposal, we used only the 2-cycle benefits associated with use of the stop-start and active aero, but in the modeling for the final rule, we now include their off-cycle credit value in the analysis of the costs and benefits of the program and, as at proposal, use these technologies' 2-cycle benefits in setting the standard.

penetration of those technologies may turn out to be much higher than the compliance pathway we present here.

TABLE III–25—TOTAL COSTS PER VEHICLE BY COMPANY, INCREMENTAL TO THE MY 2016 STANDARDS

[2010$]

Company	2021			2025		
	Cars	Trucks	Fleet	Cars	Trucks	Fleet
BMW	$967	$529	$852	$2,147	$1,250	$1,910
Chrysler/Fiat	681	796	733	1,617	2,388	1,950
Daimler	1,985	659	1,655	3,011	1,284	2,616
Ferrari [607]	6,712	0	6,712	7,864	0	7,864
Ford	680	875	746	1,811	2,505	2,025
Geely-Volvo	2,132	734	1,698	3,177	1,504	2,681
GM	519	720	619	1,518	2,237	1,861
Honda	532	829	624	1,525	1,923	1,642
Hyundai	773	875	794	1,673	2,268	1,792
Kia	625	908	689	1,572	1,977	1,658
Mazda	959	1,246	1,010	1,979	2,449	2,057
Mitsubishi	611	1,127	791	1,939	2,169	2,015
Nissan	644	904	725	1,618	2,391	1,847
Porsche [608]	4,878	604	3,871	4,807	1,274	4,044
Spyker-Saab	3,019	607	2,674	3,580	964	3,238
Subaru	982	1,594	1,128	1,926	2,495	2,054
Suzuki	1,032	1,210	1,064	2,112	1,848	2,066
Tata-JLR	3,916	1,061	2,495	5,077	1,447	3,390
Toyota	488	600	532	1,239	1,700	1,407
VW	1,492	508	1,293	2,412	1,237	2,181
Fleet	767	763	766	1,726	2,059	1,836

Costs for Aston Martin, Lotus and Tesla are not included here but can be found in EPA's RIA.

Costs include stranded capital and A/C-related costs.

[607] 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, as discussed in Section III.B., companies with U.S. sales below 5,000 vehicles that are able to demonstrate ''operational independence'' from their parent company will be eligible to petition EPA for SVM alternative standards. However, since these determinations have not yet been made, the costs shown above are based on Ferrari meeting the primary program standards.

[608] EPA analyzed Porsche and VW as separate fleets for the final rule. However, on August 1, 2012, VW completed its acquisition of Porsche and thus EPA expects that the Porsche fleet will be combined with the VW fleet for purposes of compliance with the MY 2017–2025 standards.

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Table III-26 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	MHEV
BMW	-6%	51%	15%	0%	27%	8%	35%	19%	9%	0%	15%	15%	0%	0%	57%	0%	30%	0%	77%	12%	0%
Chrysler/ Fiat	-6%	41%	15%	0%	32%	13%	29%	16%	3%	0%	8%	0%	0%	0%	0%	0%	30%	0%	55%	0%	0%
Daimler	-7%	44%	14%	0%	0%	54%	21%	22%	0%	0%	14%	15%	0%	0%	57%	0%	30%	0%	69%	17%	0%
Ferrari	-3%	40%	15%	0%	14%	0%	52%	28%	5%	0%	15%	15%	0%	0%	55%	0%	30%	0%	70%	15%	0%
Ford	-6%	65%	15%	0%	35%	15%	25%	13%	6%	0%	11%	2%	0%	0%	1%	0%	29%	0%	79%	0%	0%
Geely-Volvo	-6%	57%	15%	0%	31%	12%	32%	17%	2%	0%	15%	15%	0%	0%	61%	0%	30%	0%	76%	9%	0%
GM	-6%	40%	13%	0%	36%	16%	27%	14%	3%	0%	8%	0%	0%	0%	0%	0%	30%	0%	53%	0%	0%
Honda	-2%	19%	0%	0%	12%	7%	39%	18%	8%	0%	0%	2%	0%	0%	0%	0%	5%	0%	19%	0%	0%
Hyundai	-2%	40%	0%	0%	23%	12%	30%	16%	6%	0%	0%	0%	0%	0%	0%	0%	9%	0%	40%	0%	0%
Kia	-2%	24%	0%	0%	16%	9%	35%	19%	7%	0%	0%	0%	0%	0%	0%	0%	5%	0%	24%	0%	0%
Mazda	0%	52%	15%	0%	0%	0%	15%	0%	85%	0%	15%	15%	0%	0%	55%	0%	30%	0%	70%	15%	0%
Mitsubishi	-4%	50%	13%	0%	19%	7%	33%	18%	14%	0%	4%	0%	0%	0%	0%	0%	30%	0%	62%	0%	0%
Nissan	-6%	70%	15%	0%	27%	12%	30%	16%	5%	0%	15%	0%	0%	0%	29%	0%	30%	0%	85%	0%	12%
Porsche	-3%	35%	9%	0%	15%	8%	37%	20%	4%	0%	4%	1%	0%	0%	0%	0%	30%	0%	45%	0%	0%
Spyker-Saab	-3%	48%	15%	0%	16%	7%	22%	8%	43%	0%	15%	15%	0%	0%	57%	0%	30%	0%	77%	13%	0%

Subaru	-5%	72%	15%	0%	6%	2%	40%	21%	21%	0%	15%	0%	0%	0%	5%	0%	30%	0%	85%	0%	3%
Suzuki	-1%	70%	15%	0%	13%	7%	37%	20%	10%	0%	15%	0%	0%	0%	15%	0%	30%	0%	85%	0%	0%
Tata-JLR	-6%	51%	15%	0%	42%	15%	28%	15%	0%	0%	15%	15%	0%	0%	58%	0%	30%	0%	73%	12%	0%
Toyota	-2%	20%	0%	0%	21%	12%	32%	8%	5%	0%	0%	12%	0%	0%	0%	0%	5%	0%	24%	0%	0%
VW	-4%	50%	15%	0%	22%	6%	40%	20%	11%	0%	15%	15%	0%	0%	57%	0%	30%	0%	86%	13%	0%
Fleet	-4%	39%	8%	0%	24%	12%	32%	15%	6%	0%	6%	5%	0%	0%	7%	0%	21%	0%	49%	2%	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; MHEV=mild hybrid

Note that technology penetrations for Aston Martin, Lotus and Tesla are not included here but can be found in EPA's RIA.

Negative values for Mass Reduction represent percentage of mass removed.

Table III-27 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	MHEV
BMW	-6%	51%	15%	0%	28%	8%	35%	19%	9%	0%	15%	15%	0%	0%	57%	0%	30%	0%	77%	13%	0%
Chrysler/ Fiat	-5%	39%	14%	0%	31%	13%	30%	16%	3%	0%	7%	0%	0%	0%	0%	0%	30%	0%	53%	0%	0%
Daimler	-7%	43%	14%	0%	0%	53%	22%	23%	0%	0%	14%	15%	0%	0%	57%	0%	30%	0%	69%	17%	0%
Ferrari	-3%	40%	15%	0%	14%	0%	52%	28%	5%	0%	15%	15%	0%	0%	55%	0%	30%	0%	70%	15%	0%
Ford	-6%	65%	15%	0%	34%	14%	26%	13%	6%	0%	12%	2%	0%	0%	1%	0%	29%	0%	80%	0%	1%
Geely- Volvo	-6%	56%	15%	0%	30%	12%	33%	18%	2%	0%	15%	15%	0%	0%	60%	0%	30%	0%	75%	10%	0%
GM	-6%	42%	13%	0%	34%	15%	28%	14%	3%	0%	8%	0%	0%	0%	0%	0%	30%	0%	55%	0%	0%
Honda	-2%	18%	0%	0%	12%	6%	40%	18%	8%	0%	0%	2%	0%	0%	0%	0%	5%	0%	18%	0%	0%
Hyundai	-2%	39%	0%	0%	22%	12%	30%	16%	6%	0%	0%	0%	0%	0%	0%	0%	8%	0%	39%	0%	0%
Kia	-2%	23%	0%	0%	15%	8%	41%	15%	7%	0%	0%	0%	0%	0%	0%	0%	5%	0%	23%	0%	0%
Mazda	0%	52%	15%	0%	0%	0%	15%	0%	85%	0%	15%	15%	0%	0%	55%	0%	30%	0%	70%	15%	0%
Mitsubishi	-4%	49%	13%	0%	19%	7%	34%	18%	15%	0%	4%	0%	0%	0%	0%	0%	30%	0%	62%	0%	0%
Nissan	-5%	70%	15%	0%	25%	12%	31%	16%	5%	0%	15%	0%	0%	0%	28%	0%	30%	0%	85%	0%	12%

Porsche	-3%	35%	9%	0%	15%	8%	38%	21%	4%	0%	4%	1%	0%	0%	0%	0%	30%	0%	44%	0%	0%
Spyker-Saab	-3%	47%	15%	0%	15%	6%	22%	8%	44%	0%	15%	15%	0%	0%	56%	0%	30%	0%	77%	14%	0%
Subaru	-5%	72%	15%	0%	5%	2%	40%	21%	21%	0%	15%	0%	0%	0%	5%	0%	30%	0%	85%	0%	5%
Suzuki	-1%	70%	15%	0%	12%	7%	37%	20%	10%	0%	15%	0%	0%	0%	14%	0%	30%	0%	85%	0%	0%
Tata-JLR	-7%	50%	15%	0%	40%	14%	29%	16%	0%	0%	15%	15%	0%	0%	57%	0%	30%	0%	72%	13%	0%
Toyota	-2%	15%	0%	0%	20%	11%	34%	8%	5%	0%	0%	12%	0%	0%	0%	0%	5%	0%	20%	0%	0%
VW	-4%	50%	15%	0%	21%	6%	41%	20%	11%	0%	15%	15%	0%	0%	57%	0%	30%	0%	86%	13%	0%
Fleet	-4%	38%	8%	0%	23%	12%	33%	15%	6%	0%	6%	5%	0%	0%	8%	0%	20%	0%	49%	2%	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; MHEV=mild hybrid

Note that technology penetrations for Aston Martin, Lotus and Tesla are not included here but can be found in EPA's RIA.

Negative values for Mass Reduction represent percentage of mass removed.

Table III-28 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	MHEV
BMW	- 10%	55%	29%	6%	5%	21%	10%	53%	7%	60%	30%	7%	3%	0%	43%	75%	57%	60%	97%	0%	23%
Chrysler/ Fiat	-6%	48%	20%	2%	9%	36%	12%	41%	3%	57%	15%	0%	0%	0%	2%	75%	76%	46%	69%	0%	5%
Daimler	- 12%	44%	29%	11%	3%	27%	4%	58%	0%	58%	29%	5%	7%	0%	47%	75%	55%	60%	89%	3%	24%
Ferrari	-3%	6%	22%	15%	0%	0%	4%	78%	2%	59%	30%	26%	16%	15%	35%	75%	24%	60%	84%	0%	4%
Ford	-7%	67%	19%	3%	10%	39%	10%	34%	5%	50%	19%	2%	0%	0%	5%	74%	67%	46%	89%	0%	11%
Geely- Volvo	- 11%	45%	30%	11%	8%	32%	6%	46%	1%	59%	30%	9%	6%	0%	52%	75%	50%	60%	94%	0%	21%
GM	-7%	41%	15%	3%	10%	41%	11%	34%	3%	53%	14%	0%	0%	0%	4%	75%	72%	27%	59%	0%	5%
Honda	-4%	29%	9%	0%	4%	18%	17%	51%	8%	25%	1%	2%	0%	0%	0%	73%	74%	12%	38%	0%	1%
Hyundai	-4%	48%	17%	0%	8%	32%	13%	41%	6%	48%	2%	0%	0%	0%	0%	75%	72%	21%	65%	0%	2%
Kia	-4%	30%	10%	0%	6%	23%	16%	48%	7%	26%	1%	0%	0%	0%	0%	75%	74%	11%	40%	0%	1%

Mazda	0%	15%	29%	13%	0%	0%	0%	39%	49%	58%	30%	22%	12%	9%	38%	75%	45%	57%	88%	0%	8%
Mitsubishi	-5%	72%	28%	0%	5%	20%	13%	49%	13%	56%	28%	0%	0%	0%	7%	75%	74%	55%	100%	0%	6%
Nissan	-9%	70%	29%	0%	8%	33%	11%	42%	5%	59%	29%	1%	0%	0%	24%	75%	68%	59%	100%	0%	13%
Porsche	-3%	54%	18%	1%	6%	22%	16%	52%	4%	52%	11%	1%	0%	0%	2%	75%	75%	31%	73%	0%	5%
Spyker-Saab	-5%	17%	29%	14%	5%	19%	2%	43%	22%	59%	30%	20%	9%	11%	42%	75%	42%	59%	91%	0%	10%
Subaru	-7%	66%	30%	0%	2%	6%	14%	61%	17%	60%	30%	5%	0%	0%	10%	75%	71%	59%	100%	0%	17%
Suzuki	-2%	70%	30%	0%	5%	18%	13%	56%	7%	60%	30%	0%	0%	0%	19%	75%	69%	60%	100%	0%	26%
Tata-JLR	-11%	36%	30%	13%	10%	40%	5%	39%	0%	58%	30%	23%	7%	2%	50%	75%	52%	58%	93%	0%	7%
Toyota	-3%	38%	1%	1%	7%	28%	12%	36%	5%	22%	1%	12%	0%	0%	0%	66%	63%	1%	41%	0%	0%
VW	-7%	52%	30%	11%	4%	16%	8%	57%	8%	59%	30%	1%	6%	0%	52%	75%	56%	60%	94%	0%	29%
Fleet	-5%	46%	15%	3%	7%	30%	12%	42%	5%	44%	12%	4%	1%	0%	8%	73%	68%	29%	65%	0%	7%

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; MHEV=mild hybrid

Note that technology penetrations for Aston Martin, Lotus and Tesla are not included here but can be found in EPA's RIA.

Negative values for Mass Reduction represent percentage of mass removed.

Table III-29 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	MHEV
BMW	- 11%	8%	62%	20%	0%	26%	0%	60%	4%	91%	75%	1%	9%	0%	37%	100%	41%	91%	91%	0%	49%
Chrysler/ Fiat	-8%	22%	71%	5%	0%	43%	0%	55%	1%	100%	75%	1%	0%	0%	22%	100%	63%	100%	98%	0%	36%
Daimler	- 14%	7%	60%	14%	0%	23%	0%	64%	0%	87%	71%	3%	13%	0%	37%	100%	37%	87%	85%	2%	47%
Ferrari	-3%	0%	0%	5%	0%	0%	0%	77%	0%	77%	5%	50%	23%	22%	5%	100%	5%	77%	77%	0%	0%
Ford	-9%	19%	68%	9%	0%	48%	0%	46%	4%	97%	73%	10%	1%	0%	24%	99%	57%	97%	96%	0%	32%
Geely- Volvo	- 13%	10%	54%	20%	0%	39%	0%	50%	1%	90%	73%	3%	10%	3%	37%	100%	37%	90%	90%	0%	47%
GM	-8%	20%	66%	9%	0%	50%	0%	47%	3%	100%	74%	0%	0%	0%	23%	100%	65%	100%	95%	0%	35%
Honda	-5%	24%	73%	0%	0%	21%	0%	68%	8%	98%	73%	2%	0%	0%	1%	98%	87%	98%	98%	0%	11%
Hyundai	-6%	25%	75%	0%	0%	39%	0%	55%	6%	100%	75%	0%	0%	0%	10%	100%	82%	100%	100%	0%	18%
Kia	-5%	39%	61%	0%	0%	27%	0%	66%	7%	100%	61%	0%	0%	0%	0%	100%	88%	100%	100%	0%	12%
Mazda	0%	7%	56%	0%	0%	0%	0%	55%	25%	80%	56%	11%	20%	5%	25%	100%	25%	80%	80%	0%	39%
Mitsubishi	-7%	20%	75%	0%	0%	24%	0%	66%	8%	98%	75%	3%	2%	0%	12%	100%	56%	98%	98%	0%	39%

Nissan	-11%	20%	73%	0%	0%	39%	0%	55%	3%	97%	73%	4%	3%	0%	22%	100%	47%	97%	97%	0%	46%
Porsche	-5%	22%	73%	3%	0%	27%	0%	69%	3%	99%	75%	4%	0%	0%	14%	100%	69%	99%	99%	0%	27%
Spyker-Saab	-6%	4%	57%	13%	0%	21%	0%	51%	9%	82%	67%	1%	18%	7%	25%	100%	25%	82%	82%	0%	49%
Subaru	-10%	9%	75%	0%	0%	7%	0%	74%	13%	95%	75%	10%	5%	0%	4%	100%	63%	95%	95%	0%	22%
Suzuki	-2%	6%	75%	0%	0%	22%	0%	66%	6%	94%	75%	13%	6%	0%	11%	100%	60%	94%	94%	0%	21%
Tata-JLR	-13%	4%	38%	35%	0%	46%	0%	41%	0%	88%	66%	15%	12%	3%	34%	100%	34%	88%	88%	0%	35%
Toyota	-5%	38%	46%	4%	0%	34%	0%	51%	5%	89%	46%	11%	0%	0%	0%	89%	78%	89%	88%	0%	11%
VW	-8%	11%	72%	4%	0%	20%	0%	63%	5%	88%	75%	0%	12%	0%	38%	100%	38%	88%	88%	0%	49%
Fleet	-7%	23%	64%	6%	0%	35%	0%	56%	4%	95%	68%	5%	2%	0%	15%	97%	67%	95%	94%	0%	26%

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; MHEV=mild hybrid

Note that technology penetrations for Aston Martin, Lotus and Tesla are not included here but can be found in EPA's RIA.

Negative values for Mass Reduction represent percentage of mass removed.

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6. How does the technical assessment support the final CO_2 standards as compared to the alternatives EPA has considered?

a. What are the targets and achieved levels for the fleet in this final rule?

In this section EPA analyzes the final standards alongside several potential alternative GHG standards. These alternatives (car and truck standards which are 20 g/mile more and less stringent than those adopted) reasonably bound the range of alternatives. All analyses shown in this section are conducted using the MY 2008 based fleet projection. The analysis using the MY 2010 based fleet projection is shown in EPA RIA chapter 10 and leads to the same conclusions.

Table III–30 includes a summary of the final standards and the four alternatives considered by EPA. In this table and for the majority of the data presented in this section, EPA focuses on two specific model years in the MYs 2017–2025 time frame addressed by this final rule. 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. Table III–30 presents the projected reference case targets for the fleet in MYs 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.[609] The alternatives, like the final standards, account for projected use of A/C related credits. They represent the average targets for cars and trucks projected for the final standards and the 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, and in tables shown in Section III.A.

TABLE III–30—MYS 2021 AND 2025 FLEET TARGETS FOR THE FINAL RULE AND ALTERNATIVE STANDARDS

[g/mile CO_2] [610]

	Car target	Truck target	Fleet target
2021 Final Rule	172	249	199
Alternative 1: 2021 Trucks + 20	172	229	206
Alternative 2: 2021 Trucks − 20	172	269	192
Alternative 3: 2021 Cars + 20	192	249	212
Alternative 4: 2021 Cars − 20	152	249	186
2021 Reference Case	*224*	*296*	*250*
2025 Final Rule	143	203	163
Alternative 1: 2025 Trucks + 20	143	223	170
Alternative 2: 2025 Trucks − 20	143	183	156
Alternative 3: 2025 Cars + 20	163	203	176
Alternative 4: 2025 Cars − 20	123	203	150
2025 Reference Case	*224*	*295*	*248*

Alternatives 1 and 2 are focused on changes in the level of stringency for light-duty trucks only. Alternative 1 is 20 g/mile less stringent (higher) in 2021 and 2025, and Alternative 2 is 20 g/mile more stringent (lower) in 2021 and 2025. Alternatives 3 and 4 are focused on changes in the level of stringency for just passenger cars: Alternative 3 is 20 g/mile less stringent (higher) in MYs 2021 and 2025, and Alternative 4 is 20 g/mile more stringent (lower) in 2021 and 2025. When combined with the sales projections for MYs 2021 and 2025, these alternatives span fleet wide targets with a range of 186–212 g/mile in MY 2021 (equivalent to a range of 42–48 mpge if all improvements were made with fuel economy technologies) and a range of 150–176 g/mile in MY 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 final standards and each of the alternatives in MY 2021 and in MY 2025. It is worth noting that although Alternatives 1 and 2 consider different truck footprint curves compared to the final rule and Alternatives 3 and 4 evaluate different car footprint curves compared to the final rule, 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–30) as this is how manufacturers would view the future standards given the opportunity to transfer credits between their car and truck fleets under the GHG rule.[611] 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 projected in MYs 2021 and 2025 to be 20 g/mile less stringent than the final truck standards and the same car standards as the final 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 manufacturer fleets appropriately reflects this flexibility, since as just noted, it reflects manufacturers' expected response.

Table III–31 shows the projected target and projected achieved levels in MY 2025 for the final 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 and consequent standard.

[609] The reference case targets for MYS 2021 and 2025 may be different even though the footprint based standards are identical (the MY 2016 curves). This is because the fleet distribution of cars and trucks may change in the intervening years thus changing the targets in MYs 2021 and 2025.

[610] These targets are slightly different than those shown in the proposal due to minor updates to footprint values in the fleet projection. On average, many vehicles become slightly smaller, but this change is not significant at a fleet level. (See TSD 1.3.2). The target curves are unchanged from proposal.

[611] The curves for the alternatives were developed using the same methods as the final curves, however with different targets. Thus, just as in the final curves, the car and truck curves described in TSD 2 were ''fanned'' up or down to determine the curves of the alternatives.

TABLE III–31—MY2025 PROJECTED TARGET AND ACHIEVED LEVELS FOR THE FINAL RULE FOR INDIVIDUAL FIRMS
[g/mile CO_2]

Company	Target			Achieved			Car target-achieved	Truck target-achieved
	Cars	Trucks	Fleet	Cars	Trucks	Fleet		
BMW	146	194	159	144	199	158	2	−5
Chrysler/Fiat	146	201	170	154	191	170	−8	10
Daimler	150	208	163	140	233	161	10	−25
Ferrari	150	0	150	168	0	168	−17	n/a
Ford	147	212	167	157	192	168	−10	20
Geely-Volvo	148	189	160	138	207	159	10	−18
GM	144	213	177	156	202	178	−12	11
Honda	142	191	156	145	183	156	−3	8
Hyundai	142	188	151	146	172	152	−4	16
Kia	139	199	152	145	177	152	−6	22
Mazda	140	186	148	145	163	148	−5	22
Mitsubishi	139	180	153	146	166	153	−7	14
Nissan	145	202	162	149	191	162	−5	10
Porsche	131	195	144	118	231	143	12	−37
Spyker-Saab	139	188	146	132	231	145	7	−43
Subaru	134	169	142	145	138	143	−11	31
Suzuki	132	181	140	133	174	140	−2	8
Tata-JLR	161	182	171	114	228	167	47	−46
Toyota	141	201	163	146	193	163	−5	8
VW	138	203	151	131	228	150	7	−25
Fleet	143	203	163	147	194	163	−4	9

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 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 MY 2025 and for the alternatives and the final rule for MY 2021 are contained in Chapter 3 of EPA's RIA. With the final standards and for Alternatives 1 and 2, all companies are projected to be able to comply both in MYs2021 and 2025, with the exception of Ferrari, which in each case falls 17 g/mile short of its projected fleet wide obligation in MY 2025.[612] In Alternatives 3 and 4, where the car stringency varies, all companies are again projected to comply with the exception of Ferrari, which has a 38 gram shortfall under Alternative 4.

b. Why is the relative rate of car truck stringency appropriate?

Table III–31 illustrates the importance of car-truck credit transfer for individual firms. For example, the OMEGA model projects for the final standards that in MY 2025, Daimler would under comply for trucks by 25 g/mile but over comply in their car fleet by 10 g/mile in order to meet their overall compliance obligation. By contrast, the OMEGA model projects that under the final standards Kia's truck fleet would over comply by 22 g/mile and under comply in their car fleet by 6 g/mile in order to meet their compliance obligations. The choice of transferring credits from cars to trucks, or trucks to cars, is dependent on the fleet configuration of the individual manufacturers. Individual manufacturers will be influenced by their relative number of cars and trucks, as well as by the starting technology and emissions performance of those vehicles.

Under the FRM analysis, we project a slightly larger quantity of credit transfer than that which was projected in the proposal. The increase in credit transfer is largely attributable to the FRM modeling of stop start and active aerodynamics off-cycle credits and full-size pick-up truck HEV flexibilities, which were not included in the cost modeling used for the proposal. These credits either offer larger benefits to trucks than to cars (in the case of off-cycle credits), or are not available to cars (the full size pickup HEV flexibilities). However, while the total credit transfer value has increased relative to the proposal analysis, 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. From the reference case emission level (sales weighted average of approximately 250) to the control case (sales weighted average of approximately 163) is a drop of approximately 90 grams. Four grams of credit transfer (Table III–31) to the car fleet is relatively small in this context, and demonstrates the appropriate balance between car and truck stringencies. Table III–25 shows that the average costs for cars and trucks are also similar for MY 2021 and MY 2025. For MY 2021, the average cost to comply with the car standards is $767, while it is $763 for trucks. For MY 2025, the average cost to comply with the car standards is $1,726, while it is $2,059 for trucks. These results are consistent with the small degree of net projected credit transfer between cars and trucks. While costs are generally higher for trucks in MY 2025, these higher estimates reflect the degree of credit transfer expected in the fleet, and are not necessarily indicative of a relatively more or less stringent truck standard. One factor in this cost delta is the relatively larger degree of mass reduction modeled for trucks under our analysis of safety impacts (see section II.G.5 above).

[612] 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, as discussed above in this section and in Section III.B.5, companies with U.S. sales below 5,000 vehicles that are able to demonstrate ''operational independence'' from their parent company will be eligible to petition EPA for SVM alternative standards. However, since these determinations have not yet been made, the costs shown above are based on Ferrari meeting the primary program standards. As a result of these provisions, Ferrari is not discussed in the remainder of this section as we discuss the appropriateness and feasibility of the standards.

After including these factors, the average cost for complying with the truck and car standards are largely similar, even though the level of stringency for trucks is increasing at a slower rate than for cars in the program's initial model years. As described in Section I.B.2 of the preamble, the final car standards are decreasing (in CO_2 space, and therefore increasing in stringency) at a rate of 5% per year from MYs 2017–2025, while the final truck standards are decreasing at a rate of 3.5% per year on average from MYs 2017–2021, and 5% per year thereafter through MY2025. Given this difference in percentage rates of increase in stringency, the 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 EPA RIA. Moreover, some technologies are not made available for towing trucks. These include EVs, PHEVs, Atkinson Cycle engines (matched with HEVs), and DCTs—the prior two provide significant effectiveness, and the latter two are relatively cost effective. Together these differences result in a decrease in effectiveness potential for the heavier towing trucks compared to non-towing trucks and cars. In addition, while there is more mass reduction projected for these vehicles, 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 are among the reasons the truck curve is steeper relative to the MY 2016 truck curve, resulting in a truck curve that is ''more parallel'' to cars than was the MY 2016 truck curve.

Taken together, EPA's analysis shows that under the final standards, there is relatively little net trading between cars and trucks as a fraction of the overall improvement; average costs for compliance with cars is generally 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 relative to MY 2016. 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 MYs 2022–2025 results in car and truck standards that reflect increases in stringency over time that are comparable from the perspective of the costs born by cars versus trucks.

Many commenters questioned the relative stringency of the car and truck curves, manufacturers whose fleets are dominated by passenger cars generally indicating that the curves favored trucks at the expense of cars, and several groups going so far as maintaining that the difference in stringency and slope created an inherent incentive to upsize the fleet. These comments are not supported by the analysis conducted here. There are no indications that either the truck or car standards will encourage manufacturers to choose technology paths that lead to significant over or under compliance for cars or trucks, on an industry wide level. That is, there is no indication that on average, in light of the truck standard, manufacturers would consistently under or over comply with the car standard, or vice versa. As seen in our final rule modeling, seven manufacturers over-complied on cars, while twelve over-complied on trucks. 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 the relative stringency is appropriate in light of the technology choices available to manufacturers, and the costs of those technology choices. As just shown, that is not the case for the final car and truck standards. Moreover, as noted above, we project only a relatively small overall degree of net credit transfers from the truck fleet to the car fleet. In addition, as discussed further below, EPA did evaluate the effect of the relative stringency of the car and truck standards using alternative standards and this analysis leads to the same conclusions. EPA thus continues to believe that the relative stringency of the car and truck curves is reasonable and appropriate.

c. What are the costs and advanced technology penetration rates for the alternative standards in relation to the final standards?

Below we discuss results for the final car and truck standards compared first to the truck alternatives (Alternatives 1 and 2), followed by a comparison to the car alternatives (Alternatives 3 and 4).

Table III–32 presents our projected per-vehicle cost for the average car, truck and for the fleet in model years 2021 and 2025 for the final rule 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–32—2021 AND 2025 FLEET AVERAGE PROJECTED PER-VEHICLE COSTS FOR FINAL RULE AND ALTERNATIVES 1 AND 2

[2010$/vehicle]

	Cars	Trucks	Fleet
2021 Final Rule	$767	$763	$766
Alternative 1: 2021 Trucks + 20	497	492	496
Alternative 2: 2021 Trucks − 20	1,062	1,159	1,096
2025 Final Rule	1,726	2,059	1,836
Alternative 1: 2025 Trucks + 20	1,460	1,582	1,500
Alternative 2: 2025 Trucks − 20	2,146	2,434	2,241

Table III–33 presents the per-vehicle cost estimates in MY 2021 by company for the final rule, Alternative 1, and Alternative 2.

TABLE III–33—2021 PROJECTED PER-VEHICLE COSTS FOR THE FINAL RULE AND ALTERNATIVES 1 AND 2 BY COMPANY

[cars & trucks, 2010$/vehicle]

	Final rule	Alternative 1 (trucks + 20)	Alternative 2 (trucks − 20)
BMW	$852	$467	$1,307
Chrysler/Fiat	733	377	1,156
Daimler	1,655	1,226	2,196
Ferrari	6,712	6,712	6,712
Ford	746	438	1,116
Geely-Volvo	1,698	1,171	2,376
GM	619	271	1,087
Honda	624	450	841
Hyundai	794	620	963
Kia	689	550	872
Mazda	1,010	858	1,198
Mitsubishi	791	468	1,192
Nissan	725	495	990
Porsche	3,871	3,397	4,468
Spyker-Saab	2,674	2,375	3,009
Subaru	1,128	865	1,379
Suzuki	1,064	840	1,265
Tata-JLR	2,495	1,365	3,652
Toyota	532	359	746
VW	1,293	945	1,678
Fleet	766	496	1,096

Table III–34 presents the per-vehicle cost estimates in MY 2025 by company for the final rule, 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 generally less costly than the final rule, and Alternative 2 generally more costly. Notably, 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 more stringent standards, and these technologies increase in cost in a non-linear fashion.

TABLE III–34—MY 2025 PROJECTED PER-VEHICLE COSTS FOR FINAL RULE AND ALTERNATIVES 1 AND 2 BY COMPANY

[cars & trucks, 2010$/vehicle]

	Final rule	Alternative 1 (trucks + 20)	Alternative 2 (trucks − 20)
BMW	$1,910	$1,566	$2,300
Chrysler/Fiat	1,950	1,494	2,474
Daimler	2,616	2,176	2,995
Ferrari	7,864	7,864	7,864
Ford	2,025	1,650	2,390
Geely-Volvo	2,681	2,141	3,250
GM	1,861	1,347	2,517
Honda	1,642	1,376	1,907
Hyundai	1,792	1,617	2,025
Kia	1,658	1,449	1,868
Mazda	2,057	1,911	2,233
Mitsubishi	2,015	1,609	2,369
Nissan	1,847	1,530	2,168
Porsche	4,044	3,678	4,434
Spyker-Saab	3,238	2,971	3,360
Subaru	2,054	1,842	2,314
Suzuki	2,066	1,946	2,381
Tata-JLR	3,390	2,534	4,627
Toyota	1,407	1,163	1,788
VW	2,181	1,953	2,538
Fleet	1,836	1,500	2,241

The previous tables present the costs for the final rule and alternatives 1 and 2 at both the industry and company level. In addition to costs, another key is the technology expected to be needed to meet future standards. The EPA assessment of the final rule, as well as Alternatives 1 and 2, predict the penetration into the fleet of a large number of technologies at various rates. A subset of these technologies are discussed below, while EPA's RIA Chapter 3 includes the details on this much longer list for the passenger car, light-duty truck, and the overall fleet at both the industry and individual company level. Table III–35 and Table III–36 present only a sub-set of the technologies EPA estimates could be used to meet the final standards as well as alternatives 1 and 2 in MY 2021.

Table III–37 and Table III–38 show the same for MY 2025. The technologies listed in these tables are those for which there is a large difference in penetration rates between the final rule and the alternatives. We have not included here, for example, the penetration rates for improved high efficiency gear boxes or eight speed transmissions because for MY 2021, our modeling estimates similar total fleet penetrations of these technologies for the final rule and alternatives 1 and 2.

Table III–35 shows that in MY 2021, the final rule requires higher levels of penetration for several technologies for trucks than alternative 1. For example for trucks, compared to the final rule, alternative 1 leads to a decrease in the penetration of 24 bar turbo-charged/downsized engines, a decrease in the penetration of cooled EGR, and a 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 decrease in penetration of 18 bar turbo-downsized engines, a decrease in penetration of 24 bar turbo-downsize engines, a decrease in penetration of 8 speed dual clutch transmissions, and a 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 MY 2021, and we see this for the truck fleet as well as for the car fleet. Table III–36 shows these same overall trends but at the sales weighted fleet level in MY 2021.

Although EPA does not project dramatic differences in technology penetration between the final MY 2021 standards and those modeled in Alternative 2 during these earlier years of the program, EPA remains concerned about lead time relative to rapid increases in truck standard stringency between MYs 2016 and 2021. Several vehicle manufacturers, particularly those who manufacture large trucks, voiced concerns about the increase in stringency during MYs 2012–2016 as described in the NPRM (76 FR 74862–865). In comments on the NPRM, Ford noted that it viewed the MYs 2012–2016 standards as ''overly stringent standards imposed on light duty trucks in the 2012–2016 model year regulation.'' As discussed in TSD 2.4, EPA does not agree that the MYs 2012–2016 program is overly stringent, however we do acknowledge that it will be challenging for some manufacturers and furthermore, we acknowledge the possibility that it may be more challenging for the larger truck market than the smaller truck or car market. Several issues are unique to the trucks with the largest footprints (pickup trucks in particular). Although no individual vehicle need comply with its target, the large truck segment is dominated by relatively few vehicle platforms with relatively large sales, and this limited number of vehicle platforms makes rapid technology changes a greater challenge than in other market segments. See TSD p. 2–23. The pick-up trucks tend to have longer redesign cycles. Though there may be evidence to show that redesign periods are getting shorter for both cars and pickup trucks, the utility requirements of pick-up trucks relative to smaller vehicles results in longer development times for validation of a new platform. Pick-up truck product validation occurs across a broader range of gross vehicle weights for each platform due to a relatively large payload capacity and can include validation of trailer towing capability for multiple trailer configurations. Consequently, EPA is choosing to provide appropriate lead time in the MY 2017–2021 truck standards.

Further, EPA has carefully weighed the issue of consumer acceptance. As many commenters stressed, without consumer acceptance of these vehicles, the rule's benefits will not accrue. As noted by the U.S. Coalition for Advanced Diesels, battery electric technologies have had limited commercial success in larger trucks.[613] Although EPA has maintained utility in its analysis of compliance costs and while we do not expect that future hybrid applications will have the same degree of consumer resistance, nonetheless EPA regards the issue of consumer acceptance as legitimate and we therefore are being appropriately cautious in crafting the standards. We are thus structuring the MY 2021 truck standard to provide appropriate lead time rather than significantly depending on electrified technologies in the earlier years of the program.[614] The MY 2021 truck standard, as shown in Table III–35, is also projected to require a significant amount of turbo-charged and downsized engines, in addition to other advanced technologies. At the same time, we are providing regulatory incentives and flexibilities to promote further acceptance of electrified technologies into the pickup truck market sector.

These issues of consumer acceptance are not as pronounced for smaller light trucks and cars. On an industry basis, single vehicle models do not similarly dominate these segments. Further, hybrid electric technology is more common in both passenger cars and the smaller light truck fleet. Consumer perception of vehicle utility is also significant for the largest trucks, and greater challenges exist in convincing truck buyers that hybrid and even other advanced powertrains can provide equivalent utility, despite these technologies existing in other market segments.[615] Finally, as is shown in section III.D.7, the rate of increase in stringency for smaller trucks and cars are similar under the final standards, so that the challenges to the stringency of the truck standards are essentially addressed only to the larger footprint trucks. As to these vehicles, EPA is being properly cautious with respect to issues of lead time and consumer acceptances, as just explained.

[613] The U.S. Coalition for Advanced Diesel Cars commented: ''Hybrid powertrains have been available on pickup trucks in the U.S. market since MY 2005. Since that time, some hybrid variants have been dropped by manufacturers due to the lack of customer demand. By 2011, in fact, less than one-quarter of a percent (0.23%) of customers selected the hybrid pickup truck option where it was available as an option. In contrast, depending on the model, 15% to 50% of customers selected a diesel powertrain when such an option was offered.'' Docket no. NHTSA–2010–0131–0246–A1, p.4

[614] See Table III–35 below, where under alternative 2, we project that 20% of the vehicle fleet will be MHEV or HEV (the projection is 18% MHEV) in MY 2021. By comparison, the final rule is projected to be 13% MHEV & HEV (11% MHEV).

[615] When mass reduction technologies and turbo-charged and downsized engines were introduced to full size pickups, analogous consumer acceptance challenges were experienced (*http://moneyland.time.com/2012/07/31/can-an-aluminum-truck-really-be-considered-ford-tough/*), despite the eventual popularity of these technologies.

TABLE III–35—MY 2021 PROJECTED TECHNOLOGY PENETRATIONS FOR FINAL RULE AND ALTERNATIVES 1 AND 2 FOR ALL CARS AND TRUCKS

Technology	Cars			Trucks		
	Final rule (percent)	Alt. 1 (percent)	Alt. 2 (percent)	Final rule (percent)	Alt. 1 (percent)	Alt. 2 (percent)
Turbo-downsize(18 bar)	43	38	50	53	50	58
Turbo-downsize (24 bar)	14	9	19	16	12	24
8 speed DCT	61	61	62	7	6	7
Cooled EGR*	11	7	17	16	8	22
Hybrid Electric Vehicle	4	4	5	2	1	2
LRRT2	72	72	72	74	74	74
IACC2	71	56	70	64	57	61
GDI	60	49	74	73	65	86
MHEV	5	4	6	11	7	18

* 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 RIA).

TABLE III–36—MY 2021 PROJECTED TECHNOLOGY PENETRATIONS FOR FINAL RULE AND ALTERNATIVES 1 AND 2 FOR FLEET

	Final rule (percent)	Alt. 1 (percent)	Alt. 2 (percent)
Turbo-downsize (18 bar)	46	42	53
Turbo-downsize (24 bar)	15	10	21
8 speed DCT	42	42	43
Cooled EGR	12	7	18
Hybrid Electric Vehicle	4	3	4
LRRT2	73	73	73
IACC2	68	56	67
GDI	65	54	78
MHEV	7	5	10

Table III–37 shows that in MY 2025, there is only a small change in many of these technology penetration rates when comparing the final rule standards to alternative 1 for trucks, and most of the change shows up in the car fleet. One important exception is mild hybrid electric vehicles, where the less stringent alternative 1 is projected to be met with a decrease in penetration of mild HEVs compared to the final rule standards. As in MY 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 decrease in penetration of 24 bar turbo-downsized engines, a decrease in penetration of cooled EGR, a decrease in penetration of mild HEVs, and a 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 MY 2025, with a major exception being a significant increase (more than double) in the penetration of HEVs for trucks compared to the final rule standards, an increase in the penetration of HEVs and MHEVs for cars compared to the final rule standards, and a small increase in the penetration of EVs for cars compared to the final rule standards.

TABLE III–37—MY 2025 PROJECTED TECHNOLOGY PENETRATIONS FOR FINAL RULE AND ALTERNATIVES 1 AND 2 FOR ALL CARS AND TRUCKS

	Cars			Trucks		
	Final rule (percent)	Alt. 1 (percent)	Alt. 2 (percent)	Final rule (percent)	Alt. 1 (percent)	Alt. 2 (percent)
Turbo-downsize (18 bar)	25	24	18	19	17	18
Turbo-downsize (24 bar)	63	60	69	67	64	69
8 speed DCT	79	79	78	9	9	9
Cooled EGR	65	57	71	74	72	74
Hybrid Electric Vehicle	4	4	5	5	2	11
EV	3.0	2.3	4.6	0.3	0.1	0.5
LRRT2	96	96	96	99	99	99
IACC2	73	81	59	55	71	50
GDI	93	87	92	97	92	99
MHEV	20	13	31	39	27	38

TABLE III–38—2025 PROJECTED TECHNOLOGY PENETRATIONS FOR FINAL RULE AND ALTERNATIVES 1 AND 2 FOR FLEET

	Final rule (percent)	Alt. 1 (percent)	Alt. 2 (percent)
Turbo-downsize (18 bar)	23	21	18
Turbo-downsize (24 bar)	64	61	69
8 speed DCT	56	56	55
Cooled EGR	68	62	72
Hybrid Electric Vehicle	5	3	7
EV	2.1	1.6	3.3
LRRT2	97	97	97
IACC2	67	78	56
GDI	94	89	94
MHEV	26	17	33

The results are similar for Alternatives 3 and 4, where the truck standard stays at the final rule level and the car stringency varies, +20 g/mile and −20 g/mile respectively. Table III–39 presents our projected per-vehicle cost for the average car, truck and for the fleet in model years 2021 and 2025 for the final rule and for Alternatives 3 and 4. Compared to the final rule, Alternative 3 (with a MYs 2021 and 2025 car target 20 g/mile less stringent then the final rule) is considerably less costly on average than the final rule in MY 2021 and in 2025. Alternative 4 (with a MYs 2021 and 2025 car target 20 g/mile more stringent then the final rule) is considerably more costly on average than the final rule in MY 2021 and in MY 2025. The differences for these alternatives relative to the final rule are even more pronounced than the differences for Alternatives 1 and 2. As in the analysis above, the cost increases are greater for more stringent alternatives than the reduced costs from the less stringent alternatives.

TABLE III–39—MYS 2021 AND 2025 FLEET AVERAGE PROJECTED PER-VEHICLE COSTS FOR FINAL RULE AND ALTERNATIVES 3 AND 4

[2010$/vehicle]

	Cars	Trucks	Fleet
2021 Final rule	$767	$763	$766
Alternative 3: 2021 Cars + 20	298	388	330
Alternative 4: 2021 Cars − 20	1,422	1,261	1,365
2025 Final rule	1,726	2,059	1,836
Alternative 3: 2025 Cars + 20	1,151	1,448	1,249
Alternative 4: 2025 Cars − 20	2,556	2,612	2,574

Table III–40 presents the per-vehicle cost estimates in MY 2021 by company for the final rule, 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 several hundred dollars per vehicle less expensive then the final rule, and Alternative 4 being several hundred dollars per vehicle more expensive (with larger increment for the more stringent alternative than the less stringent alternative). In some cases the differences exceed $1,000 (e.g. BMW, Daimler, Geely/Volvo, Spyker/Saab, Suzuki and Tata).

TABLE III–40—MY 2021 PROJECTED PER-VEHICLE COSTS FOR FINAL RULE AND ALTERNATIVES 3 AND 4 BY COMPANY

[Cars & trucks combined, 2010$/vehicle]

	Final rule	Alt. 3 (cars + 20)	Alt. 4 (cars − 20)
BMW	$852	−$65	$2,075
Chrysler/Fiat	733	377	1,206
Daimler	1,655	673	3,181
Ferrari	6,712	6,712	6,712
Ford	746	254	1,403
Geely-Volvo	1,698	623	3,151
GM	619	313	1,015
Honda	624	327	1,083
Hyundai	794	351	1,426
Kia	689	353	1,249
Mazda	1,010	412	1,920
Mitsubishi	791	263	1,562
Nissan	725	282	1,292
Porsche	3,871	2,663	4,788
Spyker-Saab	2,674	1,308	4,324
Subaru	1,128	474	1,950
Suzuki	1,064	356	2,039
Tata-JLR	2,495	1,365	3,723

TABLE III–40—MY 2021 PROJECTED PER-VEHICLE COSTS FOR FINAL RULE AND ALTERNATIVES 3 AND 4 BY COMPANY—Continued

[Cars & trucks combined, 2010$/vehicle]

	Final rule	Alt. 3 (cars + 20)	Alt. 4 (cars − 20)
Toyota	532	312	857
VW	1,293	215	2,734
Fleet	766	330	1,365

Table III–41 presents the per-vehicle cost estimates in MY 2025 by company for the final rule, 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 less costly than the final rule, and Alternative 4 more costly. Again these differences are more pronounced for the car alternatives than the truck alternatives.

TABLE III–41—MY 2025 PROJECTED PER-VEHICLE COSTS FOR FINAL RULE AND ALTERNATIVES 3 AND 4 BY COMPANY

[Cars & trucks, 2010$/vehicle]

	Final rule	Alt. 3 (cars + 20)	Alt. 4 (cars − 20)
BMW	$1,910	$1,102	$3,041
Chrysler/Fiat	1,950	1,419	2,556
Daimler	2,616	1,622	3,826
Ferrari	7,864	7,416	7,864
Ford	2,025	1,302	2,800
Geely-Volvo	2,681	1,647	3,998
GM	1,861	1,400	2,417
Honda	1,642	1,105	2,293
Hyundai	1,792	1,138	2,666
Kia	1,658	1,040	2,452
Mazda	2,057	1,284	3,064
Mitsubishi	2,015	1,307	2,782
Nissan	1,847	1,244	2,583
Porsche	4,044	2,997	5,296
Spyker-Saab	3,238	2,059	4,507
Subaru	2,054	1,405	2,893
Suzuki	2,066	1,379	3,070
Tata-JLR	3,390	2,264	4,815
Toyota	1,407	1,020	1,971
VW	2,181	1,281	3,471
Fleet	1,836	1,249	2,574

Table III–42 shows that in MY 2021, for several technologies Alternative 3 leads to lower levels of technology penetration for cars as well as for trucks compared to the final rule. For example, on cars there is a decrease in the 18 bar turbo-charged/downsized engines, a decrease in the penetration of cooled EGR, and a 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 a decrease in penetration of 24 bar turbo-downsized engines, a decrease in penetration of cooled EGR, and a 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 MY 2021, for the truck fleet as well as for the car fleet. Table III–43 shows these same overall trends but at the sales weighted fleet level in MY 2021.

TABLE III–42—MY 2021 PROJECTED TECHNOLOGY PENETRATIONS FOR FINAL RULE AND ALTERNATIVES 3 AND 4 FOR ALL CARS AND TRUCKS

Technology	Cars			Trucks		
	Final rule (percent)	Alt. 3 (percent)	Alt. 4 (percent)	Final rule (percent)	Alt. 3 (percent)	Alt. 4 (percent)
Turbo-downsize (18 bar)	43	37	55	53	50	57
Turbo-downsize (24 bar)	14	7	22	16	10	25
8 speed DCT	61	60	63	7	6	7
Cooled EGR	11	5	19	16	8	24
Hybrid Electric Vehicle	4	4	7	2	1	3
LRRT2	72	72	72	74	74	74
IACC2	71	48	67	64	52	60

TABLE III–42—MY 2021 PROJECTED TECHNOLOGY PENETRATIONS FOR FINAL RULE AND ALTERNATIVES 3 AND 4 FOR ALL CARS AND TRUCKS—Continued

Technology	Cars			Trucks		
	Final rule (percent)	Alt. 3 (percent)	Alt. 4 (percent)	Final rule (percent)	Alt. 3 (percent)	Alt. 4 (percent)
GDI	60	45	84	73	63	87
MHEV	5	3	7	11	5	19

TABLE III–43—MY 2021 PROJECTED TECHNOLOGY PENETRATIONS FOR FINAL RULE AND ALTERNATIVES 3 AND 4 FOR FLEET

Technologies	Final rule (percent)	Alt. 3 (percent)	Alt. 4 (percent)
Turbo-downsize (18 bar)	46	41	56
Turbo-downsize (24 bar)	15	8	23
8 speed DCT	42	41	43
Cooled EGR	12	6	21
Hybrid Electric Vehicle	4	3	6
LRRT2	73	73	73
IACC2	68	49	65
GDI	65	51	85

Table III–44 shows that in MY 2025, there are significant differences in technology penetration rates when comparing the final rule to alternative 3 for cars, and additional change shows up in the truck fleet. As compared to the final rule, Alternative 3 would require approximately half the number of MHEVs, HEVs, and EVs As in MY 2021, we see that due to credit transfer between cars and trucks, the lower level of stringency considered for cars in alternative 3 also impacts the truck fleet penetration—with alternative 3 leading to a significant decrease in penetration of HEVs and MHEVs. For the more stringent alternative 4, we see a significant increase in the penetration of EVs, MHEVs and HEVs for cars compared to the final rule., Further, we see a sharp increase (a tripling) in the penetration of HEVs for trucks compared to the final rule.

TABLE III–44—MY 2025 PROJECTED TECHNOLOGY PENETRATIONS FOR FINAL RULE AND ALTERNATIVES 3 AND 4 FOR ALL CARS AND TRUCKS

Technologies	Cars			Trucks		
	Final rule (percent)	Alt. 3 (percent)	Alt. 4 (percent)	Final rule (percent)	Alt.3 (percent)	Alt. 4 (percent)
Turbo-downsize (18 bar)	25	20	16	19	19	19
Turbo-downsize (24 bar)	63	52	67	67	62	67
8 speed DCT	79	79	77	9	9	8
Cooled EGR	65	44	70	74	71	73
Hybrid Electric Vehicle	4	4	6	5	2	15
EV	3	1.5	6.5	0	0.0	1.1
LRRT2	96	96	97	99	98	99
IACC2	73	86	49	55	76	48
GDI	93	76	90	97	92	98
MHEV	20	9	45	39	23	35

TABLE III–45—MY 2025 PROJECTED TECHNOLOGY PENETRATIONS FOR FINAL RULE AND ALTERNATIVES 3 AND 4 FOR FLEET

Technologies	Final rule (percent)	Alt. 3 (percent)	Alt. 4 (percent)
Turbo-downsize (18 bar)	23	20	16
Turbo-downsize (24 bar)	64	56	67
8 speed DCT	56	56	55
Cooled EGR	68	53	71
Hybrid Electric Vehicle	5	3	9
EV	2	1.0	4.7
LRRT2	97	97	98
IACC2	67	83	49
GDI	94	81	93
MHEV	26	13	36

As stated above, EPA's analysis indicates that there is a technology pathway for all manufacturers to build vehicles that would meet their final standards as well as the alternative standards.[616] The differences between the final standards and these analyzed alternatives lie in the per-vehicle costs and the associated technology penetrations. We have also shown that the relative rate of increase in the stringencies of cars and trucks is appropriate such that there is greater balance among the manufacturers where the distribution of the burden is relatively evenly spread between cars and trucks, and that neither standard is disproportionately stringent relative to the other since the modeled flow of credits between cars and trucks is relatively equal. By MY 2025, the final rule standards are projected to result in MHEV or stronger battery technology on 33% of the new vehicle fleet. Our modeling shows that this level of technology is feasible and cost effective. In Section I.C of the Preamble, we also showed that the benefits of the program are significant, and that vehicle purchasers can recover this cost 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 apply technology to 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 car or truck standards less stringent, and keep the other standard as is. For both alternatives, manufacturers' car and truck fleets each increase their projected CO_2 g/mile level. Similarly, for alternatives 2 and 4, where either the truck or car fleet standard 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–46 for MY 2025.

TABLE III–46—A COMPARISON OF THE ACHIEVED CO_2 LEVELS IN RELATION TO THE FINAL ACHIEVED LEVELS FOR ALL ALTERNATIVE SCENARIOS IN MY 2025

Alternative	Change in car achieved level compared to final rule achieved level	Change in truck achieved level compared to final rule achieved level
1: truck + 20	+6	+10
2: truck − 20	− 8	− 6
3: car + 20	+12	+13
4: car − 20	− 15	− 9

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 g/mile and the truck standard more stringent by 9 g/mile. Under such an alternative, there would logically be little if any net transfer of credits between cars and trucks. Similarly, the results from alternatives 1 and 3 indicate what would be expected if EPA decreased the stringency of both the car and truck standards, and alternatives 2 and 4 indicate 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 comparably increase the CO_2 g/mile of both cars and trucks (alternatives 1 and 3). Increasing the stringency of the car and truck standards would also generally lead to comparable decreases in g/mile for both cars and trucks. Again, these analyses (which were presented at proposal and not directly controverted in any of the comments) support the relative stringency of the car and truck curves and their relation to each other. This is because there is not a disproportionate shift of projected compliance paths from car to truck improvements, or vice versa, under the final standards or the alternatives.[617]

EPA is not selecting either alternative 1 or 3 as a final standard. Under these less stringent alternatives, there would be significantly less emission reductions (as shown in section III.F.1), and would therefore forego important benefits that the final standards achieve at reasonable costs and penetrations of technology. EPA judges that there is not a good reason to forego such benefits, and is not adopting less stringent standards such as alternatives 1 and 3. Indeed, although a handful of commenters urged EPA not to establish MYs 2017–2025 standards at all, no commenters endorsed these specific standard stringencies.

Alternatives 2 and 4 increase the per vehicle estimates by roughly $300 and $600, respectively, in MY 2021 and $400 and $700, respectively, in MY2025. This increase in cost relative to the costs of the final rule standards stems from the increases in the costlier electrification technologies, such as HEVs and EVs that we project these standards would effectively force. The following tables and charts show the technology penetrations by manufacturer in greater detail.

Table III–47 and later tables describe the projected penetration rates for the OEMs of some key technologies in MY 2021 and MY2025 under the final standards. TDS27, HEV, MHEV, 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 utilize the most costly technology. Cost (as shown above) is a similar indicator.

Table III–47 describes technology penetration for MY2021 under the final rule.

[616] Except Ferrari.

[617] As also noted above, this analysis serves as a response to those commenters claiming that the truck standard was insufficiently stringent or created inherent incentives to upsize the light duty vehicle fleet. The analysis shows no indication that either the truck or car standards will encourage manufacturers to choose technology paths that lead to significant over or under compliance for cars or trucks, on an industry wide level.

TABLE III–47—PERCENT PROJECTED PENETRATION OF TECHNOLOGIES IN MY 2021 FOR THE FINAL STANDARDS

[Ferrari has been removed from this table]

	2021 Car					2021 Truck					2021 Fleet				
	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)
BMW	28	6	9	21	4	30	5	0	30	0	29	6	7	23	3
Chrysler/Fiat	21	1	0	0	0	19	3	0	11	0	20	2	0	5	0
Daimler	29	12	7	22	9	28	10	0	30	0	29	11	5	24	7
Ford	17	1	2	6	0	21	6	2	21	0	19	3	2	11	0
Geely/Volvo	30	13	13	17	9	30	6	0	30	0	30	11	9	21	6
GM	15	1	0	0	0	15	5	0	10	0	15	3	0	5	0
Honda	5	0	3	0	0	18	0	0	4	0	9	0	2	1	0
Hyundai	14	0	0	1	0	25	0	0	5	0	17	0	0	2	0
Kia	5	0	0	0	0	25	0	0	5	0	10	0	0	1	0
Mazda	28	0	0	4	0	28	0	0	14	0	28	0	0	6	0
Mitsubishi	29	0	0	6	0	30	0	3	26	0	29	0	1	13	0
Nissan	19	0	1	0	0	17	3	0	15	0	18	1	1	5	0
Porsche	28	15	25	5	27	30	11	2	28	0	29	14	20	10	21
Spyker/Saab	30	15	22	8	14	30	9	2	28	0	30	14	19	11	12
Subaru	29	0	0	19	0	30	0	20	10	0	30	0	5	17	0
Suzuki	30	0	0	25	0	30	0	0	30	0	30	0	0	26	0
Tata/JLR	30	15	25	5	17	30	12	22	8	0	30	13	23	7	9
Toyota	0	0	15	0	0	2	3	5	0	0	1	1	12	0	0
VW	30	12	1	29	8	30	7	0	30	0	30	11	1	29	6
Fleet	14	2	4	5	1	16	4	2	11	0	15	3	4	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, MHEV = Mild HEV, EV = Electric Vehicle, PHEV = Plug-in Hybrid Electric Vehicle.

It can be seen from this table that the larger volume manufacturers have levels of the most advanced technologies, such as plug-in and electric vehicles, 27 bar BMEP engines, and hybridization that are significantly below the modeled maximum penetration rates (i.e. the phase-in caps, described in the next table). On the other hand, some of the ''luxury'' manufacturers tend to require higher levels of these technologies than do the broader market manufacturers.[618] Together these seven ''luxury'' vehicle manufacturers represent 12% of vehicle sales and, as shown in Table III–48, their estimated cost of compliance is considerably higher than for broader market manufacturers in both MYs 2021 and 2025 regardless of the standard level.

TABLE III–48—COSTS BY ALTERNATIVE FOR ''LUXURY'' MANUFACTURERS VS. BROADER MARKET MANUFACTURERS

[Cars & trucks, 2010$/vehicle]

	2021		2025	
	Luxury	Broad market	Luxury	Broad market
Primary	$1,438	$672	$2,364	$1,763
Alternative 1	1,002	423	2,000	1,430
Alternative 2	1,943	979	2,797	2,165
Alternative 3	410	316	1,439	1,222
Alternative 4	2,819	1,166	3,604	2,432

Note: Several of the luxury manufacturers, including Porsche and Tata (Jaguar/Land Rover) are eligible for compliance flexibility based on their sales volumes; therefore, their costs would be lower than the sales weighted results used to generate the ''luxury'' manufacturer costs presented here.

The caps or limits on the technology phase in rates described in Chapter 3.4.2 of the joint TSD relate to the remainder of this discussion. As a modeling tool, EPA imposes upper limits on the penetration rates allowed under our modeling. These maximum penetration rates may reflect technical judgments about technology feasibility and availability, consumer acceptance, lead time, supplier capacity, up-front investment capital requirements, manufacturability, and other reasons as detailed in Chapter 3 of the Joint TSD. The maximum penetration rates are not a judgment that rates below that cap are practical or reasonable.[619] Table III–49 summarizes the caps on the phase in rates of some of the key technologies. A projected penetration rate that approaches the caps for these technologies for a given manufacturer is an indication of how much that manufacturer is being ''pushed'' to the limits of available technology by the standards.

[618] These ''luxury'' manufacturers are BMW, Daimler, Volvo, Porsche, Saab, Jaguar/LandRover, and VW. Note that we group these manufacturers here only for sake of differentiation in the analysis presented in this Section III.D.6. The term ''luxury'' manufacturer, as used here, carries no regulatory meaning and the use here should not be confused with any of our compliance flexibilities.

[619] For example, in MY 2010, there were 3% HEVs in the new vehicle fleet. In MYs 2016, 2021 and 2025 we project that the cap on this technology penetration rate increases to 15%, 30% and 50% respectively. In MY 2010, there were practically no PH/EVs. In MYs 2016, 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 for improved engine design still under development, TDS27, has a cap on penetration phase in rate in MYs 2016, 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–49—PHASE-IN RATES FOR SOME KEY ADVANCED TECHNOLOGIES

Technology	2016 (percent)	2021 (percent)	2025 (percent)
Turbocharging & downsizing with EGR Level 1 (w/cooled EGR, 24 bar)	15	30	75
Turbocharging & downsizing with EGR Level 2 (w/cooled EGR, 27 bar)	0	15	50
Mild and StrongHybrid	15	30	50
Plug-in Hybrid	5	10	14
Electric Vehicle	6	11	15

Table III–50 shows the technology penetrations for Alternative 2. In MY2021, penetration rates of truck mild and strong HEVs doubles in comparison to the final rule. The Ford truck fleet increases the MHEV penetration significantly relative to the final rule in Alternative 2.

There are other significant increases in the larger manufacturers and even more dramatic increases in the HEV penetration in smaller manufacturers' fleets. There are also now six manufacturers with total fleet PH/EV penetration rates equal to 9% or greater.

The broader market manufacturers have an estimated per vehicle cost of compliance with 2021 alternative 2 standards of roughly $1,000 which is roughly $300 more than under the final standards (see Table III–48, above). The seven ''luxury'' vehicle manufacturers now have estimated costs in 2021 of roughly $1,950, which is roughly $500 higher than the final standards (See Table III–48, above).

TABLE III–50—PERCENT PENETRATION OF TECHNOLOGIES IN MY 2021 FOR ALTERNATIVE 2

	2021 Car					2021 Truck					2021 Fleet				
	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)
BMW	28	6	12	18	7	30	9	0	30	0	29	7	9	21	5
Chrysler/Fiat	28	1	0	3	0	27	3	0	21	0	28	2	0	11	0
Daimler	30	13	16	14	13	28	10	0	30	0	29	13	12	18	10
Ford	26	1	2	12	0	29	6	2	27	0	27	3	2	17	0
Geely/Volvo	30	14	21	9	14	30	6	4	26	0	30	11	16	14	10
GM	25	1	0	2	0	24	5	0	23	0	25	3	0	12	0
Honda	10	0	3	0	0	18	0	0	6	0	12	0	2	2	0
Hyundai	17	0	0	1	0	25	0	0	5	0	18	0	0	2	0
Kia	12	0	0	0	0	25	0	0	5	0	15	0	0	1	0
Mazda	30	0	0	11	0	29	0	1	21	0	30	0	0	12	0
Mitsubishi	30	0	3	26	0	30	0	4	26	1	30	0	4	26	1
Nissan	21	0	1	0	0	25	3	0	18	0	22	1	1	6	0
Porsche	28	15	25	5	30	30	11	13	17	0	29	14	23	7	23
Spyker/Saab	30	15	22	8	17	30	9	2	28	0	30	14	19	11	14
Subaru	29	0	14	15	0	30	0	20	10	0	30	0	15	14	0
Suzuki	30	0	19	7	0	30	0	0	30	0	30	0	15	11	0
Tata/JLR	25	15	26	4	30	30	12	22	8	0	27	13	24	6	15
Toyota	4	0	15	0	0	19	3	5	8	0	10	1	11	3	0
VW	30	15	1	29	11	30	7	0	30	0	30	13	1	29	9
Fleet	19	2	5	6	2	24	4	2	18	0	21	3	4	10	1

Table III–51 shows the technology penetrations for Alternative 4 for MY 2021. The large volume manufacturer, Ford now has a significant increase compared to the final standards of truck MHEVs and the fleet MHEV penetration has gone up significantly for this company in comparison to the final standards.

Cars for several manufacturers now reach closer to the maximum technology penetration cap of 30% for HEVs. Also, there are now six manufacturers with fleet PH/EV penetration rates greater than 10%.

The broader market manufacturers now have an estimated per vehicle cost of compliance with 2021 alternative 4 standards of roughly $1,200, which is approximately $600 higher than the final standards. The seven ''luxury'' vehicle manufacturers now have estimated costs of roughly $2,800, which is approximately $1,100 higher than the final standard (See Table III–48, above). For the seven luxury manufacturers, this per vehicle cost in MY 2021 exceeds the full fleet costs under the final rule for complying with the considerably more stringent 2025 standards.

Table III-51 Percent Penetration of Technologies in MY 2021 for Alternative 4

	Car					Truck					Fleet				
	TDS24	TDS27	HEV	MHEV	PHEV+ EV	TDS24	TDS27	HEV	MHEV	PHEV+ EV	TDS24	TDS27	HEV	MHEV	PHEV+ EV
BMW	30%	14%	16%	14%	13%	30%	9%	0%	30%	0%	30%	12%	12%	18%	9%
Chrysler/Fiat	28%	1%	0%	3%	0%	27%	3%	0%	27%	0%	28%	2%	0%	14%	0%
Daimler	29%	13%	23%	7%	21%	28%	10%	0%	30%	0%	29%	13%	17%	13%	16%
Ford	28%	1%	3%	27%	0%	29%	6%	3%	28%	0%	29%	3%	3%	27%	0%
Geely/Volvo	30%	14%	22%	8%	19%	30%	6%	8%	22%	0%	30%	11%	18%	12%	13%
GM	23%	1%	0%	1%	0%	24%	5%	0%	20%	0%	23%	3%	0%	11%	0%
Honda	18%	0%	3%	0%	0%	25%	0%	0%	10%	0%	20%	0%	2%	3%	0%
Hyundai	27%	0%	0%	5%	0%	30%	0%	0%	29%	0%	28%	0%	0%	10%	0%
Kia	16%	0%	0%	0%	0%	25%	0%	0%	20%	0%	18%	0%	0%	5%	0%
Mazda	30%	1%	6%	24%	2%	30%	3%	10%	20%	2%	30%	1%	6%	24%	2%
Mitsubishi	30%	1%	5%	25%	3%	30%	4%	4%	26%	1%	30%	2%	5%	25%	2%
Nissan	29%	0%	1%	10%	0%	29%	3%	4%	24%	0%	29%	1%	2%	14%	0%
Porsche	24%	15%	29%	1%	31%	30%	15%	30%	0%	0%	25%	15%	29%	1%	24%
Spyker/Saab	28%	15%	25%	5%	27%	30%	9%	9%	21%	0%	29%	14%	23%	7%	23%
Subaru	30%	0%	17%	13%	4%	30%	0%	20%	10%	4%	30%	0%	18%	12%	4%
Suzuki	30%	0%	28%	2%	5%	30%	5%	0%	30%	0%	30%	1%	23%	7%	4%
Tata/JLR	23%	15%	26%	4%	31%	30%	12%	22%	8%	0%	27%	13%	24%	6%	15%
Toyota	4%	0%	15%	0%	0%	20%	3%	5%	9%	0%	10%	1%	11%	4%	0%
VW	30%	15%	22%	8%	17%	30%	7%	10%	20%	0%	30%	13%	20%	10%	14%
Fleet	22%	2%	7%	7%	3%	25%	4%	3%	19%	0%	23%	3%	6%	11%	2%

Table III–52 shows the technology penetrations for the final standards in MY 2025. The larger volume manufacturers have levels of advanced technologies that are below the maximum penetration rates though there are some notably high penetration rates for truck HEVs for Ford and Nissan. For the fleet in general, we note a 2% penetration rate of PHEVs and EVs, which coincidentally is similar to the current penetration rate of HEVs. It has taken approximately 10 years for HEV penetration to reach this level, without an increase in the stringency of passenger car CAFE standards. Therefore, EPA believes that there is sufficient lead time for PHEVs and EVs to reach this level of penetration by 2025.

Table III-52 Percent Penetration of Technologies in MY 2025 for the Final Standards

	Car					Truck					Fleet				
	TDS24	TDS27	HEV	MHEV	PHEV+ EV	TDS24	TDS27	HEV	MHEV	PHEV+ EV	TDS24	TDS27	HEV	MHEV	PHEV+ EV
BMW	60%	20%	1%	49%	12%	65%	19%	0%	50%	0%	62%	20%	1%	49%	9%
Chrysler/Fiat	72%	3%	0%	27%	0%	69%	8%	2%	47%	0%	71%	5%	1%	36%	0%
Daimler	60%	12%	4%	46%	17%	58%	23%	0%	50%	0%	60%	14%	3%	47%	13%
Ford	70%	4%	1%	35%	2%	64%	20%	28%	23%	0%	68%	9%	10%	32%	1%
Geely/Volvo	46%	26%	5%	45%	18%	72%	6%	0%	50%	0%	54%	20%	3%	47%	13%
GM	72%	3%	0%	22%	0%	61%	15%	0%	50%	0%	66%	9%	0%	35%	0%
Honda	73%	0%	3%	0%	0%	75%	0%	0%	36%	0%	73%	0%	2%	11%	0%
Hyundai	75%	0%	0%	10%	0%	75%	0%	0%	50%	0%	75%	0%	0%	18%	0%
Kia	57%	0%	0%	2%	0%	75%	0%	0%	49%	0%	61%	0%	0%	12%	0%
Mazda	75%	0%	3%	39%	2%	75%	0%	5%	37%	2%	75%	0%	3%	39%	2%
Mitsubishi	74%	0%	3%	47%	4%	70%	0%	7%	43%	2%	73%	0%	4%	46%	3%
Nissan	74%	0%	1%	22%	0%	70%	9%	13%	37%	2%	73%	3%	4%	27%	0%
Porsche	56%	9%	2%	48%	32%	61%	28%	0%	50%	0%	57%	13%	1%	49%	25%
Spyker/Saab	60%	8%	2%	48%	21%	65%	19%	0%	50%	0%	61%	10%	1%	49%	19%
Subaru	75%	0%	10%	17%	5%	75%	0%	12%	38%	5%	75%	0%	10%	22%	5%
Suzuki	75%	0%	16%	15%	7%	75%	0%	0%	50%	0%	75%	0%	13%	21%	6%
Tata/JLR	21%	37%	13%	37%	29%	59%	33%	16%	34%	0%	38%	35%	15%	35%	16%
Toyota	34%	1%	16%	0%	0%	68%	8%	3%	29%	0%	46%	4%	11%	11%	0%
VW	73%	2%	0%	49%	15%	69%	11%	0%	50%	0%	72%	4%	0%	49%	12%
Fleet	63%	3%	4%	20%	3%	67%	11%	5%	39%	0%	64%	6%	5%	26%	2%

All of the luxury manufacturers have significant MHEV penetrations. Several luxury manufacturers reach the maximum MHEV penetration cap on their truck portion of their fleet. 6 of the 7 luxury vehicle manufacturers also have greater than 10% penetration of PH/EVs (which has a total cap of 29%). Several companies have large penetration rates (>15%) of TDS27, such as Jaguar/LandRover, BMW, and Geely.

The estimated per vehicle cost of compliance with 2025 final standards is roughly $1,800 for the broader market manufacturers and roughly $2,400 for the seven ''luxury'' vehicle manufacturers.

Table III–53 shows the technology penetrations for Alternative 2 in MY 2025. In this alternative, Chrysler trucks increase their penetration of HEVs. GM has a large increase in truck HEVs, and PHEVs+EVs as well. Toyota also has an increased number of HEVs. In this alternative there are many more companies with a significant number of HEVs. As we noted at proposal when presenting this type of analysis, these penetration rates may well be overly aggressive in the face of uncertain consumer acceptance of both the added costs and the technologies themselves. 76 FR 75082. EPA continues to believe that these technology penetration rates are inappropriate given the concerns just voiced.[620] The estimated per vehicle cost of compliance with 2025 alternative 2 standards is roughly $2,200, which is roughly $400 higher than the final standards. The seven luxury vehicle manufacturers now have costs of roughly $2,800, which is roughly $400 higher than the final standards. See Table III–48 above.

TABLE III–53—PERCENT PENETRATION OF TECHNOLOGIES IN MY 2025 FOR ALTERNATIVE 2

	Car					Truck					Fleet				
	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)
BMW	51	20	7	43	16	65	19	0	50	0	55	20	5	45	12
Chrysler/Fiat	73	3	3	45	4	70	8	9	41	1	72	5	5	44	2
Daimler	56	14	4	46	21	58	23	0	50	0	56	16	3	47	16
Ford	70	4	6	37	5	64	20	28	23	1	68	9	13	33	4
Geely/Volvo	44	24	5	45	24	72	6	0	50	0	53	18	3	47	17
GM	72	3	1	41	4	67	15	15	35	0	70	9	8	38	2
Honda	73	0	3	14	0	75	0	2	41	0	73	0	3	22	0
Hyundai	75	0	0	23	0	75	0	0	50	0	75	0	0	28	0
Kia	75	0	0	9	0	75	0	0	50	0	75	0	0	17	0
Mazda	75	0	4	45	2	75	0	5	45	2	75	0	4	45	2
Mitsubishi	74	0	3	46	8	70	0	7	43	2	73	0	4	45	6
Nissan	74	0	0	41	2	70	9	17	33	2	73	3	5	38	2
Porsche	52	9	2	48	37	61	28	0	50	0	54	13	1	49	29
Spyker/Saab	65	8	2	48	22	65	19	0	50	0	65	10	1	49	19
Subaru	75	0	11	35	6	75	0	12	38	5	75	0	12	36	6
Suzuki	75	0	16	34	7	75	0	0	50	0	75	0	13	37	6
Tata/JLR	13	22	20	30	45	59	33	33	17	0	34	27	26	24	24
Toyota	63	1	15	13	0	68	8	6	43	0	65	4	12	24	0
VW	70	2	1	49	18	69	11	0	50	0	70	4	1	49	14
Fleet	69	3	5	31	5	69	11	11	38	1	69	6	7	33	3

Table III–54 shows the technology penetrations for Alternative 4 in 2025. In this alternative every company has a significant fraction of MHEVS and HEVs. Many of the large volume manufacturers have even more dramatic increases in the volumes of P/H/EVs than in Alternative 2.

The estimated per vehicle cost of compliance with 2025 alternative 4 standards is roughly $2,600, which is approximately $700 higher than the final standards. The seven luxury vehicle manufacturers now have costs of roughly $3,600, which is approximately $1,200 higher than the final standards. Much of this non-linear increase in cost is due to increased penetration of PHEVs and EVs (more so than HEVs).

TABLE III–54—PERCENT PENETRATION OF TECHNOLOGIES IN MY 2025 FOR ALTERNATIVE 4

	Car					Truck					Fleet				
	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)	TDS24 (%)	TDS27 (%)	HEV (%)	MHEV (%)	PHEV+EV (%)
BMW	48	20	7	43	22	65	19	0	50	0	52	20	5	45	16
Chrysler/Fiat	72	3	3	47	4	69	8	10	40	1	71	5	6	44	2
Daimler	52	14	4	46	29	58	23	0	50	0	54	16	3	47	23
Ford	70	4	6	43	8	62	20	30	21	2	68	9	13	37	6
Geely/Volvo	30	23	14	36	30	72	6	0	50	0	42	18	10	40	21
GM	72	3	1	41	2	67	15	15	35	0	70	9	8	38	1
Honda	73	0	4	29	2	75	0	8	42	2	73	0	5	33	2
Hyundai	75	0	5	45	3	75	0	0	50	0	75	0	4	46	3
Kia	75	0	2	36	3	75	0	0	50	0	75	0	1	39	3
Mazda	66	0	11	39	9	63	0	15	35	5	65	0	11	39	9
Mitsubishi	71	0	10	40	12	70	0	7	43	2	70	0	9	41	9
Nissan	74	0	4	46	5	62	9	23	27	3	71	3	9	40	4
Porsche	46	5	5	45	45	50	50	39	11	0	47	15	12	38	35
Spyker/Saab	56	8	2	48	34	65	19	0	50	0	57	10	1	49	30
Subaru	74	0	11	39	10	48	0	34	16	10	68	0	16	33	10
Suzuki	44	0	40	10	14	75	0	0	50	0	50	0	33	17	12
Tata/JLR	13	22	20	30	45	59	41	50	0	0	34	31	34	16	24
Toyota	63	1	14	21	0	68	8	16	37	1	65	4	15	27	0
VW	65	2	1	49	26	69	11	0	50	0	66	3	1	49	21
Fleet	67	3	6	37	7	67	11	15	35	1	67	6	9	36	5

[620] ACEEE stated that the more stringent alternative was preferable because ''[t]hese alternatives adhere to technology penetration rates that fall within the caps set by EPA to ensure feasibility.'' ACEEE Comments p. 8. However, the technology caps reflect the physical limits of technical capability, as explained above. That so many manufacturers are pushing up against those limits in this analysis raises legitimate issues of not only lead time and cost, but consumer acceptance as well. ACEEE's further comment that the truck standards should be more stringent in light of the incentives for advanced technologies for pickup trucks (ACEEE Comments p. 8) simply questions the agencies' policy judgment that it is more appropriate to encourage introduction of these advanced technologies into the large pickup truck sector by means of incentives, rather than to try and compel the technologies' penetration through more stringent standards, with the attendant issues just noted of rejection due to cost and consumer acceptance. Moreover, for the final rule, EPA modeled the incentives for large pickup trucks in its cost analysis and the results strongly support the decision not to adopt the more stringent alternative standards. See section d below. In addition, the agencies' policy choice is further appropriate as not creating an incentive to reduce pickup truck utility as a compliance strategy, as noted in section II.C above.

d. Summary of the Technology Penetration Rates and Costs From the Alternative Scenarios in Relation to the Final 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 MY 2021, in effect accelerating some of the technology penetration that would otherwise occur in the MYs 2022–2025 timeframe. As discussed above, EPA maintains lead time concerns about requiring aggressive technology penetration early in this time period subsequent to the advances in stringency during the MYs 2012–2016. In MY 2025, these alternatives would dramatically affect penetration rates of MHEVs, HEVs, EVs, and PHEVs, in each case leading to 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 MY 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 MY 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, the lead time issues discussed previously remain for MY 2021 and earlier years.. 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. This concern is one reason the agencies are attempting to encourage more utilization of these advanced technologies with the advanced technology incentive programs but being reasonably prudent in not adopting standards that could as a practical matter force high degrees of penetration of these technologies on towing trucks.[621]

EPA notes that the same concerns support the final 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 $400 and $700). 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 $12 and $31 billion for the MYs 2021 and 2025 final standards, respectively. Alternative 2 will cost the industry on average $5 and $7 billion in excess, while Alternative 4 will cost the industry on average $9 and $13 billion in excess of the costs for the final standards. These are large increases in percentage terms, ranging from approximately 40% to 70% in MY 2021, and from approximately 20% to 40% in MY 2025.

Under the more stringent alternatives, per vehicle costs would also increase dramatically, including for some of the largest, full-line manufacturers. Under Alternative 2, per vehicle costs for the large volume manufacturers increase roughly 50% to meet the 2021 standards and roughly 20% to meet the 2025 standards (see Table III–48, above). The per-vehicle costs to meet Alternative 4 for these manufacturers are roughly 75% in MY 2021 and 40% in MY 2025 (see Table III–48, above).

As noted, these cost increases are associated especially with increased utilization of advanced technologies. As shown in Figure III–3 below, HEV+PHEV+EV penetration are projected to increase in MY 2025 from 6% in the final standards, to 11% and nearly 13% 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 MY 2021, but still (in alternative 4) over double the penetration level of the final rule. EPA regards these differences as significant, given the factors of expense, consumer cost, consumer acceptance, and potentially (for MY 2021) lead time.

The figures below also do not show the significant penetration of mild hybrid technology into the fleet. Under the primary scenario, we project mild hybrid penetration of approximately 26% for the larger manufacturers, which rises to 33% and 37% under the two more stringent alternatives.

[621] See 76 FR 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 III-3 HEV + PHEV + EV Penetration for Manufacturers above 500,000 Sales

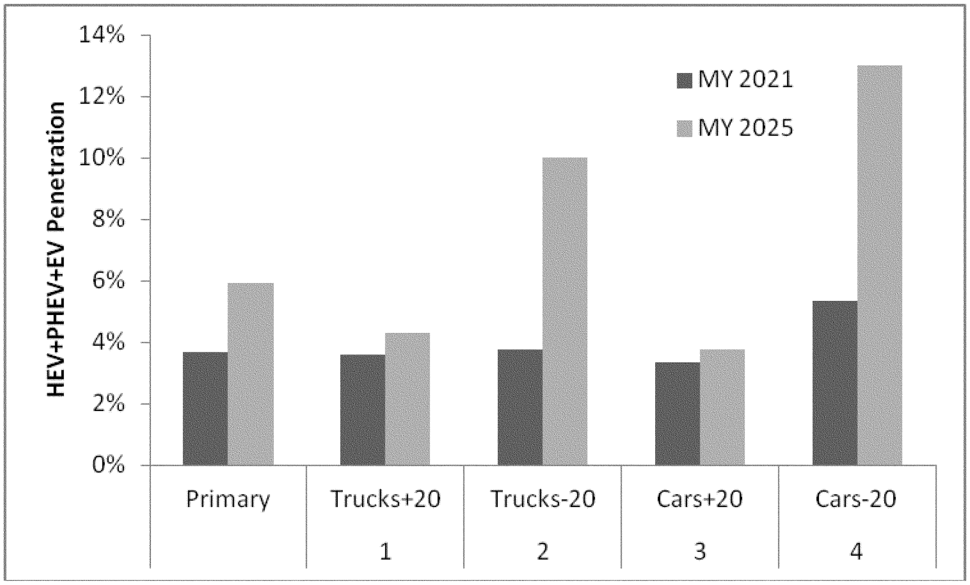
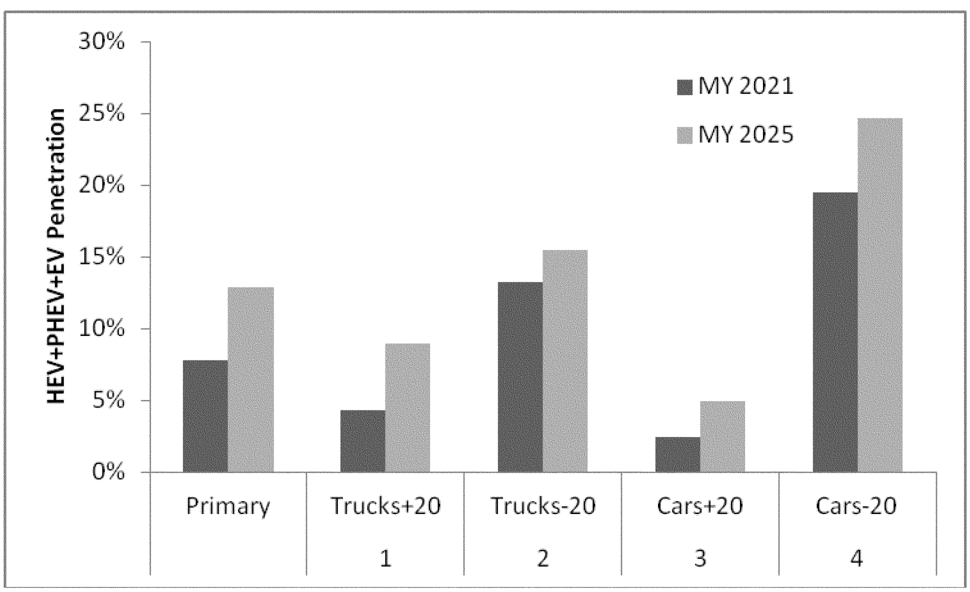


Figure III–4 below shows the HEV+PHEV+EV penetration for manufacturers with sales below 500,000 but exceeding 30,000 (including BMW, Daimler, Volvo, Kia, Mazda, Mitsubishi, Porsche, Subaru, Suzuki, and Jaguar/LandRover while excluding Aston Martin, Ferrari, Lotus, Saab, and Tesla). While the penetration rates of these advanced technologies also increase, the distribution within these are shifting to the higher cost EVs and PHEVs as noted above.

Figure III-4- HEV + PHEV + EV Penetration for Manufacturers below 500,000 (but above 30,000 Sales)



EPA modeled a number of flexibilities when conducting the analysis for the FRM. Unlike in the proposal, where 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 modeled, we have included the full size pickup truck incentive credits and some off-cycle credits in our cost analysis.[622] These credits reduce the estimated costs of the program for most manufacturers relative to the proposal. The average (non A/C) projected credit usage by manufacturer is approximately 2.7 grams (Table III–3). From an industry wide perspective, the overall impact on costs, technology penetration, and emissions reductions and other benefits is limited, as seen in projected costs and technology

[622] We did not model the manufacturer minimums as a requirement for the pick-up truck credits. See section III.C for a discussion of these minimums, and EPA RIA Chapter 3 for a table of credits by company.

penetrations that are largely similar to those from the proposal. The new analysis demonstrates that these credits provide important flexibility in achieving the final levels and promoting more advanced technology and supports the reasonableness of the final standards. As shown in the previously presented technology projections, the standards and off-cycle credits appropriately encourage technologies that will yield real benefit that is not reflected on the two cycle compliance test. Relative to the NPRM modeling, which did not consider the off-cycle credits, there is a significant increase in the modeled projections of start-stop technology. In the proposal, only 15% of the MY 2025 control case fleet was projected to receive start stop technology.[623] By contrast, in the analysis presented here, approximately 45% of vehicles have technologies that shut off engine at stop.[624]

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 adopt in this context, EPA judges that the final 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 final standards, especially in the face of unknown degree of consumer acceptance of both the increased costs and of the technologies themselves. At the same time, the final rule 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 show 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–55—COSTS BY MANUFACTURER BY MY—COMBINED FLEET (2010$)

Company	2017	2018	2019	2020	2021	2022	2023	2024	2025
BMW	$193	$386	$531	$673	$852	$1,283	$1,565	$1,826	$1,910
Chrysler/Fiat	180	314	416	521	733	1,092	1,454	1,799	1,950
Daimler	349	723	1,014	1,305	1,655	2,242	2,460	2,652	2,616
Ferrari	1,720	3,250	4,403	5,565	6,712	7,280	7,763	8,174	7,864
Ford	133	291	412	517	746	1,102	1,491	1,860	2,025
Geely-Volvo	412	794	1,075	1,357	1,698	2,366	2,567	2,746	2,681
GM	125	241	333	418	619	940	1,322	1,684	1,861
Honda	110	241	343	448	624	883	1,194	1,497	1,642
Hyundai	166	343	477	611	794	1,105	1,400	1,679	1,792
Kia	123	269	388	511	689	957	1,251	1,532	1,658
Mazda	193	430	606	775	1,010	1,312	1,634	1,942	2,057
Mitsubishi	148	321	438	565	791	1,055	1,455	1,831	2,015
Nissan	136	290	411	531	725	1,022	1,369	1,697	1,847
Porsche	39	62	1,734	2,447	3,871	4,790	4,672	4,534	4,044
Spyker-Saab	703	1,304	1,754	2,205	2,674	3,185	3,315	3,422	3,238
Subaru	262	505	673	854	1,128	1,337	1,655	1,951	2,054
Suzuki	50	66	477	651	1,064	1,377	1,686	1,972	2,066
Tata-JLR	31	61	1,057	1,486	2,495	3,891	3,832	3,756	3,390
Toyota	94	210	299	380	532	780	1,043	1,291	1,407
Volkswagen	311	602	825	1,044	1,293	1,749	1,972	2,176	2,181
Fleet	154	311	438	557	766	1,115	1,425	1,718	1,836

TABLE III–56—INDUSTRY AVERAGE VEHICLE COSTS ASSOCIATED WITH THE FINAL STANDARDS (2009$)

Model Year	2017	2018	2019	2020	2021	2022	2023	2024	2025
$/car	$206	$374	$510	$634	$767	$1,079	$1,357	$1,622	$1,726
$/truck	57	196	304	415	763	1,186	1,562	1,914	2,059
Combined	154	311	438	557	766	1,115	1,425	1,718	1,836

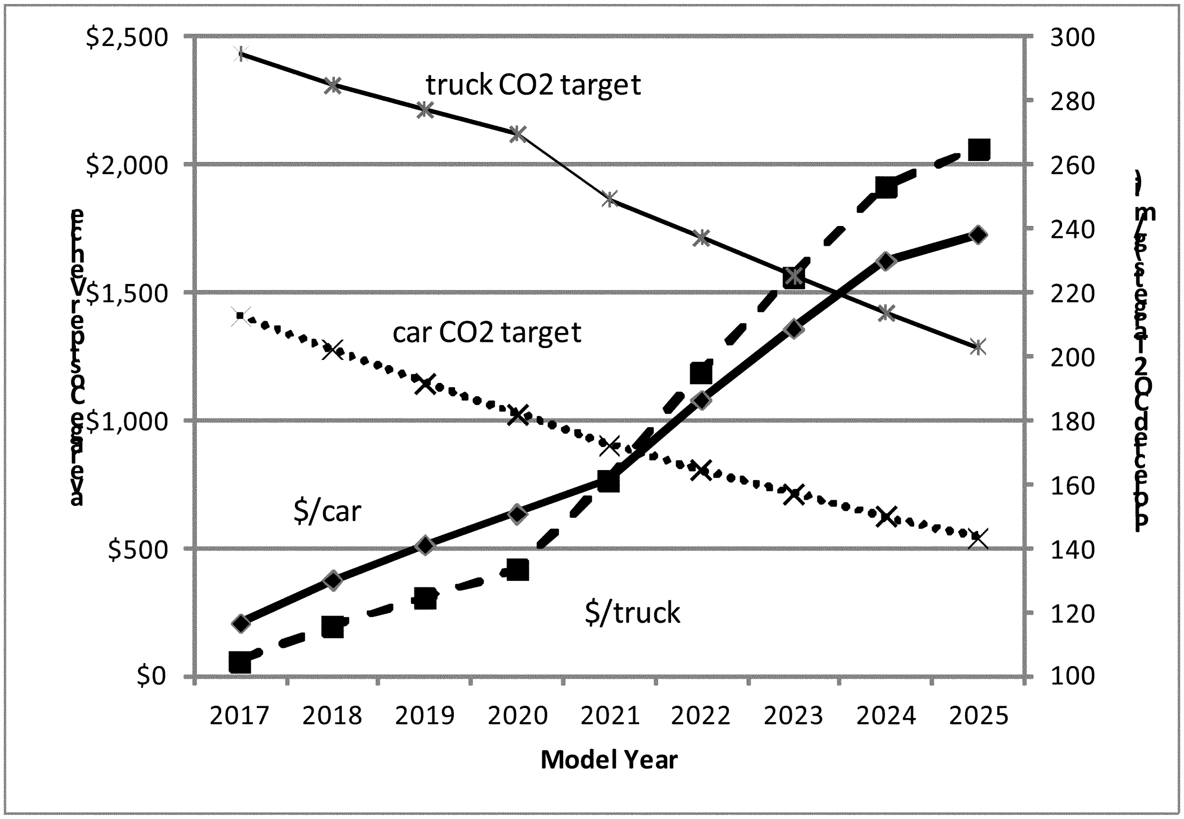
Figure III–5 below shows graphically the year on year average costs presented in Table III–56 with the per vehicle costs on the left axis and the projected CO_2 target standards on the right axis. It is quite evident and intuitive that as the stringency of the standard gets tighter, the average per vehicle costs increase. It is also clear that the costs for cars exceed that of trucks for the early years of the program, but then truck costs exceed car costs for the years 2022 through 2025. 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 to concerns over lead time relative to the standards 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

[623] 76 FR 75050. Of this 15%, nearly all are HEVs.

[624] These vehicles are a mixture of MHEVS (26%), HEVs (5%) and start-stop (15%).

conclusions and further demonstrates that based on the smooth progression of average costs (from MYs 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 is reasonable and appropriate. Also, EPA believes that any progression of standards that significantly deviates from the final standards (such as those in Alternatives 1 through 4) are much less appropriate for the reasons provided in the discussion above.

Figure III-5 Year on Year Progression of Projected (Target) CO_2 Standards and Average Cost Per Vehicle



7. Comments Received on the Analysis of Technical Feasibility and Appropriateness of the Standards

Several comments were received on the feasibility of the standards. These comments addressed the standards' technical feasibility, their feasibility for small manufacturers, and the relative stringency of the car and truck standards.

In comments on the overall feasibility of the proposed standards, some organizations, such as American Chemistry Council, Hyundai, Kia, and NADA affirmed the technical feasibility of the proposed standards. Other organizations, such as the Center for Biological Diversity, International Council on Clean Transportation (ICCT), Northeast States for Coordinated Air Use Management (NESCAUM), and the Union of Concerned Scientists commented that more stringent standards would also be technically feasible. Several comments were submitted that the technological feasibility of the full program would not be known until the mid-term evaluation (Mercedes-Benz, Nissan, Alliance, Global Automakers). EPA agrees with commenters that this program is technically feasible and cost-effective. As shown in the analysis earlier in this section, significant reductions can be made in tailpipe GHG emissions with technology that is either currently available, or available in the near term.

Lead time is a significant component of technical feasibility, and several comments were received with regard to the appropriateness of the lead time provided to meet the standards. Consumers' Union, Hyundai, and Kia commented that the amount of lead time provided by this rulemaking was appropriate. In contrast, Mitsubishi, Suzuki and Chrysler commented on the difficulty of forecasting consumer preferences into the future, and were therefore concerned as to the number of model years covered by the rules, even though not questioning that the rules provide sufficient lead time to meet the standards. The ICCT and CBD both commented that the long lead time should virtually eliminate costs of stranded capital. EPA agrees that the long lead time in this rulemaking should provide additional certainty to manufacturers in their product planning. EPA believes that there are several factors that have quickened the pace with which new technologies are being brought to market, and this will also facilitate regulatory compliance. These factors are discussed in Technical

Support Document section 3.4. EPA plans to assess consumer acceptance of vehicles produced under the MYs 2012–2016 rulemaking, as well as under this rulemaking, during the mid-term evaluation. Indeed, the mid-term evaluation is a chief mechanism for evaluating the assumptions on which the standards are based, and so addresses comments such as those of Mitsubishi, Suzuki, and Chrysler.

EPA agrees with the commenters that the analyses supporting this final rulemaking have demonstrated the feasibility of these standards, particularly as further supported by the number of vehicles today which meet the MY 2017 (and later) standards (see III.D.8 below). However, as discussed earlier in Section III.D.6, our analyses have shown that increasing the stringency beyond the promulgated levels would add significant cost with diminishing additional benefit, and for light trucks, potentially leading to overly aggressive penetration rates of certain advanced technologies, raising issues of lead time, costs, and consumer acceptance, as well as creating incentives to comply by reducing vehicle utility. As such, EPA has not made changes to increase or decrease the overall stringency across the car and truck fleets from the levels proposed.

Several comments addressed the feasibility of the standards for smaller manufacturers. As an example, Jaguar/Land Rover, and Porsche commented that the technology penetrations the agency projected for their companies were too severe, disproportionate to improvements needed for other companies to comply with the standards, and requested additional lead time to meet the standards. EPA's analyses tend to confirm the thrust of these comments. See, e.g. Table III–47 and Table III–48 and accompanying text above. In light of the comments regarding smaller manufacturers, EPA is finalizing provisions to allow intermediate volume manufacturers some amount of additional lead time out to MY 2021. Details of this alternative standard, and the rationale for it, can be found in Section III.B.6.

The comments on the relative car and truck stringency were largely divided between NGOs and OEMs (typically manufacturers of smaller trucks) that were concerned with the shape and relative rate of increase of the truck curve, and OEMs (typically manufacturers of larger trucks) who expressed concern about their ability to comply with a large truck standard that continued to increase in stringency at the rate of the MY 2016 standard. For example, Ford Motor Company commented: ''Ford also believes that the relative stringency levels for the car and truck fleets, as proposed by the agencies, are appropriate * * *. In terms of the product actions necessary to comply, the proposed car and truck standards are roughly equivalent in stringency. This is attributable to the unique attributes expected from trucks—particularly the larger work trucks that constitute a significant portion of our full-line vehicle fleet offering—and also to the overly stringent standards imposed on light duty trucks in the 2012–2016 model year regulation.'' General Motors submitted comments that the company ''supports the target standard curve shapes, [and] the relative car and truck stringency.'' Chrysler submitted similar comments. The UAW commented that ''In particular the UAW supports the aspects of the proposals that recognize the importance of balancing the challenges of adding fuel-economy improving technologies to the largest light trucks with the need to maintain the full functionality of these vehicles across a wide range of applications.''

As mentioned above, several commenters raised concerns about the relative stringency between cars and trucks. ACEEE commented that ''[t]he weakness of the standards at the large footprint end of the light truck spectrum not only will result in a direct loss in GHG reductions relative to what would have been saved with a uniform five percent annual emissions reduction across all classes, but also runs the risk of pushing production towards that larger end.'' Honda commented that it was ''concerned that the relative stringency between small footprint light trucks and large footprint light trucks diverge dramatically from one another, and that the stringency increases fall disproportionately on the smaller footprint light trucks. Consumer's Union stated that ''[t]here are several strong indicators that the gap between the curves is too large.'' The ICCT wrote: ''the 2017–2025 rule increased the gap between cars and light trucks, providing stronger incentives for manufacturers to reclassify cars as light trucks and potentially undermining the benefits of the rule.'' The agencies received similar comments from several mass comment campaigns (Union of Concerned Scientists, NACAA, NRDC), and other NGOs. VW, Toyota, and Nissan also expressed similar concerns, with Toyota stating ''we remain concerned about two aspects of the proposed standards. First, the targets for trucks require a lower average rate of improvement than for cars. And second, the targets for larger trucks require a lower average rate of improvement than smaller trucks.''

EPA recognizes that significant differences in the year-to-year stringency for cars and trucks could lead to the result of an increasingly widening gap between the car and truck curves and increase the incentives to reclassify cars as light trucks, thus undermining the fuel economy and greenhouse gas reduction benefits of the standards. However, even with reduced stringency of the truck standard in the early model years of the rule, the trend of a gradually widening gap during this period is reversed during the MY 2021–2025 period. As shown in Table III–57, by MY 2025 the gap for larger footprint vehicles is at levels similar to the MY 2012–2016 rule, while for smaller footprint vehicles, the gap is less than during the MY 2012–2016 rule. EPA believes that the increase in stringency for the truck standard in the latter phase of the rule is a reasonable approach for avoiding a large gap between car and truck curves while also taking account of the challenges of implementing efficiency technologies in trucks during the first phase of the rule as explained in Section III.D.6 above.

TABLE III–57—GAP BETWEEN CAR AND TRUCK CURVES, MYS 2012–2025 (G/MILE)

Model Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Smaller Footprint Vehicles (left car cutpoint = 41 sq. ft.)	50	47	47	44	41	43.4	41.9	44.2	45.8	38.2	35.5	33.1	30.8	28.6
Larger Footprint Vehicles[a] (right car cutpoint = 56 sq. ft.)	39.8	37.9	36.6	33.3	30.3	44.0	48.1	51.8	54.3	44.6	41.3	38.5	35.8	33.5

[a] Vehicles with footprints of approximately 56 sq. ft. include the MY 2010 Lincoln Town Car, and Toyota Tacoma. Only a few MY 2010 cars have footprints greater than 56 sq. ft.

EPA's determination of the standards was based on considerations of the technical differences between the cars and trucks, as described in Chapter 2 of the Joint TSD and Section II.C of the Preamble. As compared to the MY 2016 standard, the gap between the MY 2025 car and truck targets decreases in the smaller footprint range where these regulatory classes share the most design attributes, and the target curves appropriately reflect differences in the vehicle characteristics at the larger footprint end (see discussion in TSD chapter 2.4.2) As a result, the car and truck curves developed from this analysis exhibit differences in both the relative level of the target at a given footprint, and the overall stringency as standards increase year-to-year. EPA believes that the final standards reasonably balance the issues and address the concerns raised by commenters, resulting in significant CO_2 emissions reductions using technologies that can be feasibly adopted over the rulemaking timeframe. It is important to note that while it was not an express goal of the EPA's analysis or standards to distribute compliance burdens equitably among manufacturers and vehicle types, we believe that the promulgated standards will do just that, by promoting emissions reductions across the full range of vehicles. Furthermore, by considering the technical features unique to cars and trucks at all footprint sizes, the standards avoid the technically inappropriate result of the car and truck curves converging at footprint levels at which cars and truck properties are most different.

With regard to the year-to-year increase in stringency, the promulgated standards encourage manufacturers to apply additional technologies throughout the rulemaking timeframe. The standards are based on footprint, and increase in stringency at all vehicle sizes.[625] The year-to-year stringency for trucks is in general lower than cars in the early years of the program, in consideration of the technical challenges involved in applying efficiency technologies to these vehicles as well as lead time concerns relative to the early years of the programs. Moreover, EPA recognizes that trucks do not uniformly face the same technical challenges,[626] and the standards reflect these differences. Thus, the promulgated standards promote similar levels of emission reductions for smaller trucks and for cars of the same size. For example, the average year-to-year increase in the target level over the entire MY 2017–2025 period is identical for cars and trucks at the 41 sq. ft. curve cutpoint (5.1 percent per year), and is nearly the same over the initial MY 2017–2021 period (4.8 and 4.5 percent per year, for cars and trucks, respectively.) Some commenters expressed concern that manufactures will use the initially lower truck standards to delay implementation of efficient technologies, and then use this circumstance to argue in the mid-term evaluation for relaxed standards. EPA does not believe this concern in justified, since the mid-term evaluation will occur before many of these vehicles are in production. EPA will carefully monitor this issue during the mid-term evaluation.

8. To what extent do any of today's vehicles meet or surpass the final 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 final 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 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 standards, and illustrates the need for the leadtime 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 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 do 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 current vehicles and their 2-cycle CO_2 emissions performance (that is, the performance over the city and highway test cycles that are used for compliance with this rule). Data is currently available for all MY 2012 vehicles and some MY 2013 vehicles. EPA gathered vehicle footprint data from EPA reports, manufacturer submitted CAFE reports, and manufacturer Web sites.

EPA evaluated these vehicles against the final CO_2 footprint-based standard curves to determine which vehicles would meet or exceed the final MY 2017–MY 2025 footprint-based CO_2 targets assuming air conditioning credit generation consistent with today's final rule, but no other changes. Under the final MY 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 overall manufacturer obligation is a company-specific, sales-weighted, fleet-wide CO_2 standard for each company's passenger cars and truck fleets calculated using the final 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 efficiency and refrigerant 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.1. of this preamble. No adjustments were made to vehicle CO_2 performance other than this assumption of air conditioning credit generation, although additional credits may be available. The details regarding this assessment are in Chapter 3 of the EPA RIA.

This assessment shows that a significant number of vehicles models sold today (over 100 models) have CO_2 values at or below the final MY 2017 footprint-based targets with current powertrain designs, assuming air conditioning credit generation consistent with our final rule. The list of vehicles meeting MY 2017 targets, with no technology improvements other than air conditioning system upgrades, cover 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. These vehicles utilize a wide variety of powertrain

[625] This was achieved by applying a proportional year-to-year increase (multiplicative) to the target at every footprint level, unlike the MY 2012–2016 rule in which a constant-value (additive) increase was applied by offsetting curves vertically.

[626] See preamble II.C for discussion of these technical challenges.

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 MY 2017 footprint CO_2 targets 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 meet 2017 targets (though the HEV Silverado and Sierra's meet not just the MY 2017 footprint-based CO_2 targets with A/C improvements, but their respective targets through MY 2022). EPA also assessed the subset of these vehicles that have emissions within 5% of the final CO_2 targets. As detailed in Chapter 3 of the EPA RIA, the analysis shows that there are more than 66 additional vehicle models (primarily with gasoline and diesel powertrains) that are within 5% of the MY 2017 CO_2 targets, including compact cars, midsize cars, large cars, SUVs, station wagons, minivans, small and standard pickup trucks. In total, nearly 175 current vehicle models (or about 15% of all models) meet or are within 5% of the final MY 2017 targets.

The number of vehicles available that meet the final MY 2017 targets has already significantly increased since the proposal. In particular, the number of vehicles with conventional gasoline powertrains that meet or exceed the final MY 2017 targets has increased from 27 at the time of proposal to 65 models currently. An additional 58 vehicles currently available with conventional gasoline powertrains are within 5% of the final MY 2017 standards. As the CO_2 targets become more stringent each model year, fewer MY 2012 and MY 2013 vehicles achieve or surpass the final CO_2 targets, in particular for gasoline powertrains. While approximately 65 unique gasoline vehicle models achieve or surpass the MY 2017 targets, this number falls to approximately 38 for the MY 2018 targets, 23 for the model year 2019 targets, and 12 unique gasoline vehicle models can achieve the MY 2020 final CO_2 targets with A/C improvements.

TABLE III–58—NUMBER OF VEHICLES COMPLIANT WITH MY2017 TARGETS

Model year	Gasoline	Diesel	CNG	HEV	PHEV	EV	FCV	Total
2011/2012	27	1	1	27	1	3	0	60
2012/2013	65	3	1	29	1	8	1	108

TABLE III–59—NUMBER OF VEHICLES WITHIN 5% OF THE MY2017 TARGETS

Model year	Gasoline	Diesel	CNG	HEV	PHEV	EV	FCV	Total
2011/2012	38	6	0	3	0	0	0	47
2012/2013	58	6	0	2	0	0	0	66

Prior to each model year, EPA receives projected sales data from each manufacturer. Based on this data, approximately 17% of MY 2012 sales will be vehicles that meet or are lower than their vehicle specific MY 2017 targets, requiring only improvements in air conditioning systems. This is more than double the 7% of MY 2011 sales that EPA projected to meet the MY 2017 targets. An additional 12% of projected MY 2012 sales will be within 5% of the MY 2017 footprint CO_2 target with only simple improvements to air conditioning systems, five model years before the standard takes effect.

With improvements to air conditioning systems, the most efficient gasoline internal combustion engines would meet the MY 2022 footprint targets. After MY 2022, the only current vehicles that continue to meet the footprint-based CO_2 targets (assuming improvements in air conditioning) are hybrid-electric, plug-in hybrid-electric, and fully electric vehicles, and CNG vehicles. However, the MY 2021 standards would not need to be met for another 8 years. Today's Toyota Prius (three versions), Ford Fusion Hybrid, Chevrolet Volt, Nissan Leaf, Honda Civic Hybrid, Camry Hybrid, Lexus CT 200h Hybrid, Lincoln MKZ Hybrid, and Hyundai Sonata Hybrid all meet or surpass the footprint-based CO_2 targets through MY 2025. In fact, the current Prius, Volt, and several EVs meet the 2025 CO_2 targets without air conditioning credits.

This assessment of MY 2012 and MY 2013 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 75 percent of the new vehicles could be advanced gasoline powertrains. The assessment of MY 2012 and MY 2013 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 program (i.e., model years 2017–2022) 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 standards for the early years of the program, and certainly for the later years. These technology improvements are the very technologies EPA and NHTSA describe in detail in Chapter 3 of the Joint Technical Support Document and for which we project penetration rates earlier in this section III.D. These technologies 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 most 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 3.4.2 of the Joint Technical Support Document. In that Chapter, we explain that many CO_2 reducing technologies should be able to penetrate the new vehicle market at high levels between now and MY 2016. These are also many of the key technologies we project as being needed to achieve the MYs 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 25467–68, May 7, 2010). In addition, engines and transmissions generally have longer lifetimes than 5 years, typically on the order of 10 years. Thus, major powertrain technologies generally take longer to penetrate the new vehicle fleet than can be done in a 5-year redesign cycle. As detailed in Chapter 3.4 of the Joint TSD, EPA projects that 8-speed transmissions could increase their maximum penetration in the fleet from 30% in MY 2016 to 80% in MY 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 MY 2017–2025 standards and the product development and introduction process which is fairly standard in the automotive industry today, our assessment of the MY 2012 and MY 2013 vehicles in comparison to the standards supports our overall feasibility assessment, and reinforces our assessment of the lead time needed for the industry to achieve the 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. EPA has had the statutorily-designated responsibility for managing the testing, data collection, and calculation procedures of the CAFE program since the 1970's, see 49 U.S.C. 32904(c) and EPA's experience with that program allowed EPA to integrate the newer GHG requirements with the older CAFE requirements such that little to no additional test data is required and data and reporting requirements are largely synchronized. The EPA and NHTSA programs for MYs 2017 and later replicate the compliance protocols established in the MY 2012–2016 rule.[627] The certification, testing, reporting, and associated compliance activities track current practices and are thus familiar to manufacturers. As is the case under the MYs 2012–2016 program, EPA and NHTSA have designed a coordinated compliance approach for MY 2017 and later model years such that the compliance mechanisms for both GHG and CAFE standards are consistent and non-duplicative. Readers are encouraged to review the MYs 2012–2016 final rule for background and a detailed description of these certification, compliance, and enforcement requirements.[628]

Vehicle emission standards established under the CAA apply throughout a vehicle's full useful life. Today's rule establishes two sets of EPA standards: fleet average greenhouse gas standards and in-use standards. Compliance with the fleet average standard in a given model year is determined based on testing performed prior to production and on actual vehicle production in that model year, as with the current CAFE standards. 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.[629] 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 Section III.C. Because much of the compliance program was largely finalized with the 2012–2016 GHG standards, there were very few comments specifically related to these elements of the 2017 and later GHG program. Comments mostly addressed some of the newly proposed provisions, such as new flexibilities for off-cycle credits, credits for certain pickup trucks, small volume alternative standards, and others. These comments are discussed in Sections III.B and 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 type[630] and on 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

[627] See 75 FR 25468, May 7, 2010.

[628] Also see current regulations at 40 CFR Part 86, Subpart S, and 40 CFR Part 600.

[629] Dual fuel vehicles (with the exception of plug-in hybrid electric vehicles) are treated slightly differently. These vehicles would be potentially tested in use on either or both fuels, and each fuel would have an associated standard.

[630] A model type is ''a unique combination of car line, basic engine, and transmission class'' (40 CFR 600.002).

in Section III.E.5.h of the MYs 2012–2016 final rule preamble (see 75 FR 25481). EPA received no significant comments on these general compliance provisions, unless specifically noted below, and these provisions are being finalized as they were proposed.

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 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-based fleet 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 allowing the carry-forward and carry-back of 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 III.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 III.E.2.b of the MYs 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.[631]

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 III.E.3 of the MYs 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 type 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 III.E.4 of the MYs 2012–2016 final rule preamble (75 FR 25473) for a detailed discussion of the in-use standard, in-use testing requirements, and use of 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, including some new programs which are not part of the MYs 2012–2016 rule (e.g., credits for certain pickup trucks). Please see Section III.E.5 of the MYs 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 MYs 2012–2016 rulemaking remains in place. Please see Section III.E.6 of the MYs 2012–2016 final rule preamble (75 FR 25482) for a discussion of these provisions.

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 emissions. Acts that are prohibited by section 203 of the Clean Air Act include the introduction into commerce or the sale of a vehicle without a certificate of conformity, removing or otherwise defeating emission control equipment, the sale or installation of devices designed to defeat emission controls, and other actions. EPA finalized language in the 2012 greenhouse gas regulations that details the specific prohibited acts under the Clean Air Act. While these regulations carry no specific regulatory burden and essentially repeat the Clean Air Act language, EPA believed that providing that language was helpful and added clarity to our regulations. We proposed no changes to this language in this rulemaking for the 2017 and later model years, no comments were received, and thus the language will continue to apply to the 2017 and later model years.

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. For test groups that are using carry-over data for certification, EPA will allow those test groups to carry over the N_2O compliance statement (now allowed through the 2016 model year) into the 2017 and 2018 model years.

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

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 were entirely exempted from the MYs 2012–2016 GHG requirements. However, based on comments from at least one small business, we are including a provision in this final rule that will provide these previously exempted manufacturers with the option of voluntarily opting in to the program. Once opted in, however, such a manufacturer would be fully subject to

[631] CAA section 206(a)(1).

all the GHG standards and requirements in the regulations.

As discussed in detail in Section III.B.5, small volume manufacturers with annual sales volumes of less than 5,000 vehicles will be required to meet the primary GHG standards, with the option of petitioning the Agency for alternative standards developed on a case-by-case basis.

d. Onboard Diagnostics (OBD) and CO_2 Regulations

As under the current program, EPA will 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 business exemption and the conditional exemption for small volume manufacturers available through the 2016 model year, 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 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. Because fuel converters are not required to meet a fleet average standard, the new provisions allowing a small volume manufacturer to petition EPA for alternative standards do not apply. 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 retaining the process promulgated in 40 CFR part 85 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 emission data vehicle 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 continuing to allow conversion manufacturers, on a test group basis, to convert CO_2 over-compliance 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 N2O standards.

g. Geographical Location of Greenhouse Gas Fleet Vehicles

EPA emission certification regulations require emission compliance [632] 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.

h. Temporary Lead-time Allowance Alternative Standards (TLAAS) Implementation

EPA is also clarifying provisions of the MYs 2012–2016 light duty vehicle GHG standards to address an inadvertent gap in those rules dealing with situations of mergers between non-TLAAS manufacturers and TLAAS manufacturers. By way of background, the TLAAS provisions provide additional lead time for limited volume manufacturers, whereby a specified number of vehicles are subject to a less stringent standard in either MYs 2012–2015, or (for smaller volume manufacturers), MY 2016. See 75 FR 25414–419. Limited volume manufacturers may elect to use the TLAAS provisions, but are not required to do so.

The TLAAS rule provisions address situations where TLAAS manufacturers merge with or are acquired by another manufacturer. See section 86.1818–12(e)(1)(i)(B) and (C). These provisions address two scenarios. The first is when companies merge and the new company exceeds the 400,000 vehicle sale threshold (the eligibility threshold for the base TLAAS program). In such cases, the manufacturer may use TLAAS in the model year underway at the point of the merger, but loses eligibility in the model year following the merger.[633] For example, if the merger takes place during MY 2013 (which began January 2, 2012), beginning in MY 2014, the merged entity may not use TLAAS. The second scenario addressed by the regulations is where the companies being merged are both TLAAS manufacturers, and both participate in TLAAS, and the merged company does not exceed the 400,000 vehicle threshold. In such cases the allotments of the two companies under TLAAS are not additive and the new (merged) company only receives a single TLAAS allotment.

EPA received a comment from Volkswagen requesting clarification in cases where the parent company, while eligible for TLAAS, has not elected to use TLAAS and does not plan to use TLAAS for future years. The commenter recommended that in such a case, the parent company should have the option of being treated in the same manner as when the company resulting from the merger exceeds the 400,000 vehicle threshold (i.e., the first scenario described above). The company would no longer be allowed to use TLAAS in the model year following the merger but could use TLAAS for the company being acquired for the model years already underway. EPA recognizes that this was not a scenario specifically contemplated by the existing regulatory language, but we believe that this is a reasonable approach since it brings parity to the transitional merger provisions of a large (non-TLAAS eligible) company compared to those of a TLAAS eligible company that chooses to forgo its opportunity to participate in the TLAAS program. EPA is adding this clarification to the MYs2012–2016 regulations. The revised regulatory text clarifies that in cases where one manufacturer that is eligible for TLAAS but nevertheless elects to forgo the use of TLAAS acquires another company that is already using TLAAS, the parent company is required to end the use of TLAAS for the acquired company in the model year following the merger (whether or not the 400,000 sales threshold is exceeded). The

[632] 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.''

[633] The model year following the merger is referred to as the model year that is numerically two years greater than the calendar year in which the merger/acquisition took place in the regulatory text.

manufacturer must notify EPA in writing prior to the end of the model year in which the merger is effective of its decision to elect not to use the TLAAS program in any year. As provided in the current rules, the total cumulative allotment that may be used for the manufacturer being acquired is limited to 100,000 vehicles (i.e., the lower level of allotments available to companies with between 50,000–400,000 vehicle sales).

In addition to treating all non-TLAAS participants identically in this situation, the clarified rule leads to environmental benefits compared to the alternative. Consider the case of a merger between a TLAAS-eligible TLAAS non-participant and a TLAAS manufacturer with sales under 50,000, where the merged entity remains under the 400,000 sales threshold. Without today's clarified rule, the merged entity would have a strong incentive to elect to use TLAAS, because the present rules only provide all-or-nothing alternatives due to the lack of explicit provisions allowing the additional model year of TLAAS for the smaller merger partner. Thus, the merged entity could produce up to 100,000 vehicles (minus the TLAAS allotment already used by the smaller company) through MY 2015 which would be subject to the more lenient TLAAS standards. Under the clarified rule, the merged entity could use the TLAAS allotment for the smaller company for one additional model year, at which point the merged entity would be subject to the principal GHG standards (i.e. just as if the merger exceeded the 400,000 sales threshold, as in present section 86.1818–12 (e)(1) (i)).

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 III.E.10 of the MYs 2012–2016 final rule preamble (75 FR 25486) for a discussion of these provisions.

9. Miscellaneous Technical Amendments and Corrections

EPA is including a number of noncontroversial amendments and corrections to the existing regulations in this final rule. 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 rule presents an opportunity to make corrections and clarifications to all or any of these programs. Consequently, EPA proposed and is now finalizing a number of minor and non-substantive corrections to the regulations that implement these programs. We note that certain provisions of the existing model year 2012–2016 program are repeated in the final regulations for readers' convenience. We are not reopening. reconsidering. or otherwise reexamining those provisions.

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.
EPA proposed to revise the definition of ''Footprint'' in 86.1803–01 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. EPA received no comments on this provision, and is finalizing as proposed.

We are also finalizing 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 adding another option that will be applicable starting with the 2012 model year. The new option will allow clean alternative fuel conversion manufacturers to satisfy the greenhouse gas standards if the pre-conversion sum of CH_4 plus N_2O plus CREE emissions from the vehicle is less than the post-conversion emissions, 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.'' [634] EPA's current definition of base tire is the ''tire specified as standard equipment by the manufacturer.'' [635] NHTSA proposed a specific change to the base tire definition for the CAFE program (see Section IV.I.5.g, and proposed 49 CFR 523.2), and EPA requested comment on whether the base tire definition should be clarified to ensure a more uniform application across manufacturers (76 FR 75088, December 1, 2011).

Vehicle manufacturers were the only parties providing comments on this issue, and they were essentially unanimous in stating a desire for a level playing field, while reiterating that the issue is complex. Several manufacturers pointed out that the proposed NHTSA definition, which includes a connection to a vehicle configuration, may not be workable because the definition of a configuration is independent of vehicle size, or footprint. Several manufacturers suggested that EPA, NHTSA, and the auto companies should postpone action on this issue in this rule and work together to ensure a consistent and complete understanding of the issue. Others agreed that the definition could benefit from some clarification. After consideration of the comments, and a recognition of the importance that the footprint calculation (and therefore all the elements that comprise the footprint calculation) be harmonized across EPA and NHTSA, EPA is finalizing a revised definition in this final rule, which is consistent with the definition being finalized by NHTSA. The revised definition is as follows:

Base tire means the tire size specified as standard equipment by the manufacturer on each unique

[634] See 40 CFR 86.1803–01

[635] 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.

combination of a vehicle's footprint and model type. Standard equipment is defined in 40 CFR 86.1803–01.

This definition appropriately removes the link to vehicle configuration that was in NHTSA's proposal, and improves upon EPA's existing definition with additional specificity that is consistent with the goal of a footprint-based program, which, as stated by the Alliance of Automobile Manufacturers, is that ''All vehicles should be included * * * using a representative footprint based on the physical vehicle * * *'' EPA agrees with this broadly stated goal, and we believe that the revised definition offers reasonable clarification that should help ensure a consistent application of the footprint-based standards across manufacturers. This new definition, which is harmonized with the definition being finalized by NHTSA, is also consistent with existing regulatory language that specifies how EPA intends that footprint-based standards be implemented. For example, EPA regulations currently state that ''Each CO_2 target value, which represents a unique combination of model type and footprint value, shall be multiplied by the total production of that model type/footprint combination for the appropriate model year'' (see 40 CFR 86.1818–12(c)(2)).

11. Treatment of Driver-Selectable Modes and Conditions

EPA requested 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 in certification testing. See 76 FR 75089; see also section II.F of this preamble for a discussion of how driver-selectable technologies may be eligible for off-cycle credits under the case-by-case demonstration provisions in the rule. 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. Note that this discussion pertains specifically to implementing the testing required on the Federal Test Procedure and the Highway Fuel Economy Test to generate combined City/Highway GHG and MPG values for each model type for use in calculating fleet average GHG and MPG values. For the purpose of assigning off-cycle credit values that may be based on a driver-selectable technology (see section II.F), where determination of an accurate real-world benefit of the technology is a fundamental goal, the policy described here and in current EPA guidance may not be appropriate.

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. 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 choice for testing. 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. For PHEVs and dual fuel CNG vehicles, where the consumer pays an up-front premium for the vehicle but can recoup that investment by using a less expensive fuel, the regulations allow the use of utility factors to 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 40 CFR 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 a certain 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 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 requested 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. Manufacturers, who were the only commenters on this issue, commented that the current case-by-case approach is adequate, and EPA agrees. We recognize that 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. We believe it would be difficult at this time to construct regulations that adequately and generically address the use of multiple modes in GHG/MPG testing.

12. Publication of GHG Compliance Information

As was the case in the MYs 2012–2016 regulation, EPA received several comments about the need for transparency in its implementation of the greenhouse gas program and specifically about the need for public access to information about Agency compliance determinations. NRDC argued that EPA and NHTSA should publish data on each manufacturer's credit status and technology penetration on an annual basis. They suggested specific data that should be disclosed, by car and truck fleets, including the amount of cumulative credits or debits, the within-manufacturer credit transfers between car and truck fleets, air conditioning credits, use of multipliers for EVs, PHEVs, and FCVs, full size pick-up truck HEV and performance-based credits, and off-cycle technology credits. They further suggested that the Fuel Economy Trends Report and the Fuel Economy Guide and associated online database could be enhanced to include additional vehicle and technology information, by model and manufacturer. The Union of Concerned Scientists (UCS) reiterated these comments, noting that EPA should have a ''clear public accounting of credits and program compliance.'' They specifically request that data at the ''sub-model level'' be published regularly, and that such data include the following: model year, make, model/nameplate, engine family, transmission type, criteria pollutant certification levels, number of cylinders, fuel type, drive type, horsepower, footprint, GHG emissions and fuel economy test results, window label fuel economy, sales volume, sales origin, market classification, EPA classification, and whether a vehicle is using the TLAAS program standards. Like NRDC, UCS also requested enhancements to the Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends report by adding information on car/truck designations and vehicle size/footprint.

EPA remains committed to the principle of transparency and to disseminating as much information as we are reasonably and legally able to provide. Not surprisingly, manufacturers have also commented about the need to protect confidential business information, a practice to which we also remain committed. As stated in the MYs 2012–2016 final rule, EPA expects that the dissemination of GHG program data will possibly take place through the annual Fuel Economy Trends report, the annual Compliance Report, or through other means, such as online distribution through *fueleconomy.gov* or other EPA Web sites, new GHG-specific reports, or through some combination of all of these. Given that the data will be released well after the conclusion of a given model year, certain information is clearly no longer confidential business information. For example, vehicle production volumes by model type are unlikely to be treated as confidential given that essentially the same information can be purchased from sources like WardsAuto. But production volumes at a finer level of detail, such as at the subconfiguration or configuration level, could potentially be considered confidential because those volumes, which are not available elsewhere, may potentially reveal something about a manufacturer's long-term strategies. These are issues and questions that EPA expects to be addressing as we move forward with publishing our compliance data.

EPA already releases a considerable amount of information regarding fuel economy, emissions, and vehicle characteristics, both at the test level and at the model type level.[636] The downloadable model type data available at *fueleconomy.gov* will soon have CO_2 emissions values (adjusted label values and unadjusted values, similar to the MPG reporting) in addition to the 127 columns of data we already provide for each model type. However, we plan to expand what we release publicly such that more information is available regarding GHG program compliance, For example, EPA intends to publish the applicable fleet average standards (for cars and for trucks) and the actual fleet performance for each manufacturer, and the resulting credits or debits (in Megagrams, or metric tons). In addition, EPA anticipates publishing the amount of credits generated by each manufacturer (separately for each of the car and truck fleets) under the optional credit programs, and the associated volumes of vehicles to which those credits apply. EPA will also likely publish various credit transactions (transfers among fleets within a manufacturer and trades between manufacturers), as well as the total credits or debits accumulated in a model year and the resulting overall credit or debit balance, taking into account the credit and debit carry-forward provisions. EPA anticipates that the data publication will evolve over time, both as the program progresses and as our data systems adapt to the new requirements and are able to manage and report data accurately and effectively. For example, our first public release of information is likely to be a summary of the early credits generated in the 2009–2011 model years that, at least initially, may not be as comprehensive as the reporting that follows the 2012 model year.[637] EPA is currently assessing how to best release these data (both the content and the mechanism), but expects that publication will occur later this year.

F. How will this rule 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–60 shows emissions of carbon dioxide (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, in 2010 U.S. GHG emissions made up roughly 15 percent of total worldwide emissions. The contribution of direct emissions from cars and light-trucks to this U.S. share is an estimated 16 percent of U.S. emissions by 2030 in the

[636] See *http://www.epa.gov/otaq/tcldata.htm* and *http://www.fueleconomy.gov/.*

[637] Reporting of these credits was due from manufacturers at the end of March, 2012, and EPA is currently evaluating the data to ensure compliance with regulatory requirements.

absence of control (beyond the control provided by the MY 2016 GHG standards for these vehicles). 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–60—GHG EMISSIONS BY CALENDAR YEAR WITHOUT THE MY 2017–2025 STANDARDS

[$MMTCO_2eq$] [638]

	2010	2020	2030	2040	2050
All Sectors (Worldwide) [a]	45,000	53,000	61,000	69,000	76,000
All Sectors (U.S. Only) [a b]	6,800	7,300	7,600	8,000	8,100
U.S. Cars/Light Truck Only [c]	1,100	1,200	1,200	1,400	1,600

[a] Global Change Assessment Model (GCAM).[639]

[b] 2010 data is from USEPA GHG Inventory,[640] future year data is from Applied Dynamic Analysis of the Global Economy (ADAGE) model.[641]

[c] 2010 data is from USEPA GHG Inventory, future year data from OMEGA model, Tailpipe CO_2 and HFC134a only (includes impacts of MYs 2012–2016 standards).

This rule will result in significant GHG reductions as newer, cleaner vehicles come into the fleet. EPA estimates the reductions attributable to the MYs 2017–2025 standards 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.

For this rule, EPA estimates greenhouse gas 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 as a result of the credit program, (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 the light duty fleet as a result of this rule. EPA also accounted for the greenhouse gas impacts of additional vehicle miles travelled (VMT) due to the ''rebound'' effect discussed in Section III.H.

EPA has updated a number of analytic inputs for this final rule analysis, as compared to the proposal. The majority of these changes have small impacts. Two notable changes are a lower VMT projection, corresponding to a lower projection in Annual Energy Outlook (AEO) 2012 as compared to the AEO 2011 estimates used in the NPRM, and new emission factors for electricity, discussed later in this section and in EPA RIA Chapter 4. No significant comments were received on the general methods used for calculating greenhouse gas impacts, including the use of the OMEGA model. All tables in this section contain data from the analysis with the MY 2008 based future fleet projection. For the analysis containing the MY 2010 alternate future fleet projection, please see EPA RIA chapter 10.

Using this approach EPA estimates the standards will reduce annual fleetwide car and light truck vehicle GHG emissions by approximately 220 million metric tons (MMT) CO_2eq or 17 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 60 $MMTCO_2eq$ of reduced emissions are attributable to reductions in gasoline production, distribution and transport. 10 $MMTCO_2eq$ 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 will be approximately 270 $MMTCO_2$-equivalent ($MMTCO_2eq$) annually by 2030, which represents a reduction of 4% percent of total U.S. GHG emissions and 0.5% percent of total worldwide GHG emissions projected in that year. That year, these GHG emission reductions will result in savings of approximately 23 billion gallons of petroleum-based gasoline.[642]

EPA projects the total GHG reductions of the program over the full life of model year 2017–2025 vehicles to be about 1,960 $MMTCO_2eq$, with fuel savings of 160 billion gallons (3.9 billion barrels) of gasoline over the life of these vehicles.

Section III.F.1 discusses the emission inventory impacts of this rulemaking, while III.F.2 discusses the climate change impacts of GHGs. The impacts of this rule on atmospheric CO_2 concentrations, global mean surface temperature, sea level rise, and ocean pH are discussed in Section III.F.3.

1. Impact on GHG Emissions

The modeling of fuel savings and greenhouse gas emissions is substantially similar to the modeling conducted in the proposal as well as in the MYs 2012–2016 rulemaking and the MYs 2017–2025 Interim Joint Technical Assessment Report (TAR). As detailed in EPA 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 schedules derived from AEO 2012 Early Release. These estimates reflect the real-world CO_2 emissions reductions projected for the entire U.S. vehicle fleet in a specified calendar year. EPA also estimated full lifetime impacts 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 GHG emission reductions projected for model years 2017 through

[638] 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 rule. 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 or the 2014–2018 HD GHG rule. All emissions data were rounded to two significant digits.

[639] Based on the Representative Concentration Pathway scenario in GCAM available at *www.globalchange.umd.edu/gcamrcp*. See section III.F.3 and RIA Chapter 6.4 for additional information on GCAM.

[640] U.S. EPA (2012) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010. EPA 430–R–12–001. Available at *http://epa.gov/climatechange/emissions/downloads12/US-GHG-Inventory-2012-Main-Text.pdf.*

[641] 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 (*www.epa.gov/climatechange/economics/economicanalyses.html*).

[642] All estimates of fuel savings presented here assume that manufacturers use air conditioning leakage credits as part of their compliance strategy. If these credits are not used, then manufacturers would be meeting the standards via adding more fuel efficient technologies, and thus the fuel savings of the program would be larger.

2025 vehicles over their entire life. Upstream impacts from power plant emissions came from OMEGA estimates of EV/PHEV penetration into the fleet as a result of the final GHG rule (approximately 2% in MY 2025). For both calendar year and model year assessments, EPA estimated the environmental impact of the advanced technology multiplier, pickup truck hybrid electric vehicle (HEV) incentive credits, intermediate volume manufacturer provisions, and air conditioning credits. While the projected usage of off-cycle credits was quantified, their environmental impacts are not explicitly estimated, as these credits are assumed to be inherently environmentally neutral (see Section III.C). EPA also did not assess the impact of the credit banking carry-forward programs.

As in the MYs 2012–2016 rulemaking, this rule allows manufacturers to earn credits for improvements for controls of both direct and indirect AC emissions. Since these improvements are relatively low cost, EPA again projects that manufacturers will utilize these flexibilities widely, leading to additional reductions from GHG 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 (so called indirect A/C emissions). In particular, EPA estimates that direct emissions of the refrigerant HFC–134a, one of the most potent greenhouse gases, will be fully removed from light-duty vehicles through the phase-in of alternative refrigerants. More efficient air conditioning systems will 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 (i.e. have 100% refrigerant replacement, and obtain the maximum credit for control of indirect A/C emissions) by MY 2021.

Upstream greenhouse gas emission reductions associated with the production and distribution of fuel were estimated using emission factors from the Department of Energy's (DOE's) GREET1.8c model, with modifications as detailed in Chapter 4 of the RIA. These estimates include both international and domestic emission reductions, since reductions in foreign exports of finished gasoline and/or crude 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 EPA RIA.

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. For the proposal, we derived average national GHG emission factors (EFs) from the IPM version 4.10 base case run for the ''Proposed Transport Rule.[643]'' The proposal further discussed the potential consideration of emission factors other than national power generation, such as marginal power emission factors, or regional emission factors.

EPA received several comments on the use of marginal or incremental emission factors. These comments are discussed extensively in section III.C.2.a.vi, but generally favored the use of marginal power as opposed to national average during the impacts analysis. A national average EF is based on all power in U.S., including existing hydro-electric, coal, and nuclear. Some of these power sources may not be available to electric vehicles, as they are at full capacity with current demands. For this final rulemaking, EPA updated the electricity emission factor in several ways. The final rulemaking emission factors include a newer IPM version that incorporates new EPA stationary source emissions controls (such as the Mercury and Air Toxics Standards and the Cross-State Air Pollution Rule)[644] and reflects recent economic conditions. EPA also changed from a ''national average'' electricity GHG emissions factor to one that projects the average electricity GHG emissions factor for the additional electricity demand represented by the EVs and PHEVs that EPA projects will be on the road in calendar year 2030 as a result of this final, and bases the locations of these vehicles on the distribution of hybrid vehicle sales in 2006–2009. The cumulative effect of the changes is that IPM projects that about 80 percent of the electricity that will be used by EVs and PHEVs in 2030 will come from natural gas, with 15 percent from coal, and 5 percent from wind and other feedstocks. Details of this analysis can be found in EPA RIA chapter 4.7.3

a. Calendar Year Reductions for Future Years

Table III–61 shows reductions estimated from these GHG standards assuming a reference 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.

For selected years, Table III–61 contains the detailed breakdown of the sources contributing to the GHG reductions. Table III–62 contains total GHG impacts and fuel savings for all years.

TABLE III–61—PROJECTED DETAILED GHG IMPACTS FROM THE MY 2017–2025 STANDARDS

[MMTCO$_2$eq per year]

Calendar year:	2020	2030	2040	2050
Net Delta *	−27	−271	−455	−569
Net CO_2	*−23*	*−247*	*−417*	*−522*
Net other GHG	*−4*	*−25*	*−38*	*−47*
Downstream	−22	−223	−374	−467
CO_2 (excluding A/C)	*−18*	*−201*	*−341*	*−428*
A/C—indirect CO_2	*−1*	*−3*	*−4*	*−5*

[643] 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.

[644] Citations to rules.

TABLE III–61—PROJECTED DETAILED GHG IMPACTS FROM THE MY 2017–2025 STANDARDS—Continued

[MMTCO$_2$eq per year]

Calendar year:	2020	2030	2040	2050
A/C—direct HFCs	*−3*	*−19*	*−28*	*−35*
CH_4 (VMT rebound effect)	*0*	*0*	*0*	*0*
N_2O (VMT rebound effect)	*0*	*0*	*0*	*0*
Gasoline Upstream	*−5*	*−57*	*−96*	*−121*
CO_2	*−5*	*−50*	*−84*	*−105*
CH_4	*−1*	*−7*	*−12*	*−15*
N_2O	*0*	*0*	*0*	*−1*
Electricity Upstream	1	9	15	19
CO_2	*1*	*7*	*13*	*16*
CH_4	*0*	*1*	*2*	*3*
N_2O	*0*	*0*	*0*	*0*

TABLE III–62—PROJECTED ANNUAL IMPACTS FROM THE MY 2017–2025 STANDARDS

Calendar year	GHG impact (MMT CO2 Eq)	Light duty fuel consumption impact (billion gallons)	Light duty fuel consumption impact (%)
2017	−2	0	0
2018	−8	−1	0
2019	−16	−1	0
2020	−27	−2	0
2021	−43	−3	0
2022	−63	−5	0
2023	−85	−7	0
2024	−111	−9	1
2025	−140	−12	2
2026	−167	−14	3
2027	−195	−16	4
2028	−221	−19	6
2029	−247	−21	7
2030	−271	−23	9
2031	−295	−25	11
2032	−317	−27	13
2033	−338	−29	15
2034	−358	−30	16
2035	−377	−32	18
2036	−394	−34	19
2037	−411	−35	20
2038	−427	−36	21
2039	−441	−38	22
2040	−455	−39	23
2041	−468	−40	24
2042	−480	−41	25
2043	−492	−42	25
2044	−504	−43	26
2045	−515	−44	26
2046	−526	−45	26
2047	−537	−46	27
2048	−548	−47	27
2049	−558	−48	27
2050	−569	−49	27
Total 2017–2050	−10,605	−903	

The total program emission reductions yield significant emission decreases relative to worldwide and national total emissions.

TABLE III–63—PROJECTED GHG REDUCTIONS FROM THE MY 2017–2025 STANDARDS AS A PERCENTAGE OF TOTAL EMISSIONS

[MMTCO$_2$eq per year]

Emission Reduction Relative to:	2020 (percent)	2030 (percent)	2040 (percent)	2050 (percent)
Worldwide reference	−0.1	−0.4	−0.7	−0.8

TABLE III–63—PROJECTED GHG REDUCTIONS FROM THE MY 2017–2025 STANDARDS AS A PERCENTAGE OF TOTAL EMISSIONS—Continued

[MMTCO_2eq per year]

Emission Reduction Relative to:	2020 (percent)	2030 (percent)	2040 (percent)	2050 (percent)
U.S. reference (all sectors)	−0.4	−3.6	−5.7	−7.0
U.S. reference (cars + light trucks)*	−2.5	−22.6	−32.5	−35.6

* 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 will be affected by this program.[645] These results, including both upstream and downstream GHG contributions, are presented in Table III–64.

TABLE III–64—PROJECTED NET MY 2017–2025 LIFETIME GHG IMPACTS

[MMTCO_2eq per year]

MY	Downstream	Upstream (Gasoline)	Electricity	Total CO_2e
2017	−25	−6	1	−30
2018	−58	−14	2	−70
2019	−89	−21	3	−108
2020	−124	−29	4	−149
2021	−178	−43	5	−216
2022	−222	−55	7	−270
2023	−262	−66	9	−320
2024	−304	−78	11	−371
2025	−347	−90	14	−423
Total	−1,610	−402	57	−1,956

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 (i.e., the VMT rebound effect) was accounted for in our assessment of economic and environmental impacts of this rule. A 10 percent rebound case was used for this analysis, meaning that VMT for affected model years is modeled as increasing by 10 percent as much as the decrease in fuel cost per mile; i.e., a 10 percent decrease in fuel cost per mile from our standards would result in a 1 percent increase in VMT. Detailed results are shown in Table III–65. (This increase is accounted for in the GHG impacts previously presented in this section). The table below compares the GHG emissions under two different scenarios: One in which the control scenario VMT estimate is entirely insensitive to the cost of travel, and one in which the control scenario is affected by the rebound effect. RIA Chapter 4.5 includes a sensitivity analysis of GHG emissions impacts from this rule assuming higher and lower values of the VMT rebound effect.

TABLE III–65—DELTA GHG INCREASE FROM A 10% VMT REBOUND EFFECT[a]

[MMTCO_2eq per year]

CY	Downstream	Upstream gasoline	Electricity[646]	Total CO_2e
2020	2	1	0	2
2030	16	4	0	21
2040	26	7	0	34
2050	33	9	1	43

[a] These impacts are included in the reductions shown in Table III–61 through Table III–64.

d. Analysis of Alternatives

EPA analyzed four alternative standard scenarios for this rule using the MY 2008 based future fleet projection (Table III–66, Table III–67, Table III–68). EPA assumed that manufacturers would use air conditioning improvements in identical penetrations as in the primary scenario. EPA re-estimated the impact of the electric vehicle multiplier and the HEV pickup incentives under each alternative. Under these alternatives, EPA projects that the achieved fleetwide average emission levels would be 156 g/

[645] As detailed in RIA Chapter 4 and TSD Chapter 4, for this analysis the full life of the vehicle is represented by average lifetime mileages for cars (196,000 miles [MY 2017] and 206,000 miles [MY 2025]) and trucks (213,000 miles [MY 2017] and 224,000 miles [MY 2025]). These estimates are a function of how far vehicles are driven per year and scrappage rates.

[646] This assessment assumes that owners of grid-electric powered vehicles react similarly to changes in the cost of driving as owners of conventional gasoline vehicles.

mile CO_2 to 176 g/mile CO_2eq in MY 2025. As in the primary scenario, EPA assumed that the fleet complied with the standards. For full details on modeling assumptions, please refer to RIA Chapter 4.2. EPA's assessment of these alternative standards is discussed in Section III.D.6.

TABLE III–66—GHG G/MILE TARGETS OF ALTERNATIVE SCENARIOS

Title	2021 CO_2 g/mile targets			2025 CO_2 g/mile Targets		
	Cars	Trucks	Fleet	Cars	Trucks	Fleet
Primary	172	249	199	143	203	163
A—Cars +20 g/mile	192	249	212	163	203	176
B—Cars −20 g/mile	152	249	186	123	203	150
C—Trucks +20 g/mile	172	229	206	143	223	170
D—Trucks −20 g/mile	172	269	192	143	183	156

TABLE III–67—CALENDAR YEAR IMPACTS OF ALTERNATIVE SCENARIOS

Scenario	GHG delta (MMT2 CO_2eq)				Fuel savings (B. Gallons petroleum gasoline)			
	2020	2030	2040	2050	2020	2030	2040	2050
Primary	−27	−271	−455	−569	−2	−23	−39	−49
A—Cars +20 g/mile	−19	−223	−382	−480	−1	−18	−32	−40
B—Cars −20 g/mile	−34	−311	−514	−641	−3	−28	−46	−58
C—Trucks +20 g/mile	−27	−249	−420	−526	−2	−21	−36	−45
D—Trucks −20 g/mile	−36	−294	−484	−604	−3	−25	−42	−53

TABLE III–68—MODEL YEAR LIFETIME IMPACTS OF ALTERNATIVE SCENARIOS

[Summary of MY 2017–MY 2025]

	Total CO_2e (MMT)	Fuel delta (b. gal petroleum gasoline)	Fuel delta (b. barrels petroleum gasoline)
Primary	−1,956	−163	−3.9
A—Cars +20 g/mile	−1,537	−122	−2.9
B—Cars −20 g/mile	−2,314	−200	−4.8
C—Trucks +20 g/mile	−1,781	−146	−3.5
D—Trucks −20 g/mile	−2,231	−189	−4.5

2. Climate Change Impacts From GHG Emissions

The impact of GHG emissions on the climate has been reviewed in the NPRM, as well as in the MYs 2012–2016 light-duty rulemaking and the heavy-duty GHG rulemaking. See 76 FR 75096; 75 FR 25491; 76 FR 57294. This section briefly discusses again the issue of climate impacts noting the context of transportation emissions.

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 2010 (27 percent of total domestic emissions).[647]

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") [648] 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 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 that endangers

[647] U.S. EPA (2012) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010. EPA 430–R–12–001. Available at *http://epa.gov/climatechange/emissions/downloads12/US-GHG-Inventory-2012-Main-Text.pdf*.

[648] 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).

public health and welfare. 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. The D.C. Circuit recently emphatically upheld the reasonableness of all of these conclusions. See *Coalition for Responsible Regulation* v. *EPA,* (No. 09–1322, (June 26, 2012) (D.C. Circuit)) slip op. p. 30 (upholding all of EPA's findings and stating ''EPA had before it substantial record evidence that anthropogenic emissions of greenhouse gases 'very likely' caused warming of the climate over the last several decades. EPA further had evidence of current and future effects of this warming on public health and welfare. Relying again upon substantial scientific evidence, EPA determined that anthropogenically induced climate change threatens both public health and public welfare. It found that extreme weather events, changes in air quality, increases in food- and water-borne pathogens, and increases in temperatures are likely to have adverse health effects. The record also supports EPA's conclusion that climate change endangers human welfare by creating risk to food production and agriculture, forestry, energy, infrastructure, ecosystems, and wildlife. Substantial evidence further supported EPA's conclusion that the warming resulting from the greenhouse gas emissions could be expected to create risks to water resources and in general to coastal areas as a result of expected increase in sea level.'')

More recent assessments have reached 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.'' [649] 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 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 for an increase of 3 degrees C the sea level will rise 1.6 to 3.3 feet by 2100, and that coral bleaching and erosion will increase due both to warming and ocean acidification. 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 This Rule's GHG Emissions Reductions

Although ''EPA need not establish a minimum threshold of risk or harm before determining whether an air pollutant endangers'', and similarly need not condition regulation under section 202(a) ''on evidence of a particular level of mitigation''. see *Coalition for Responsible Regulation* v. *EPA* No. 09–1322, June 26, 2012 (D.C. Circuit) slip op. pp. 33, 43, EPA examined [650] 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. The analysis projects that the final rule 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

[649] National Research Council (NRC) (2010). Advancing the Science of Climate Change. National Academy Press. Washington, DC. (Docket EPA–HQ–OAR–2010–0799).

[650] 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. EPA applied the CO2SYS program to estimate the effects of this rulemaking's greenhouse gas emissions reductions on ocean acidification. Please refer to Chapter 6.4 of the RIA for additional information.

notes this would be true for any given GHG mitigation action when taken alone or when considered in isolation. See *Coalition for Responsible Regulation* v. *EPA,* No. 09–1322, June 26, 2012 (D.C. Circuit)) slip op. p 43 noting that the GHG emission reductions of the MYs 2012–2016 rule ''result in meaningful mitigation of greenhouse gas emissions''; the projected emissions reductions of this MYs 2017–2025 rule are projected to be approximately double those of the MYs 2012–2016 rule so that this rule obviously results in ''meaningful mitigation of greenhouse gas emissions'' as well. EPA also repeats 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, sea level rise, and ocean acidification are meaningful in the context of this action. The results of the analysis demonstrate that relative to the reference case, by 2100 projected atmospheric CO_2 concentrations are estimated to be reduced by 3.21 to 3.58 part per million by volume (ppmv), global mean temperature is estimated to be reduced by 0.0074 to 0.0176°C, and sea-level rise is projected to be reduced by approximately 0.071–0.159 cm, based on a range of climate sensitivities (described below). The analysis also demonstrates that ocean pH will increase by 0.0017 pH units by 2100 relative to the reference case (ie, reduced acidification).

a. Estimated Reductions in Atmospheric CO_2 Concentration, Global Mean Surface Temperatures, Sea Level Rise, and Ocean pH

As in the NPRM, 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) [651] coupled with the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC, version 5.3v2).[652] 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 non-GHG and GHG 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 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 rule.[653] The emissions reductions past calendar year 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 RIA that accompanies this final rule.

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) that are presented in the RIA Chapter 6 were not included in the calculations. 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. See 77 FR 38890, 38991–993 (June 29, 2012). 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 final standards. See generally, EPA, Response to Comments to the Endangerment Finding Vol. 9 section 9.1.6.1 [654] and the discussion of black carbon in the endangerment finding at 74 FR 66520 as well as EPA's discussion in the recent proposal to revise the PM NAAQS (77 FR 38991–993). Additionally, the magnitude of $PM_{2.5}$ emissions changes (and therefore, black carbon emission changes) related to these final standards are small in comparison to the changes in the pollutants which have been included in the MAGICC model simulations.

[651] GCAM is a long-term, global integrated assessment model of energy, economy, agriculture and land use, that considers the sources of emissions of a suite of GHG's, emitted in 14 globally disaggregated regions, the fate of emissions to the atmosphere, and the consequences of changing concentrations of greenhouse related gases for climate change. GCAM begins with a representation of demographic and economic developments in each region and combines these with assumptions about technology development to describe an internally consistent representation of energy, agriculture, land-use, and economic developments that in turn shape global emissions. Brenkert A, S. Smith, S. Kim, and H. Pitcher, 2003: Model Documentation for the MiniCAM. PNNL–14337, Pacific Northwest National Laboratory, Richland, Washington. (Docket EPA–HQ–OAR–2010–0799)

[652] 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)

[653] Due to timing constraints, this analysis was conducted with preliminary estimates of the emissions reductions projected from the final rule, which were highly similar to the final estimates presented in Chapter 4 of the RIA. For example, the final projected CO_2 emissions reductions for most years in the 2017–2050 time period were roughly one-tenth of a percent smaller than the preliminary estimates. The preliminary emissions reduction projections are available in the docket (see ''Emissions for MAGICC modeling'' in Docket EPA–HQ–OAR–2010–0799), and the files used as inputs for the MAGICC model are also available (see ''MAGICC Input File (policy)'' and ''MAGICC Input File (reference)'').

[654] See *http://epa.gov/climatechange/endangerment/comments/volume9.html#1-6-1* (last accessed August 10, 2012) or Docket EPA–HQ–OAR–2009–0171–11676.

The International Council on Clean Transportation (ICCT) and the Manufacturers of Emissions Control Association (MECA) mentioned the benefits of black carbon reductions. Since the proposed rule, EPA has recently released a Report to Congress addressing black carbon.[655] EPA continues to recognize that black carbon is an important climate forcing agent and takes very seriously the emerging science on black carbon's contribution to global climate change in general and the high rates of observed climate change in the Arctic in particular. MECA also mentioned the effects of NO_X on climate. As discussed above, changes in NO_X emissions are included as an input into the MAGICC model. However, the effects due to NO_X changes alone have not been isolated, and because NO_X emissions lead to decreased levels of methane in addition to increased levels of ozone, the net effect on climate of changes in NO_X emissions is unclear.

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 final rule, the output from the policy scenario associated with EPA's final 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.[656] 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.[657] Details about this modeling analysis can be found in the RIA Chapter 6.4.

The Institute for Energy Research (IER) argued that the climate sensitivity is likely to be below or in the low end of the range used by the EPA. However, this assertion was based on only two recent studies, while other recent studies have come to different conclusions. The EPA has relied on assessments like those of the National Academies, U.S. Global Change Research Program, and IPCC because assessments cover the full range of the literature and place the individual studies in context. In addition, one of the two specific studies relied on by IER to assert that EPA overestimated the climate sensitivity provided estimates of transient climate sensitivity. Transient sensitivity is a measure of the temperature change precisely at the time of doubling of CO_2 concentrations, before the climate system has come to equilibrium. The transient sensitivity is usually about half of the equilibrium sensitivity. Therefore, it would be premature to conclude that the range used by the EPA either under or overestimates the likely equilibrium climate sensitivity.

The results of this modeling, summarized in Table III–69, show quantified 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 final standards, relative to the reference case the atmospheric CO_2 concentration is projected by 2100 to be reduced by 3.21–3.58 ppmv, the global mean temperature is projected to be reduced by approximately 0.0074–0.0176 °C by 2100, and global mean sea level rise is projected to be reduced by approximately 0.071–0.159 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.

TABLE III–69—IMPACT OF GHG EMISSIONS REDUCTIONS ON PROJECTED CHANGES IN GLOBAL CLIMATE ASSOCIATED WITH EPA'S FINAL GHG STANDARDS FOR MYS 2017–2025

[Based on a range of climate sensitivities from 1.5–6 °C]

Variable	Units	Year	Projected change
Atmospheric CO_2 Concentration	ppmv	2100	−3.21 to −3.58
Global Mean Surface Temperature	°C	2100	−0.0074 to −0.0176
Sea Level Rise	cm	2100	−0.071 to −0.159
Ocean pH	pH units	2100	+0.0017 [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

[655] See EPA, March 2012. *Report to Congress on Black Carbon* (EPA–450/R–12–001) available at *http://epa.gov/blackcarbon/* (last accessed August 10, 2012).

[656] 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).

[657] 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).

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.[658] Further discussion of EPA's modeling analysis is found in the RIA, Chapter 6.

IER and a number of private citizens asserted that the reductions in temperature and other climate factors are too small to be meaningful. However, as has been stated, no one rule will prevent climate change by itself. As stated in the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act; final rule (74 FR at 66543), ''The commenters' approach, if used globally, would effectively lead to a tragedy of the commons, whereby no country or source category would be accountable for contributing to the global problem of climate change, and nobody would take action as the problem persists and worsens.'' [659] While this rule does not single-handedly eliminate climate change, it is an important contribution to reducing the rate of change, and this reduction in rate is global and long-lived. EPA appropriately placed the benefits of reductions in context in the rule, by calculating the likely reductions in temperature and comparing them to total projected changes in temperature over the same time period. In addition, EPA used the social cost of carbon methodology in order to estimate a monetization of the benefits of these reductions (see section III.H.6), and the net present value resulting from the CO_2 reductions due to this rule (between years 2017 and 2050) was calculated to be between tens to hundreds of billions of dollars. As noted above, the D.C. Circuit pointedly rejected the argument that EPA should refrain from issuing GHG standards under section 202(a) due to claimed lack of mitigating effect on the endangerment, and further held that ''the emission standards would result in meaningful mitigation of greenhouse gas emissions'' in the form of ''960 million metric tons of CO_2e over the lifetime of the model year 2012–2016 vehicles''. *Coalition for Responsible Regulation* v. *EPA,* No. 09–1322, (June 26, 2012) (D.C. Circuit)) slip op. p 43; projected emissions reductions of this MYs 2017–2025 rule are projected to be approximately double those of the MYs 2012–2016 rule and thus, in the D.C. Circuit's language, ''result in meaningful mitigation of greenhouse gas emissions.''

The National Wildlife Federation (NWF), Union of Concerned Scientists, American Medical Association of California, Ceres, Environmental Defense Fund, and several private citizens also discussed the importance of these standards in terms of mitigating climate risks, noting impacts to heat, ozone, extreme events, wildfires, floods, agriculture, coastal regions, droughts, and vulnerable populations. The EPA agrees that the reductions enacted in this rule are an important step towards reducing climate risks over the coming decades and centuries.

A summary of comments on climate change impacts from GHG emissions and other climate-forcing agents as well as changes in global indicators associated with GHG emissions reductions from this rule is available in sections 16.2 and 16.3 of EPA's Response to Comments document. These sections also contain EPA's more detailed responses to these comments.

EPA used the computer program CO2SYS,[660] 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 final rule.[661] 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 final rule, the program calculates an increase in ocean pH of 0.0017 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 EPA's final standards 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 RIA, 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 II–63 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 some degree of permanent climate change. Therefore, reductions in emissions in the near-term are important in determining climate impacts experienced not just over the next decades but over thousands of years.[662] Though the magnitude, in isolation, 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 this rule'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.

[658] 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)

[659] The Supreme Court likewise spoke to this issue, stating that ''[a]gencies, like legislatures, do not generally resolve massive problems'' like climate change ''in one fell regulatory swoop.'' *Massachusetts* v. *EPA,* 549 U.S. at 524. They ''whittle away at them over time.'' *Id.* The Supreme Court additionally emphasized that ''reducing domestic automobile [greenhouse gas] emissions is hardly a tentative step'' toward addressing climate change, inasmuch as ''the United States transportation sector emits an enormous quantity of carbon dioxide into the atmosphere.'' *Id.* Thus, ''[j]udged by any standard, U.S. motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations.'' *Id.* at 525.

[660] 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)

[661] Due to timing constraints, this analysis was conducted with preliminary estimates of the CO_2 emissions reductions projected from the final rule, which were highly similar to the final estimates presented in Chapter 4 of this RIA. The final projected CO_2 emissions reductions for most years in the 2017–2050 time period were roughly one-tenth of a percent smaller than the preliminary estimates. The preliminary CO_2 emissions reduction projections are available in the docket (see ''Emissions for MAGICC modeling'' in Docket EPA–HQ–OAR–2010–0799).

[662] 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)

G. How will the rule impact non-GHG emissions and their associated effects?

Although this rule focuses on GHGs, it will also have an impact on the emissions of non-GHG pollutants. Section III.G.1 of this preamble details the criteria pollutant and air toxic inventory impacts of this rule. The subsequent sections, III.G.2 and III.G.3, discuss the health and environmental effects associated with the criteria and toxic air pollutants that are being impacted by this rule. In Section III.G.4, we discuss the potential impact of this rule 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 proposal and in the MYs 2012–2016 light duty rulemaking.

1. Inventory

a. Impacts

In addition to reducing the emissions of greenhouse gases, this rule will influence ''non-GHG'' pollutants, i.e., ''criteria'' air pollutants and their precursors, and air toxics. The rule will 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–70 and Table III–71 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 the light duty fleet as a result of this rule. The GHG rule's 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–70, EPA estimates that the light duty vehicle program will result in reductions of NO_X, VOC, $PM_{2.5}$ and SO_X, but will increase CO emissions. 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.

We received several comments on the methods used to quantify emissions from advanced technology vehicles. Growth Energy commented that ''There is substantial evidence that GDI increases PM mass and PM number emissions compared to the conventional port fuel injection (PFI) technology now in widespread use * * *. Therefore, the final rule should evaluate and consider both the increased PM due to GDI use and the potential for more widespread ethanol use to decrease PM mass and number emissions.'' The Clean Fuels Development Coalition submitted similar comments. EPA agrees with the commenter that testing on initial GDI technology, primarily wall-guided systems, has shown an increase in PM emissions over the FTP as compared to conventional PFI gasoline engines. However, the technology is still evolving, making it difficult to predict future PM emission performance of GDI vehicles. Testing on initial spray-guided GDI systems has shown less of a PM increase over the FTP, and even reduced PM emissions over the USO6 compared to PFI vehicles.[663] Due to the improved fuel economy and reduced emissions offered by spray-guided GDI technology, it is anticipated that spray-guided GDI will replace wall-guided systems in the 2017 to 2025 timeframe.[664] As a result, in the technical assessment conducted by the agencies as part of this rulemaking, the agencies assessed the emissions and fuel consumption improvements associated with spray-guided GDI systems and assumed that their overall in-use PM emission performance was comparable to that of PFI vehicles.

For all criteria pollutants the overall impact of the program will be small compared to total U.S. inventories across all sectors. In 2030, EPA estimates that the program will reduce total NO_X, $PM_{2.5}$, VOC and SO_X inventories by 0.1 to 1.0 percent, while increasing the total national CO inventory by 0.4 percent.

As shown in Table III–71, EPA estimates that the program will result in similarly small changes for air toxic emissions compared to total U.S. inventories across all sectors. In 2030, EPA estimates the program will increase total 1,3-butadiene and acetaldehyde emissions by 0.1 to 0.2 percent. Total acrolein, benzene and formaldehyde emissions will decrease by similarly small amounts.

TABLE III–70—ANNUAL CRITERIA EMISSION IMPACTS OF PROGRAM

[Short tons]

	Pollutant	CY 2020		CY 2030	
		Impacts (short tons)	% of total U.S. inventory	Impacts (short tons)	% of total U.S. inventory
Total	VOC	−11,712	−0.1	−123,070	−1.0
	CO	14,164	0.0	224,875	0.4
	NO_X	−904	0.0	−6,509	−0.1
	$PM_{2.5}$	−136	0.0	−1,254	0.0
	SO_X	−1,270	0.0	−13,377	−0.2
Downstream	VOC	249	0.0	4,835	0.0
	CO	14,414	0.0	227,250	0.4
	NO_X	498	0.0	8,281	0.1
	$PM_{2.5}$	40	0.0	568	0.0

[663] ''Test Program to evaluate PM emissions from GDI vehicles,'' Memo from Michael Olechiw to EPA docket EPA–HQ–OAR–2010–0799

[664] The technology modeling for this rule includes a spray guided GDI system. See Joint TSD Section 3.3

TABLE III–70—ANNUAL CRITERIA EMISSION IMPACTS OF PROGRAM—Continued

[Short tons]

	Pollutant	CY 2020		CY 2030	
		Impacts (short tons)	% of total U.S. inventory	Impacts (short tons)	% of total U.S. inventory
	SO_X	−420	0.0	−4,498	−0.1
Fuel Production and Distribution	VOC	−12,043	−0.1	−128,823	−1.0
	CO	−749	0.0	−8,009	0.0
	NO_X	−1,757	0.0	−18,795	−0.2
	$PM_{2.5}$	−280	0.0	−3,000	−0.1
	SO_X	−1,198	0.0	−12,813	−0.2
Electricity	VOC	81	0.0	917	0.0
	CO	499	0.0	5,634	0.0
	NO_X	355	0.0	4,005	0.0
	$PM_{2.5}$	104	0.0	1,179	0.0
	SO_X	348	0.0	3,933	0.0

TABLE III–71—ANNUAL AIR TOXIC EMISSION IMPACTS OF PROGRAM

[Short tons]

	Pollutant	CY 2020		CY 2030	
		Impacts (short tons)	% of total U.S. inventory	Impacts (short tons)	% of total U.S. inventory
Total	1,3-Butadiene	1	0.0	25	0.2
	Acetaldehyde	3	0.0	57	0.1
	Acrolein	0	0.0	2	0.0
	Benzene	−16	0.0	−101	0.0
	Formaldehyde	−7	0.0	−43	0.0
Downstream	1,3-Butadiene	1	0.0	28	0.2
	Acetaldehyde	4	0.0	70	0.1
	Acrolein	0	0.0	3	0.0
	Benzene	8	0.0	160	0.1
	Formaldehyde	3	0.0	66	0.0
Fuel Production and Distribution	1,3-Butadiene	0	0.0	−2	0.0
	Acetaldehyde	−1	0.0	−14	0.0
	Acrolein	0	0.0	−2	0.0
	Benzene	−24	0.0	−261	−0.1
	Formaldehyde	−10	0.0	−110	−0.1
Electricity	1,3-Butadiene	0	0.0	0	0.0
	Acetaldehyde	0	0.0	1	0.0
	Acrolein	0	0.0	1	0.0
	Benzene	0	0.0	0	0.0
	Formaldehyde	0	0.0	1	0.0

b. Methodology

As in the MYs 2012–2016 rulemaking and in the proposal, for the downstream analysis, the current version of the EPA motor vehicle emission simulator (MOVES2010a) was used to estimate 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 rule assumes that MY 2017 and later vehicles are compliant with the agency's Tier 2 emission standards. This rule does not model any future Tier 3 emission standards, because these standards have not yet been proposed (see Section III.A).

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 rulemaking would in fact increase the fraction of the U.S. fuel supply that is made up by renewable fuels. The impacts of this increase are difficult to project at the present time. Since it is not centrally relevant to the analysis for this rulemaking, we have not included renewable fuel volumes in this analysis beyond the assumption that all gasoline is E10.

In this rulemaking EPA modeled the three impacts on criteria pollutant emissions (VMT 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.[665] 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 which are not estimated in the final rulemaking inventory 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 rule. In all, these additional analyses would likely result only 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,[666] but in some cases the GREET values were modified or updated by EPA to be consistent with the National Emission Inventory (NEI) or other relevant data.[667] EPA made several additional updates between proposal and final rulemaking to the non-GHG emission rates as discussed in chapter 4 of the RIA. 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; newer information on on-site refinery emissions from the NEI, which were significantly lower than GREET estimates; new mobile source emission factors; 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 and in RIA Chapter 4. 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 discusses revisions to these emission factors in Section III.F and in RIA chapter 4.

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 vehicle standards.

a. Particulate Matter

Particulate matter (PM) is a highly complex mixture of solid particles and liquid droplets distributed among numerous atmospheric gases which interact with solid and liquid phases. Particles range in size from those smaller than 1 nanometer (10^{-9} meter) to over 100 micrometer (µm, or 10^{-6} meter) in diameter (for reference, a typical strand of human hair is 70 um in diameter and a grain of salt is about 100 µm). Atmospheric particles can be grouped into several classes according to their aerodynamic and physical sizes, including ultrafine particles (<0.1 µm), accumulation mode or 'fine' particles (< 1 to 3 µm), and coarse particles (>1 to 3 µm). For regulatory purposes, fine particles are measured as $PM_{2.5}$ and inhalable or thoracic coarse particles are measured as $PM_{10-2.5}$, corresponding to their size (diameter) range in micrometers and referring to total particle mass under 2.5 and between 2.5 and 10 micrometers, respectively. The EPA currently has standards that measure $PM_{2.5}$ and PM_{10}.[668]

Particles span many sizes and shapes and consist of hundreds of different chemicals. Particles are emitted directly from sources and are also formed through atmospheric chemical reactions; the former are often referred to as ''primary'' particles, and the latter as ''secondary'' particles. Particle pollution also varies by time of year and location and is affected by several weather-related factors, such as temperature, clouds, humidity, and wind. A further layer of complexity comes from particles' ability to shift between solid/liquid and gaseous phases, which is influenced by concentration and meteorology, especially temperature.

Fine particles are produced primarily by combustion processes and by transformations of gaseous emissions (e.g., sulfur oxides (SO_X), 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 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.

i. 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.[669] Further discussion of health effects associated with PM can also be found in the RIA for this final rule. 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.[670]

[665] 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.

[666] 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/*.

[667] U.S. EPA. 2002 National Emissions Inventory (NEI) Data and Documentation, *http://www.epa.gov/ttn/chief/net/2002inventory.html*.

[668] 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.

[669] 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.

[670] See also 77 FR 38906–909 (proposing revisions to the primary PM NAAQS and

Continued

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.[671] 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.[672] 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 $PM_{2.5}$.[673]

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 $PM_{10-2.5}$.[674,675]

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.[676]

b. Ozone

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.

i. 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.[677,678] 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.[679] Animal toxicological evidence indicates that with repeated exposure, ozone can inflame and damage the lining of the lungs, which may lead to permanent changes in lung tissue and irreversible reductions in lung function. The respiratory effects observed in controlled human exposure studies and animal studies are coherent with the evidence from epidemiologic studies supporting a causal relationship between acute ambient ozone exposures and increased respiratory-related emergency room visits and hospitalizations in the warm season. In addition, there is suggestive evidence of a contribution of ozone to cardiovascular-related morbidity and non-accidental and cardiopulmonary mortality.

c. Nitrogen Oxides and Sulfur Oxides

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

summarizing evidence on health effects related to exposure to fine particulate matter).

[671] *See* U.S. EPA, 2009 Final PM ISA, Note 669, at Section 2.3.1.1.

[672] *See* U.S. EPA 2009 Final PM ISA, Note 669, at page 2–12, Sections 7.3.1.1 and 7.3.2.1.

[673] *See* U.S. EPA 2009 Final PM ISA, Note 669, at Section 2.3.2.

[674] *See* U.S. EPA 2009 Final PM ISA, Note 669, at Section 2.3.4, Table 2–6.

[675] See also 77 FR 38947–948 (discussing health effects related to exposure to $PM_{10-2.5}$).

[676] *See* U.S. EPA 2009 Final PM ISA, Note 669, at Section 2.3.5, Table 2–6.

[677] 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.

[678] 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.

[679] 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.

effects of ambient PM are discussed in Section III.G.2.a 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.2.b.i.

i. 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.[680] 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. Based on both short- and long-term studies, the ISA concludes that associations of NO_2 with respiratory health effects are stronger among a number of groups; these include individuals with preexisting pulmonary conditions (e.g., asthma or COPD), children and older adults. 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.

ii. 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.[681] SO_2 has long been known to cause adverse respiratory health effects, particularly among individuals with asthma. Other potentially sensitive groups include children and the elderly. During periods of elevated ventilation, asthmatics may experience symptomatic bronchoconstriction within minutes of exposure. Following an extensive evaluation of health evidence from epidemiologic and laboratory studies, the EPA has concluded that there is a causal relationship between respiratory health effects and short-term exposure to SO_2. Separately, based on an evaluation of the epidemiologic evidence of associations between short-term exposure to SO_2 and mortality, the EPA has concluded that the overall evidence is suggestive of a causal relationship between short-term exposure to SO_2 and mortality.

d. Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas emitted from combustion processes. Nationally and, particularly in urban areas, the majority of CO emissions to ambient air come from mobile sources.

i. Health Effects of CO

Information on the health effects of CO can be found in the EPA Integrated Science Assessment (ISA) for Carbon Monoxide.[682] The ISA concludes that ambient concentrations of CO are associated with a number of adverse health effects.[683] This section provides a summary of the health effects associated with exposure to ambient concentrations of CO.[684]

Human clinical studies of subjects with coronary artery disease show a decrease in the time to onset of exercise-induced angina (chest pain) and electrocardiogram changes following CO exposure. In addition, epidemiologic studies show associations between short-term CO exposure and cardiovascular morbidity, particularly increased emergency room visits and hospital admissions for coronary heart disease (including ischemic heart disease, myocardial infarction, and angina). Some epidemiologic evidence is also available for increased hospital admissions and emergency room visits for congestive heart failure and cardiovascular disease as a whole. The ISA concludes that a causal relationship is likely to exist between short-term exposures to CO and cardiovascular morbidity. It also concludes that available data are inadequate to conclude that a causal relationship exists between long-term exposures to CO and cardiovascular morbidity.

Animal studies show various neurological effects with in-utero CO exposure. Controlled human exposure studies report inconsistent neural and behavioral effects following low-level CO exposures. The ISA concludes the evidence is suggestive of a causal relationship with both short- and long-term exposure to CO and central nervous system effects.

A number of epidemiologic and animal toxicological studies cited in the ISA have evaluated associations between CO exposure and birth outcomes such as preterm birth or cardiac birth defects. The epidemiologic studies provide limited evidence of a CO-induced effect on preterm births and birth defects, with weak evidence for a decrease in birth weight. Animal toxicological studies have found associations between perinatal CO exposure and decrements in birth weight, as well as other developmental outcomes. The ISA concludes these studies are suggestive of a causal relationship between long-term exposures to CO and developmental effects and birth outcomes.

[680] 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.

[681] 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.

[682] 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

[683] 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.

[684] 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.

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 mobile source air toxics, which are compounds that are known or suspected as human or animal carcinogens, or that have noncancer health effects.[685] 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.[686] 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.[687]

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.[688,689,690] 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.[691,692]

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.[693,694] The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.[695,696] 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.[697,698,699,700] 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.[701,702] 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.[703,704] There

[685] U.S. Environmental Protection Agency (2007). Control of Hazardous Air Pollutants from Mobile Sources; final rule. 72 FR 8434, February 26, 2007.

[686] U.S. EPA. (2011) Summary of Results for the 2005 National-Scale Assessment. *www.epa.gov/ttn/atw/nata2005/05pdf/sum_results.pdf.* Docket EPA–HQ–OAR–2010–0799.

[687] U.S. EPA (2011) 2005 National-Scale Air Toxics Assessment. *http://www.epa.gov/ttn/atw/nata2005.* Docket EPA–HQ–OAR–2010–0799.

[688] 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.

[689] 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

[690] Irons, R.D.; Stillman, W.S.; Colagiovanni, D.B.; Henry, V.A. 1992. Synergistic action of the benzene metabolite hydroquinone on myelopoietic stimulating activity of granulocyte/macrophage colony-stimulating factor in vitro, Proc. Natl. Acad. Sci. 89:3691–3695. Docket EPA–HQ–OAR–2010–0799.

[691] See IARC, Note 689, above.

[692] 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

[693] Aksoy, M. (1989). Hematotoxicity and carcinogenicity of benzene. Environ. Health Perspect. 82: 193–197. Docket EPA–HQ–OAR–2010–0799.

[694] Goldstein, B.D. (1988). Benzene toxicity. Occupational medicine. State of the Art Reviews. 3: 541–554. Docket EPA–HQ–OAR–2010–0799.

[695] 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.

[696] U.S. EPA (2002) Toxicological Review of Benzene (Noncancer Effects). Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington DC. This material is available electronically at *http://www.epa.gov/iris/subst/0276.htm.* Docket EPA–HQ–OAR–2010–0799.

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[699] Lan, Qing, Zhang, L., Li, G., Vermeulen, R., et al. (2004) Hematotoxically in Workers Exposed to Low Levels of Benzene. Science 306: 1774–1776. Docket EPA–HQ–OAR–2010–0799.

[700] 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.

[701] 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.

[702] 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.

[703] International Agency for Research on Cancer (1999) Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 71, Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide and Volume 97 (in preparation), World Health Organization, Lyon, France. Docket EPA–HQ–OAR–2010–0799.

[704] U.S. Department of Health and Human Services (2005) National Toxicology Program 11th Report on Carcinogens available at:

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.[705]

iii. Formaldehyde

In 1991, EPA concluded that formaldehyde is a carcinogen based on nasal tumors in animal bioassays.[706] An Inhalation Unit Risk for cancer and a Reference Dose for oral noncancer effects were developed by the Agency and posted on the Integrated Risk Information System (IRIS) database. Since that time, the National Toxicology Program (NTP) and International Agency for Research on Cancer (IARC) have concluded that formaldehyde is a known human carcinogen.[707,708,709]

The conclusions by IARC and NTP reflect the results of epidemiologic research published since 1991 in combination with previous animal, human and mechanistic evidence. Research conducted by the National Cancer Institute reported an increased risk of nasopharyngeal cancer and specific lymphohematopoietic malignancies among workers exposed to formaldehyde.[710,711,712] A National Institute of Occupational Safety and Health study of garment workers also reported increased risk of death due to leukemia among workers exposed to formaldehyde.[713] Extended follow-up of a cohort of British chemical workers did not report evidence of an increase in nasopharyngeal or lymphohematopoietic cancers, but a continuing statistically significant excess in lung cancers was reported.[714] Finally, a study of embalmers reported formaldehyde exposures to be associated with an increased risk of myeloid leukemia but not brain cancer.[715]

Health effects of formaldehyde in addition to cancer were reviewed by the Agency for Toxics Substances and Disease Registry in 1999[716] and supplemented in 2010,[717] and by the World Health Organization.[718] These organizations reviewed the literature concerning effects on the eyes and respiratory system, the primary point of contact for inhaled formaldehyde, including sensory irritation of eyes and respiratory tract, pulmonary function, nasal histopathology, and immune system effects. In addition, research on reproductive and developmental effects and neurological effects were discussed.

EPA released a draft Toxicological Review of Formaldehyde—Inhalation Assessment through the IRIS program for peer review by the National Research Council (NRC) and public comment in June 2010.[719] The draft assessment reviewed more recent research from animal and human studies on cancer and other health effects. The NRC released their review report in April 2011[720] (*http://www.nap.edu/catalog.php?record_id=13142*). The EPA is currently revising the draft assessment in response to this review.

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.[721] 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.[722,723] 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.[724] In short-term (4 week) rat studies, degeneration of olfactory epithelium was observed at various concentration levels of acetaldehyde exposure.[725,726] Data from

ntp.niehs.nih.gov/index.cfm?objectid=32BA9724–F1F6–975E–7FCE50709CB4C932. Docket EPA–HQ–OAR–2010–0799.

[705] Bevan, C.; Stadler, J.C.; Elliot, G.S.; et al. (1996) Subchronic toxicity of 4-vinylcyclohexene in rats and mice by inhalation. Fundam. Appl. Toxicol. 32:1–10. Docket EPA–HQ–OAR–2010–0799.

[706] EPA. Integrated Risk Information System. Formaldehyde (CASRN 50–00–0) *http://www.epa.gov/iris/subst/0419/htm.*

[707] National Toxicology Program, U.S. Department of Health and Human Services (HHS), 12th Report on Carcinogens, June 10, 2011.

[708] IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 88 (2006): Formaldehyde, 2-Butoxyethanol and 1-tert-Butoxypropan-2-ol.

[709] IARC Mongraphs on the Evaluation of Carcinogenic Risks to Humans Volume 100F (2012): Formaldehyde.

[710] Hauptmann, M..; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Blair, A. 2003. Mortality from lymphohematopoetic malignancies among workers in formaldehyde industries. Journal of the National Cancer Institute 95: 1615–1623. Docket EPA–HQ–OAR–2010–0799.

[711] Hauptmann, M..; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Blair, A. 2004. Mortality from solid cancers among workers in formaldehyde industries. American Journal of Epidemiology 159: 1117–1130. Docket EPA–HQ–OAR–2010–0799.

[712] Beane Freeman, L. E.; Blair, A.; Lubin, J. H.; Stewart, P. A.; Hayes, R. B.; Hoover, R. N.; Hauptmann, M. 2009. Mortality from lymphohematopoietic malignancies among workers in formaldehyde industries: The National Cancer Institute cohort. J. National Cancer Inst. 101: 751–761. Docket EPA–HQ–OAR–2010–0799.

[713] Pinkerton, L. E. 2004. Mortality among a cohort of garment workers exposed to formaldehyde: an update. Occup. Environ. Med. 61: 193–200. Docket EPA–HQ–OAR–2010–0799.

[714] Coggon, D, EC Harris, J Poole, KT Palmer. 2003. Extended follow-up of a cohort of British chemical workers exposed to formaldehyde. J National Cancer Inst. 95:1608–1615. Docket EPA–HQ–OAR–2010–0799.

[715] Hauptmann, M,; Stewart P. A.; Lubin J. H.; Beane Freeman, L. E.; Hornung, R. W.; Herrick, R. F.; Hoover, R. N.; Fraumeni, J. F.; Hayes, R. B. 2009. Mortality from lymphohematopoietic malignancies and brain cancer among embalmers exposed to formaldehyde. Journal of the National Cancer Institute 101:1696–1708.

[716] ATSDR. 1999. Toxicological Profile for Formaldehyde, U.S. Department of Health and Human Services (HHS), July 1999.

[717] ATSDR. 2010. Supplement to the Toxicological Profile for Formaldehyde U.S. Department of Health and Human Services (HHS), October 2010.

[718] IPCS. 2002. Concise International Chemical Assessment Document 40. Formaldehyde. World Health Organization.

[719] EPA (U.S. Environmental Protection Agency). 2010. Toxicological Review of Formaldehyde (CAS No. 50–00–0)—Inhalation Assessment: In Support of Summary Information on the Integrated Risk Information System (IRIS). External Review Draft. EPA/635/R–10/002A. U.S. Environmental Protection Agency, Washington DC [online]. Available: *http://cfpub.epa.gov/ncea/irs_drats/recordisplay.cfm?deid=223614.*

[720] NRC (National Research Council). 2011. Review of the Environmental Protection Agency's Draft IRIS Assessment of Formaldehyde. Washington DC: National Academies Press.

[721] U.S. EPA. 1991. Integrated Risk Information System File of Acetaldehyde. Research and Development, National Center for Environmental Assessment, Washington, DC. *Available at http://www.epa.gov/iris/subst/0290.htm.* Docket EPA–HQ–OAR–2010–0799.

[722] U.S. Department of Health and Human Services National Toxicology Program 11th Report on Carcinogens available at: *ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932.* Docket EPA–HQ–OAR–2010–0799.

[723] 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.

[724] *See* Integrated Risk Information System File of Acetaldehyde, Note 721, above.

[725] 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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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.[727] The agency is currently conducting a reassessment of the health hazards from inhalation exposure to acetaldehyde.

v. Acrolein

Acrolein is extremely acrid and irritating to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation, mucus hypersecretion and congestion. The intense irritancy of this carbonyl has been demonstrated during controlled tests in human subjects, who suffer intolerable eye and nasal mucosal sensory reactions within minutes of exposure.[728] 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.[729] 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.[730] Lesions to the lungs and upper respiratory tract of rats, rabbits, and hamsters have been observed after subchronic exposure to acrolein.[731] Acute exposure effects in animal studies report bronchial hyper-responsiveness.[732] 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.[733] 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.[734] The IARC determined in 1995 that acrolein was not classifiable as to its carcinogenicity in humans.[735]

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.[736,737] 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.[738] 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.[739] 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).[740,741] These and similar studies are being evaluated as a part of the ongoing IRIS assessment of health effects associated with exposure to benzo[a]pyrene.

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. Acute (short-term) exposure of humans to naphthalene by inhalation, ingestion, or dermal contact is associated with hemolytic anemia and damage to the liver and the nervous system.[742] Chronic (long term) exposure of workers and rodents to naphthalene has been reported to cause cataracts and retinal

726 Appleman, L.M., R.A. Woutersen, and V.J. Feron. 1982. Inhalation toxicity of acetaldehyde in rats. I. Acute and subacute studies. *Toxicology.* 23: 293–297. Docket EPA–HQ–OAR–2010–0799.

727 Myou, S.; Fujimura, M.; Nishi K.; Ohka, T.; and Matsuda, T. 1993. Aerosolized acetaldehyde induces histamine-mediated bronchoconstriction in asthmatics. *Am. Rev. Respir.Dis.*148(4 Pt 1): 940–3. Docket EPA–HQ–OAR–2010–0799.

728 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.

729 *See* U.S. EPA 2003 Toxicological review of acrolein, Note 728, above.

730 *See* U.S. EPA 2003 Toxicological review of acrolein, Note 728, at p. 11.

731 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.

732 *See* U.S. 2003 Toxicological review of acrolein, Note 728, at p. 15.

733 Morris JB, Symanowicz PT, Olsen JE, et al. 2003. Immediate sensory nerve-mediated respiratory responses to irritants in healthy and allergic airway-diseased mice. J Appl Physiol 94(4):1563–1571. Docket EPA–HQ–OAR–2010–0799.

734 U.S. EPA. 2003. Integrated Risk Information System File of Acrolein. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available at *http://www.epa.gov/iris/subst/0364.htm.* Docket EPA–HQ–OAR–2010–0799.

735 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.

736 Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for Polycyclic Aromatic Hydrocarbons (PAHs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available electronically at *http://www.atsdr.cdc.gov/ToxProfiles/TP.asp?id=122&tid=25.*

737 U.S. EPA (2002). *Health Assessment Document for Diesel Engine Exhaust.* EPA/600/8–90/057F Office of Research and Development, Washington DC. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060.* Docket EPA–HQ–OAR–2010–0799.

738 International Agency for Research on Cancer (IARC). (2012). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans, Chemical Agents and Related Occupations. Vol. 100F. Lyon, France.

739 U.S. EPA (1997). Integrated Risk Information System File of indeno(1,2,3-cd)pyrene. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/ncea/iris/subst/0457.htm.*

740 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.

741 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.

742 U.S. EPA. 1998. Toxicological Review of Naphthalene (Reassessment of the Inhalation Cancer Risk), Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0436.htm.*

damage.[743] EPA released an external review draft of a reassessment of the inhalation carcinogenicity of naphthalene based on a number of recent animal carcinogenicity studies.[744] The draft reassessment completed external peer review.[745] Based on external peer review comments received, a revised draft assessment that considers all routes of exposure, as well as cancer and noncancer effects, is under development. The external review draft does not represent official agency opinion and was released solely for the purposes of external peer review and public comment. The National Toxicology Program listed naphthalene as ''reasonably anticipated to be a human carcinogen'' in 2004 on the basis of bioassays reporting clear evidence of carcinogenicity in rats and some evidence of carcinogenicity in mice.[746] 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.[747] Naphthalene also causes a number of chronic non-cancer effects in animals, including abnormal cell changes and growth in respiratory and nasal tissues.[748]

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 rule. Mobile source air toxic compounds that would potentially be impacted include ethylbenzene, propionaldehyde, toluene, and xylene. Information regarding the health effects of these compounds can be found in EPA's IRIS database.[749]

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.[750] 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.[751] 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.[752] 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.[753]

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.[754]

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.[755]

[743] U.S. EPA. 1998. Toxicological Review of Naphthalene (Reassessment of the Inhalation Cancer Risk), Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0436.htm.*

[744] U.S. EPA. 1998. Toxicological Review of Naphthalene (Reassessment of the Inhalation Cancer Risk), Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0436.htm.* Docket EPA–HQ–OAR–2010–0799.

[745] Oak Ridge Institute for Science and Education. (2004). External Peer Review for the IRIS Reassessment of the Inhalation Carcinogenicity of Naphthalene. August 2004. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=84403.* Docket EPA–HQ–OAR–2010–0799.

[746] 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.*

[747] International Agency for Research on Cancer (IARC). (2002). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans. Vol. 82. Lyon, France. Docket EPA–HQ–OAR–2010–0799.

[748] U.S. EPA. 1998. Toxicological Review of Naphthalene, Environmental Protection Agency, Integrated Risk Information System, Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *http://www.epa.gov/iris/subst/0436.htm.*

[749] U.S. EPA Integrated Risk Information System (IRIS) database is available at: *www.epa.gov/iris.*

[750] 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.

[751] HEI Panel on the Health Effects of Air Pollution. (2010) Traffic-related air pollution: a critical review of the literature on emissions, exposure, and health effects. [Online at *www.healtheffects.org*] Docket EPA–HQ–OAR–2010–0799.

[752] Salam, M.T.; Islam, T.; Gilliland, F.D. (2008) Recent evidence for adverse effects of residential proximity to traffic sources on asthma. Current Opin Pulm Med 14: 3–8. Docket EPA–HQ–OAR–2010–0799.

[753] Holguin, F. (2008) Traffic, outdoor air pollution, and asthma. Immunol Allergy Clinics North Am 28: 577–588. Docket EPA–HQ–OAR–2010–0799.

[754] 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.

[755] Raaschou-Nielsen, O.; Reynolds, P. (2006) Air pollution and childhood cancer: A review of the

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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.[756] 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.[757,758,759]

Students may also be exposed in situations where schools are located near major roads. In a study of nine metropolitan areas across the United States, Appatova et al. (2008) found that on average greater than 33% of schools were located within 400 m of an Interstate, U.S., or state highway, while 12% were located within 100 m.[760] 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.[761,762,763] 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.[760]

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.[764] Visibility impairment is caused by light scattering and absorption by suspended particles and gases. Visibility is important because it has direct significance to people's enjoyment of daily activities in all parts of the country. Individuals value good visibility for the well-being it provides them directly, where they live and work, and in places where they enjoy recreational opportunities. Visibility is also highly valued in significant natural areas, such as national parks and wilderness areas, and special emphasis is given to protecting visibility in these areas. For more information on visibility see the final 2009 PM ISA.[765]

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 by the DC Circuit and EPA has proposed to revise the suite of secondary PM standards by adding a distinct standard for $PM_{2.5}$ to address PM-related visibility impairment.[766]

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

epidemiological literature. Int J Cancer 118: 2920–2929. Docket EPA–HQ–OAR–2010–0799.

[756] 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.

[757] Lena, T.S.; Ochieng, V.; Carter, M.; Holguín-Veras, J.; Kinney, P.L. (2002) Elemental carbon and $PM_{2.5}$ levels in an urban community heavily impacted by truck traffic. Environ Health Perspect 110: 1009–1015. Docket EPA–HQ–OAR–2010–0799.

[758] 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.

[759] 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.

[760] 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.

[761] 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.

[762] 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.

[763] 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.

[764] 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/.*

[765] *See* U.S. EPA 2009 Final PM ISA, Note 669.

[766] See *American Farm Bureau* v. *EPA,* 559 F. 3d 512, 528–32 (DC Cir. 2009) (remanding secondary NAAQS) and 77 FR 38979–991 (proposing distinct secondary standard for $PM_{2.5}$ to address visibility impairment).

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.[767]

Adverse impacts on water quality can occur when atmospheric contaminants deposit to the water surface or when material deposited on the land enters a waterbody through runoff. Potential impacts of atmospheric deposition to waterbodies include those related to both nutrient and toxic inputs. Adverse effects to human health and welfare can occur from the addition of excess nitrogen via atmospheric deposition. The nitrogen-nutrient enrichment contributes to toxic algae blooms and zones of depleted oxygen, which can lead to fish kills, frequently in coastal waters. Deposition of heavy metals or other toxics may lead to the human ingestion of contaminated fish, impairment of drinking water, damage to 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.[768,769,770,771,772]

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 6.1.2.3.1 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.[773] In laboratory experiments, a wide range of tolerance to VOCs has been observed.[774] 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

[767] 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.

[768] 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.

[769] Gao, Y., E.D. Nelson, M.P. Field, et al. 2002. Characterization of atmospheric trace elements on $PM_{2.5}$ particulate matter over the New York-New Jersey harbor estuary. *Atmos. Environ.* 36: 1077–1086. Docket EPA–HQ–OAR–2010–0799.

[770] 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.

[771] 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.

[772] 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.

[773] 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.

[774] 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.

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.[775]

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.[776,777,778] 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

Air quality modeling was performed to assess the impact of the vehicle standards on criteria and air toxic pollutants. In this section, we present information on current levels of pollution as well as projections for 2030, with respect to ambient $PM_{2.5}$, ozone, selected air toxics, visibility levels and nitrogen and sulfur deposition. The results are discussed in more detail in Section 6.2.2 of the RIA.

a. Ozone

i. Current Levels

Concentrations that exceed the level of the ozone NAAQS occur in many parts of the country. The primary and secondary NAAQS for ozone are 8-hour standards with a level of 0.075 ppm. The most recent revision to the ozone standards was in 2008; the previous 8-hour ozone standards, set in 1997, had a level of 0.08 ppm. In 2004, the U.S. EPA designated nonattainment areas for the 1997 8-hour ozone NAAQS.[779,780] As of July 20, 2012, there were 43 ozone nonattainment areas for the 1997 ozone NAAQS composed of 237 full or partial counties, with a total population of over 129 million. Nonattainment designations for the 2008 ozone standards were finalized on April 30, 2012 and May 31, 2012.[781] These designations include 46 areas, composed of 227 full or partial counties, with a population of over 123 million. As of July 20, 2012, 140 million people are living in ozone nonattainment areas.

ii. Projected Levels Without the Vehicle Standards

States with ozone nonattainment areas are required to take action to bring those areas into attainment. The attainment date assigned to an ozone nonattainment area is based on the area's classification. Most ozone nonattainment areas are required to attain the 1997 8-hour ozone NAAQS in the 2007 to 2013 time frame and attainment dates for the 2008 8-hour ozone NAAQS are in the 2015 to 2032 timeframe.[782] Once an ozone nonattainment area has attained the NAAQS they are then required to maintain it thereafter.

EPA has already adopted many emission control programs that are expected to reduce ambient ozone levels. As a result of these and other federal, state and local programs, 8-hour ozone levels are expected to improve in the future. Even so, our air quality modeling projects that in 2030, with all current controls but excluding the impacts of the vehicle standards, up to 10 counties with a population of over 30 million would have projected design values above the level of the 2008 ozone standard of 0.075 ppm (75 ppb). These numbers do not account for those areas that are close to (e.g., within 10 percent of) the 2008 ozone standard. These areas, although not above the standards, will also be impacted by changes in ozone concentrations as they work to ensure long-term maintenance of the ozone NAAQS.

iii. Projected Levels With the Vehicle Standards

Our modeling indicates that there will be very small changes in ambient ozone concentrations across most of the country. However, there will be small decreases in ozone design value concentrations in some areas of the country and small increases in ozone design value concentrations in other areas.[783] The increases in ozone design values are likely due mainly to the VMT rebound effect in some places and in other places are likely due mainly to increased electricity generation. The ozone decreases are likely due mainly to changes in the location of EGUs, or power plants, in some places and in other places are likely due mainly to reduced fuel production. The average modeled 8-hour ozone design values are projected to increase by 0.01 ppb in 2030 and the design values for those counties that are projected to be above the 2008 ozone standard in 2030 will decrease by 0.14 ppb due to the vehicle standards.

b. Particulate Matter

i. Current Levels

There are many areas of the country that are currently in nonattainment for the $PM_{2.5}$ NAAQS. There are two NAAQS for $PM_{2.5}$: An annual standard (15 micrograms per cubic meter (μg/m^3) and a 24-hour standard (35 μg/m^3). The most recent revisions to these standards were in 1997 and 2006. In June 2012, EPA proposed to revise the $PM_{2.5}$ NAAQS and is scheduled to issue final revisions in December 2012 under a court-ordered schedule. The proposed changes include revising the annual $PM_{2.5}$ standard to a level between 12 and 13 μg/m^3, and establishing a distinct secondary $PM_{2.5}$ standard for the protection of visibility, particularly in urban areas.

In 2005 EPA designated nonattainment areas for the 1997 $PM_{2.5}$ NAAQS.[784] As of July 20, 2012, over 91 million people lived in the 35 areas that are designated as nonattainment for the 1997 $PM_{2.5}$ NAAQS. These $PM_{2.5}$ nonattainment areas are comprised of 191 full or partial counties. On October 8, 2009, the EPA issued final nonattainment area designations for the 2006 24-hour $PM_{2.5}$ NAAQS.[785] These designations include 32 areas,

[775] 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.

[776] 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.

[777] 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.

[778] 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.

[779] 69 FR 23858 (April 30, 2004).

[780] A nonattainment area is defined in the Clean Air Act (CAA) as an area that is violating an ambient standard or is contributing to a nearby area that is violating the standard.

[781] 77FR 30088 (May 21, 2012).

[782] The Los Angeles South Coast Air Basin 8-hour ozone nonattainment area and the San Joaquin Valley Air Basin 8-hour ozone nonattainment area are designated as extreme and will have to attain before June 15, 2024. The Sacramento, Coachella Valley, Western Mojave and Houston 8-hour ozone nonattainment areas are designated as severe and will have to attain by June 15, 2019.

[783] An 8-hour ozone design value is the concentration that determines whether a monitoring site meets the 8-hour ozone NAAQS. The full details involved in calculating an 8-hour ozone design value are given in appendix I of 40 CFR part 50.

[784] 70 FR 19844 (April 14, 2005).

[785] 74 FR 58688 (November 13, 2009).

composed of 121 full or partial counties, with a population of over 70 million. In total, there are 50 $PM_{2.5}$ nonattainment areas with a population of over 105 million people.[786]

ii. Projected Levels Without the Vehicle Standards

States with $PM_{2.5}$ nonattainment areas will be required to take action to bring those areas into attainment in the future. The 1997 $PM_{2.5}$ nonattainment areas are required to attain the 1997 $PM_{2.5}$ NAAQS in the 2010 to 2015 time frame and then maintain it thereafter. The 2006 24-hour $PM_{2.5}$ nonattainment areas are required to attain the 2006 24-hour $PM_{2.5}$ NAAQS in the 2014 to 2019 time frame and then maintain it thereafter.[787]

EPA has already adopted many mobile source emission control programs that are expected to reduce ambient PM levels. As a result of these and other federal, state and local programs, the number of areas that fail to meet the $PM_{2.5}$ NAAQS in the future is expected to decrease. Even so, our air quality modeling projects that in 2030, with all current controls but excluding the impacts of the vehicle standards adopted here, at least 4 counties with a population of almost 7 million would have projected design values above the level of the 1997 annual $PM_{2.5}$ standard of 15 $\mu g/m^3$ and 21 counties with a population of over 31 million would have projected design values above the level of the 2006 24-hour $PM_{2.5}$ standard of 35 $\mu g/m^3$. These numbers do not account for those areas that are close to (e.g., within 10 percent of) the $PM_{2.5}$ standards. These areas, although not above the standards, will also be impacted by any changes in $PM_{2.5}$ concentrations as they work to ensure long-term maintenance of the $PM_{2.5}$ NAAQS.

iii. Projected Levels With the Vehicle Standards

Our modeling indicates that there will be very small changes in ambient $PM_{2.5}$ concentrations across most of the country. However, there will be small decreases in $PM_{2.5}$ design value concentrations in some areas of the country and small increases in $PM_{2.5}$ design value concentrations in other areas.[788] The decreases in $PM_{2.5}$ design values for some counties are likely due to emission reductions related to lower fuel production and the increases are likely due to increased emissions from the VMT rebound effect or increased electricity generation.

c. Air Toxics

i. Current Levels

The majority of Americans continue to be exposed to ambient concentrations of air toxics at levels which have the potential to cause adverse health effects.[789] 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 2007 Mobile Source Air Toxics Rule.[790] According to the National Air Toxic Assessment (NATA) for 2005,[791] mobile sources were responsible for 43 percent of outdoor toxic emissions and over 50 percent of the cancer risk and noncancer hazard associated with primary emissions. Mobile sources are also large contributors to precursor emissions which react to form secondary concentrations of air toxics. Formaldehyde is the largest contributor to cancer risk of all 80 pollutants quantitatively assessed in the 2005 NATA. Mobile sources were responsible for over 40 percent of primary emissions of this pollutant in 2005, and are major contributors to formaldehyde precursor emissions. Benzene is also a large contributor to cancer risk, and mobile sources account for over 70 percent of ambient exposure. Over the years, EPA has implemented a number of mobile source and fuel controls which have resulted in VOC reductions, which also reduced formaldehyde, benzene and other air toxic emissions.

ii. Projected Levels

Our modeling indicates that national average ambient concentrations of the modeled air toxics change less than 1 percent across most of the country due to the final standards. Additional detail on the air toxics results can be found in Section 6.2.2.3 of the RIA.

d. Nitrogen and Sulfur Deposition

i. Current Nitrogen and Sulfur Deposition Levels

Over the past two decades, the EPA has undertaken numerous efforts to reduce nitrogen and sulfur deposition across the U.S. Analyses of long-term monitoring data for the U.S. show that deposition of both nitrogen and sulfur compounds has decreased over the last 17 years. The data show that reductions were more substantial for sulfur compounds than for nitrogen compounds. In the eastern U.S., where data are most abundant, total sulfur deposition decreased by about 44 percent between 1990 and 2007, while total nitrogen deposition decreased by 25 percent over the same time frame.[792] These numbers are generated by the U.S. national monitoring network and they likely underestimate nitrogen deposition because neither ammonia nor organic nitrogen is measured. Although total nitrogen and sulfur deposition has decreased over time, many areas continue to be negatively impacted by deposition. Deposition of inorganic nitrogen and sulfur species routinely measured in the U.S. between 2005 and 2007 were as high as 9.6 kilograms of nitrogen per hectare (kg N/ha) averaged over three years and 20.8 kilograms of sulfur per hectare (kg S/ha) averaged over three years.[793]

ii. Projected Nitrogen and Sulfur Deposition Levels

Our air quality modeling projects increases in nitrogen deposition in some localized areas across the U.S. along with a few areas of decreases in nitrogen deposition as a result of the GHG standards. The increases in nitrogen deposition are likely due to projected upstream emissions increases in NO_X from increased electricity generation and increased driving due to the VMT rebound effect. The decreases in nitrogen deposition are likely due to projected upstream emissions decreases in NO_X from changes in the location of electricity generation. The remainder of

[786] Data come from Summary Nonattainment Area Population Exposure Report, current as of July 20, 2012 at: *http://www.epa.gov/oar/oaqps/greenbk/popexp.html* and contained in Docket EPA–HQ–OAR–2010–0799.

[787] U.S. EPA. (2011). PM Standards Revision—2006: Timeline. Available at *http://www.epa.gov/PM/naaqsrev2006.html#timeline*. Accessed December 31, 2011.

[788] An annual $PM_{2.5}$ design value is the concentration that determines whether a monitoring site meets the annual NAAQS for $PM_{2.5}$. The full details involved in calculating an annual $PM_{2.5}$ design value are given in appendix N of 40 CFR part 50. A 24-hour $PM_{2.5}$ design value is the concentration that determines whether a monitoring site meets the 24-hour NAAQS for $PM_{2.5}$. The full details involved in calculating a 24-hour $PM_{2.5}$ design value are given in appendix N of 40 CFR part 50.

[789] U.S. Environmental Protection Agency (2007). Control of Hazardous Air Pollutants from Mobile Sources; final rule. 72 FR 8434, February 26, 2007.

[790] U.S. Environmental Protection Agency (2007). Control of Hazardous Air Pollutants from Mobile Sources; final rule. 72 FR 8434, February 26, 2007.

[791] U.S. EPA. (2011). 2005 National-Scale Air Toxics Assessment. *http://www.epa.gov/ttn/atw/nata2005/*.

[792] U.S. EPA. (2012). U.S. EPA's Report on the Environment. Data accessed online February 15, 2012 at: *http://cfpub.epa.gov/eroe/index.cfm?fuseaction=detail.viewPDF&ch=46&lShowInd=0&subtop=341&lv=list.listByChapter&r=216610* and contained in Docket EPA–HQ–OAR–2010–0799.

[793] U.S. EPA. (2012). U.S. EPA's Report on the Environment. Data accessed online February 15, 2012 at: *http://cfpub.epa.gov/eroe/index.cfm?fuseaction=detail.viewPDF&ch=46&lShowInd=0&subtop=341&lv=list.listByChapter&r=216610* and contained in Docket EPA–HQ–OAR–2010–0799.

the country will experience only minimal changes in nitrogen deposition, ranging from decreases of less than 0.5% to increases of less than 0.5%.

Our air quality modeling also projects both increases and decreases in sulfur deposition as a result of the GHG standards. The decreases in sulfur deposition are likely due to projected upstream emissions decreases from changes in the location of electricity generation and from reduced gasoline production. The increases in sulfur deposition are likely due to projected upstream emissions increases from increased electricity generation. The remainder of the country will experience only minimal changes in sulfur deposition, ranging from decreases of less than 0.5% to increases of less than 0.5%.

For maps of 2030 deposition impacts and additional information on these impacts see Section 6.2.2.4 of the RIA.

e. Visibility

i. Current Visibility Levels

As mentioned in Section III.G.4.i, millions of people live in nonattainment areas for the $PM_{2.5}$ NAAQS. These populations, as well as large numbers of individuals who travel to these areas, are likely to experience visibility impairment. In addition, while visibility trends have improved in mandatory class I federal areas, the most recent data show that these areas continue to suffer from visibility impairment. In summary, visibility impairment is experienced throughout the U.S., in multi-state regions, urban areas, and remote mandatory class I federal areas.

ii. Projected Visibility Levels

Air quality modeling was used to project visibility conditions in 139 mandatory class I federal areas across the U.S. The results show that in 2030 all the modeled areas would continue to have annual average deciview levels above background.[794] Overall the vehicle standards will have a very small impact on visibility. The average visibility at all modeled mandatory class I federal areas on the 20 percent worst days is projected to improve by 0.003 deciviews, or 0.03 percent, in 2030. Section 6.2.2.5 of the RIA contains more detail on the visibility portion of the air quality modeling.

5. Other Unquantified Health and Environmental Effects

In the NPRM, EPA sought comment on whether there are any other health and environmental impacts associated with advancements in vehicle GHG reduction technologies that the agency should consider. In particular, EPA requested information on studies or research underway on a vehicle's life-cycle impacts (e.g., materials usage, manufacturing, end of life disposal) beyond issues regarding fuel production and distribution (upstream) discussed in Section III.C.[795]

EPA received a mix of comments on this topic, many highlighting recent or upcoming studies including new research from the University of California, Davis and the University of Michigan. Some commenters argued that EPA should base future GHG standards on life-cycle emissions in order to avoid favoring technologies that have lower emissions during operation or the ''use phase,'' but higher total greenhouse gas emissions when production and other stages of a vehicle's life are considered. For example, several organizations from the steel industry recommended that EPA and NHTSA consider incorporating life-cycle assessment into vehicle regulations as part of the 2018 mid-term evaluation and outlined one potential framework for establishing such life-cycle based standards.

Other commenters agreed with the agencies' proposal not to consider life-cycle impacts as part of the standards, arguing that life-cycle analysis (LCA) is beyond the intended scope of the rulemaking and that regulating emissions from vehicle operation addresses the majority of GHG emissions. The American Chemistry Council also noted, ''Further, this type of rulemaking is not an appropriate place to apply LCA because of the lack of consensus regarding how to calculate inputs and outputs in an LCA evaluation at this time.''

EPA is glad to see the advances in research on this important topic and plans to monitor new work in this area. However, the agency continues to believe that, as of the time of this rulemaking, there is too much uncertainty about the life-cycle impacts of future advanced technologies to conduct the type of detailed, vehicle-specific assessments that would be needed in a regulatory context. See the EPA Response to Comments document for a more detailed discussion on this topic and a fuller summary of comments received.[796]

H. What are the estimated cost, economic, and other impacts of the rule?

In this section, EPA presents the costs and impacts of the 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 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

[794] The level of visibility impairment in an area is based on the light-extinction coefficient and a unitless visibility index, called a ''deciview'', which is used in the valuation of visibility. The deciview metric provides a scale for perceived visual changes over the entire range of conditions, from clear to hazy. Under many scenic conditions, the average person can generally perceive a change of one deciview. The higher the deciview value, the worse the visibility. Thus, an improvement in visibility is a decrease in deciview value.

[795] See 76 FR 75112.

[796] Also, see Ch. 6 of NHTSA's Environmental Impact Statement for this rulemaking, ''Literature Synthesis of Life-cycle Environmental Impacts of Certain Vehicle Materials and Technologies,'' Docket No. NHTSA–2011–0056. The range of different models and approaches utilized in the surveyed LCA studies, and the sensitivity of the results to study assumptions, demonstrate the challenge of developing a fair and robust method to evaluate life-cycle impacts across a range of different vehicle technologies at this time.

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 rule consist of the effects of the standards on:

- The vehicle costs;
- Fuel savings associated with reduced fuel usage resulting from the 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 VMT ''rebound'' effect.

EPA also presents the cost per ton of GHG reductions associated with the 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 standards are projected to be between $257 to $743 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 standards are projected to be between $118 to $604 billion, depending on the value used for the social cost of carbon. These benefits are summarized below in Table 103. The present value in 2012 of technology and maintenance costs of the standards are estimated to be between $247 to $561 billion for new vehicle technology (assuming a 7 and 3 percent discount rate, respectively, and costs through 2050), less $607 to $1,600 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, and fuel savings through 2050). These costs are summarized below in Table III–101 and the fuel savings are summarized in Table III–102. The total net present value of net benefits under the standards are projected to be between $1,290 and $1,780 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 net present value of net benefits under the standards are projected to be between $478 billion to $964 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 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 rule, 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, VMT 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 RIA. 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. EPA has also analyzed the potential impact of this rule on vehicle sales and employment. These impacts are not included in the analysis of overall costs and benefits of the standards. Further information on these and other aspects of the economic impacts of EPA's rule are summarized in the following sections and are presented in more detail in the RIA for this rulemaking.

1. Conceptual Framework for Evaluating Consumer Impacts

For this rule, EPA projects significant private gains to consumers in three major areas: (1) reductions in spending on fuel; (2) for gasoline-fueled vehicles, time saved due to less refueling; and (3) additional driving that results from the VMT 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 changes in the vehicles. Because conventional gasoline- and diesel-fueled vehicles have quite different characteristics from alternatively fueled 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 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.5). 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, which would reduce the benefits consumers receive from their vehicles.

We sought comments that identify any such changed qualities omitted from the analysis. Some comments asserted that these costs must exist, because it is implausible that the market would otherwise not provide all the cost-effective fuel savings found in the rule. In the absence of identified impacts, though, the conundrum remains. A number of comments discussed consumer acceptance of the vehicles that will be built in response to this rule; some expressed worry that people would not want them, and that they will find their choices of vehicles limited; others expressed confidence that people will want more fuel-efficient vehicles and note the increase in choices that will be available to consumers. We note that the footprint-based standards are intended to preserve the current range of choice of vehicles, and the costs of the rule take into account the costs of preserving the current attributes of those vehicles (see RIA Chapter 1.3). Some comments suggested that auto makers would substitute improvements in fuel economy for improvements in other vehicle attributes, such as power. Though that tradeoff may be true for a given engine or vehicle cost, those comments do not take into account that it is possible to have improvements in both fuel economy and other attributes through applications of additional technologies. Those combinations would increase vehicle costs. The costs of this rule have been estimated for vehicles with maintained power, size, and other attributes. Because increases in power or changes in other vehicle attributes are voluntary design choices by auto makers, we have not included the costs of those changes in the rule. If those changes would have taken place in the absence of the rule, and if those changes would be more expensive for vehicles with increased fuel economy, then there may be some incremental costs of these technologies not accounted for in the rule—the difference in cost, for instance, for greater power with and without higher fuel economy. In the absence of data to estimate this effect, we rely on our cost estimates based on holding those other attributes constant.

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).[797] There are many possible reasons discussed in academic research why this might occur: [798]

- 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''—that is, selecting a vehicle that is acceptable rather than optimal—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.
- When buying vehicles, consumers may focus on visible attributes that convey status, such as size, and pay less attention to attributes such as fuel economy that do not visibly convey status.
- 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.[799]

A great deal of work in behavioral economics identifies and elaborates factors of this sort, which help account for the Energy Paradox.[800] This paradox is found 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 MYs 2012–2016 light duty rulemaking and in the medium- and heavy-duty greenhouse gas rulemaking (see 75 FR 25510–13; 76 FR 57315–19), as well in as the NPRM and in RIA Chapter 8.1.2.6. 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. 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.[801] A review commissioned by EPA finds great variability in estimates of the role of fuel economy in consumers' vehicle purchase decisions.[802] 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 this value from the literature. Thus, estimating consumer response to higher vehicle fuel economy is still unsettled science.

EPA requested and received a number of comments discussing the role of the Energy Paradox in consumer vehicle

[797] 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–2010–0799–0651.

[798] 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–2010–0799–0652.

[799] 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.

[800] 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–2010–0799–0651.

[801] 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–2010–0799–0652).

[802] Greene, David L. ''How Consumers Value Fuel Economy: A Literature Review.'' EPA Report EPA–420–R–10–008, March 2010 (Docket EPA–HQ–OAR–2010–0799–0711).

purchase decisions. Some comments argued that it is possible that consumers rationally discount higher than the 3 and 7 percent rates used in this rulemaking, because of uncertainty and volatility related to fuel savings; those comments recommend that those higher rates should be used in estimating the value of the fuel savings achieved by the rule. Other comments support the use of 3 and 7 percent as the discount rates in our analysis of fuel savings as representing the opportunity costs of capital. We note that the high discount rates affect how consumers think about fuel savings in the course of buying a vehicle, and thus may affect vehicle sales (see Section III.H.11), but do not represent the social opportunity costs of capital that the discount rate is intended to reflect; we thus continue our use of 3 and 7 percent as the discount rates for fuel savings in the benefit-cost analysis. Other arguments state that it is unprofitable for manufacturers to make vehicles with better fuel economy and the vehicle attributes that consumers desire, because consumers are unwilling to pay for the fuel-saving technologies; if there are profit-making opportunities, EPA has not explained why auto makers have not pursued them. These arguments, which do not come with data or references to support them, serve to reinforce the existence of the paradox without explaining it. EPA cannot fully explain why we appear to have identified possible profit-making opportunities associated with fuel-saving technologies that the auto makers have historically not adopted. We agree that the forces of competition would be expected to lead to auto makers offering these technologies in response to consumer demand. As discussed in Section III.D.1, though, we do not have a basis to expect that auto makers will go beyond the standards for MY 2016 in the absence of this rule. Other comments emphasize the ''positional'' nature of cars and trucks: people buy them as a reflection of their status, and focus on vehicle attributes, such as size, that visibly convey that status. These comments argue that consumers may become better off through reduced incentives to compete on these positional attributes and perhaps increased incentives to compete on fuel economy. EPA acknowledges that vehicles can be positional, and appreciates the possibility that fuel economy may become a more valued attribute for consumers; at the same time, the positional nature of vehicles may not be sufficient by itself to explain the energy paradox, and increasing the visibility of fuel economy as an attribute may not by itself be sufficient to meet the greenhouse gas standards of this rule. Any increase in the desirability of fuel economy, though, would be expected to facilitate meeting those emissions goals. Other comments addressed consumer heterogeneity: though some will benefit, others may be made worse off, and a ''one size fits all'' policy reduces consumer options. We note that the footprint-based standard as well as the numerous flexibilities in the rule mean that there are many different paths to compliance that maintain consumer options; we expect no reduction in consumer choices. Some commenters expressed that the rule would increase choices through options for advanced technologies. Though some consumers who drive little may face longer-than-average payback periods, those who drive more are expected to benefit, with the gains outweighing the losses.[803]

EPA and NHTSA recently revised the fuel economy label on new vehicles in ways intended to improve information for consumers.[804] 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.[805] To the extent that the label improves consumers' understanding of the value of fuel economy, purchase decisions could change. At least 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. Several commenters specifically supported this argument in support of using expected future fuel savings in the benefit-cost analysis. Other comments argued that consumers are willing to pay only 25 percent of expected future fuel savings, and that that value should be used in the benefit-cost analysis,[806] while also arguing against the existence of the energy paradox.[807] We note, again, the difference between what consumers think about when they buy their vehicles (which may not be expected future fuel savings) and what they will experience once they have bought their vehicles.

[803] One commenter noted that aggregating consumers' preferences is a controversial area of economic theory. In fact, aggregating consumers' preferences is the basis of benefit-cost analysis and welfare analysis more generally. Though people discuss the merits of benefit-cost analysis as a decision rule versus a contribution to a decision, and ethical questions can arise about the distributional impacts of policies, the practice of aggregating preferences is quite common.

[804] 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.

[805] 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–2010–0799–0712).*

[806] The comment that consumers are willing to pay for only 25 percent of expected future fuel savings is based on a study, not of consumer preferences, but rather of vehicle technology (Bandivadekar, Anup, et al. (July 2008). *On the Road in 2035: Reducing Transportation's Petroleum Consumption and GHG Emissions,* Massachusetts Institute of Technology, Laboratory for Energy and the Environment Report No. LFEE 2008–05 RP, Docket EPA–HQ–OAR–2010–0799–0736); it is based on a comparison of the fuel-saving technology that auto companies provide in European vs. U.S. vehicles. Technology tradeoffs do not estimate consumer behavior, unless auto manufacturers perfectly understand and respond to consumer desires. Using the technology tradeoffs to measure consumer behavior is additionally unnecessary and inappropriate because a number of studies specifically examine consumer behavior for fuel economy; see, e.g., Greene's review in note 802, above.

[807] These two statements are contradictory. The existence of the energy paradox is based on comparing consumer willingness to pay for fuel savings with the expected fuel savings they will receive. If consumers are willing to pay for only 25% of fuel savings, they undervalue fuel savings, and there is an energy paradox; if they do not undervalue fuel savings, and there is no energy paradox, they are willing to pay for 100% of fuel savings.

While acknowledging the conundrum, EPA continues to value fuel savings from the standards using the projected market value over the vehicles' entire lifetimes, and to report that value among private benefits of the 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 by subsequent owners. We note that comments arguing for use of less than fuel savings did not dispute the existence of those fuel savings, but only how to estimate their value; we continue to use the market valuation rather than the subjective preference at the time of vehicle purchase. In addition to these other factors, 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 in the relevant literature on the value of additional fuel economy. 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 possible that some of these savings would have occurred in the absence of the standards.[808] 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 standards), the analysis overestimates private and social benefits and also overestimates the rule's 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 structure and results of these models.[809] 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 has developed a preliminary vehicle choice model. As described in the NPRM, 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.[810] The nesting structure in EPA's model involves a hierarchy of choices. For instance, 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. After two more nodes, at the bottom are the individual models. At this bottom level, vehicles that are similar to each other end up in the same nest; for example, two such nests are standard subcompacts and prestige large vehicles. 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 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 RIA and in the model documentation.[811]

In the peer review of EPA's model, the reviewers found the basic structure of the model to be reasonable, while pointing out, first, that its use in policy analysis depended on its integration with OMEGA, and second, that conducting uncertainty analysis would be important given the uncertainties around the model's parameters.[812] These are valuable suggestions for next steps in the modeling process, now that a preliminary model has been developed.

In the NPRM, EPA asked for comments on the use of vehicle choice modeling for predicting changes in sales mix, and on methods to test the predictive abilities of models. See 76 FR 75116. Several commenters expressed concern that consumer choice models are too uncertain to be used in policy making. One comment argued that the rulemaking should not continue if the agencies do not use vehicle choice models that have been subject to public comment and peer review, to reflect consumer acceptability. As discussed in greater detail in Section 18.1 of the Response to Comment Document, we disagree that the rulemaking requires the use of vehicle choice models. Because the predictive ability of these models has not been well tested, the quality of the information that would come from a vehicle choice model is not well understood. Instead, we provide here and in Section III.H.11(a) thorough discussion of the effects of the rule on consumer welfare and on vehicle sales.

EPA agrees with some commenters that there is yet much to learn about consumer vehicle choice models and their predictive abilities. EPA is therefore not using its preliminary consumer choice model in this rulemaking because we believe it needs further development and testing before we have confidence in its use and results. As the peer review noted, it has not yet been integrated with OMEGA, an important step for ensuring that changes in the vehicle fleet estimated by the model will result in a fleet compliant with the standards. In addition, concerns remain that vehicle choice models have rarely been validated against real-world data. In response to these concerns, we would expect any use of the model to involve, at the least,

[808] However, as discussed at section III.D.1 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.

[809] 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–2010–0799–0652).

[810] 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).

[811] Greene, David L., and Changzheng Liu (March 2012). ''Consumer Vehicle Choice Model Documentation.'' Prepared for the U.S. Environmental Protection Agency by Oak Ridge National Laboratory. Docket EPA–HQ–OAR–2010–0799.

[812] U.S. Environmental Protection Agency. ''Peer Review for the Consumer Vehicle Choice Model and Documentation.'' Office of Transportation and Air Quality, Assessment and Standards Division, EPA–420–R–12–013, April 2012. Docket EPA–HQ–OAR–2010–0799.

a number of sensitivity analyses to examine the robustness of results to key parameters. We will continue model development and testing to understand better the results and limitations of using the model.

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.[813] In addition, the analysis assumes that the full technology costs are passed along to consumers. With these assumptions, because paying the consumers back the technology costs would completely compensate them for their losses,[814] the price increase measures the loss to the buyer.[815] 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

The analysis of this rule finds that alternative-fuel vehicles, especially electric vehicles (EVs), may form a part (albeit limited) of some manufacturers' compliance strategies. 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 alternative fuel 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 may need adjustments to account for these differences.

Comments differed on consumer attitudes toward EVs. The National Automobile Dealers Association and some fuels-related organizations argued that consumers are likely to hesitate to buy even hybrid electric vehicles, in part because they like vehicles that are familiar to them, and it is risky to depend on EVs to meet the standards of this program. Some fuels organizations pointed to low sales of existing EVs and plug-in hybrid electric vehicles (PHEVs) as evidence of consumer unwillingness to consider these vehicles, and thus as evidence that the standards are too stringent because they rely on electrification. We note that electrification is an option for compliance but is not required under this rule (and indeed, EPA projects minimal penetration of electrification as the likely compliance path even for the MY 2025 standards, as documented in section III.D.6.c above). Others note the expense of EVs. Environmental and consumer organizations argue that there are reasons to be optimistic about consumer adoption of these vehicles because consumers may appreciate their low or zero gasoline consumption. EPA recognizes all these as possibilities in response to this rule. Many of the organizations skeptical of EVs expressed concern that the rule would reduce vehicle choices for consumers, by requiring people to buy more fuel-efficient vehicles when they might otherwise not choose them. Those optimistic about EVs said that choices were expected to increase, because consumers could choose between conventional and alternative fuel vehicles.

A first important point to observe in response to these concerns is that, although auto makers are required to comply with the standards, producing EVs as a compliance strategy is not 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 may need 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. While it is theoretically possible to quantify such a welfare loss, the data needed to support such a calculation is not available at this time. To quantify this value, the deadweight loss can be approximated as one-half of the size of the subsidy needed for the

[813] If the reference-case vehicles include different vehicle characteristics, such as improved acceleration or towing capacity, then the costs for the 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.

[814] 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.

[815] 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.

marginal purchaser, times the number of sales that would need the subsidy.[816] 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.[817] 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, limited range or lack of home recharging may become less of a barrier to purchase. Of course, other attributes of the marketed EVs, such as their cost, 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 $59,000 (2010$) (see RIA Chapter 8.1.2.7 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.[818] 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.[819] 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.[820] 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 findings 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 we do not 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. As noted above, our projections of technology penetrations indicate that a very small portion (fewer than 3 percent) of new vehicles produced in MY 2025 will need to be EVs. For the purposes of the analysis presented here for this rule, we assume that the consumer market will be sufficient to absorb the number of EVs expected to be used for compliance under this rule.

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-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

[816] This calculation approximately measures the area between the supply and demand curves for these vehicles when the number sold exceeds the equilibrium value. The supply curve approximately measures the costs of producing the vehicles, and the demand curve estimates how much consumers are willing to pay for the vehicles. The measure described here estimates the difference between the extra cost for these excess vehicles and their value to their buyers.

[817] 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.

[818] 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–2010–0799–0668).

[819] 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–2010–0799–0670).

[820] 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–2010–0799–0671).

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 may have to subsidize their prices, if they have no other less costly technologies available to meet the standards. 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 some 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 now and when the MY 2017–25 standards take effect. The analysis in this rule assumes that the consumer market is sufficient to absorb the expected number of EVs without subsidies.

2. Costs Associated With the Vehicle Standards

In this section, EPA presents our estimate of the costs associated with the vehicle program. The presentation here summarizes the vehicle level costs associated with the new technologies expected to be added to meet the GHG standards, including hardware costs to comply with the A/C credit program. The analysis summarized here provides our estimate of incremental costs on a per vehicle basis and on an annual total basis.

The presentation here summarizes the outputs of the OMEGA model that was discussed in some detail in Section III.D of this preamble. For details behind the analysis such as the OMEGA model inputs and the estimates of costs associated with individual technologies, the reader is directed to Chapter 1 of the EPA's final RIA and Chapter 3 of the Joint TSD. For more detail on the outputs of the OMEGA model and the overall vehicle program costs summarized here, the reader is directed to Chapters 3 and 5 of EPA's 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 the full suite of available off-cycle credits.

a. New Technology Costs per Vehicle

To develop technology costs per vehicle, EPA has used the same methodology as that used in the recent 2012–2016 final rule, the 2010 TAR and the proposal for this rule. 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.[821] All of these individual technology costs are described in detail in Chapter 3 of the joint TSD. Also described there are the ICMs used in this rule 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 rule 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. Learning effects in this final rule are applied exactly as was done in the proposal. 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 rule). Again, this is detailed in Chapter 3 of the joint TSD.

We requested comment on all aspects of our technology cost analysis—the DMCs themselves, the ICMs, learning effects, etc. We received a comment from NADA that our ICMs were too low and that we should use a Retail Price Equivalent (RPE) approach to estimating indirect costs rather than the ICM approach.[822] Using the RPE approach would result in all indirect costs incurred by industry increasing due to regulatory demands. In contrast, the ICM approach results in a subset of all indirect costs increasing—the subset of indirect costs that are tied to changes in regulatory demands. For example, healthcare costs of currently retired employees would not be expected to increase due to a new regulation. An RPE approach would estimate increased healthcare costs for retired employees while an ICM approach would not. Further, the NADA comment suggested that an RPE factor of 2x was most appropriate, despite industry filings to the Security and Exchange Commission (SEC) that support a factor of 1.5x.[823] EPA disagrees with both of these comments, as discussed in more detail in Chapter 3.1.2.2 of the Joint TSD.

We received comments from ICCT that our ICM approach was more appropriate than an RPE approach, and that our updated method of applying ICMs to estimate indirect costs was much more appropriate than our old approach (i.e., delinking indirect costs and learning effects).[824]

We did not receive comments on our approach to manufacturer learning. We did not receive any specific comments suggesting that our estimates of technology direct manufacturing costs were inappropriately high or low.

EPA 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

[821] The ICM approach was updated for the proposal and has not changed for this final rule.

[822] See NADA (Docket Number EPA–HQ–OAR–2010–0799–9575, at page 4).

[823] Rogozhin, Alex, 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.

[824] See ICCT (EPA–HQ–OAR–2009–0472–7156, at page 19).

configuration, vehicle class, etc.). 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 summarized in Section III.D.3 of this preamble and is detailed in Chapter 1 of EPA's final RIA. These packages are then used as inputs to the OMEGA model to estimate the most cost effective means of compliance with the 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 joint TSD, are shown in Table III–72. Not included in the costs presented in Table III–72 are costs associated with maintenance. We discuss maintenance costs in Section III.H.2.b, below.

TABLE III–72—INDUSTRY AVERAGE VEHICLE COSTS ASSOCIATED WITH THE STANDARDS

[2010 dollars]

Model year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
$/car	$206	$374	$510	$634	$767	$1,079	$1,357	$1,622	$1,726	$1,710	$1,710	$1,710
$/truck	57	196	304	415	763	1,186	1,562	1,914	2,059	2,044	2,044	2,044
Combined	154	311	438	557	766	1,115	1,425	1,718	1,836	1,818	1,816	1,816

b. Costs of the National Program

i. Technology Costs

The costs presented here represent the incremental costs for newly added technology to comply with the 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–72, above result in the total annual costs presented in Table III–73 below. Note that the costs presented in Table III–73 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. Similarly, the costs presented in Table III–73 do not include the maintenance costs that we have estimated in this final rule. Maintenance costs, presented below, were not included in the proposal. Note also that the costs presented here represent costs estimated to occur presuming that the MY 2025 standards would continue in perpetuity. Any changes to the standards would be considered as part of a future rulemaking. In other words, the 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–73—UNDISCOUNTED ANNUAL TECHNOLOGY COSTS, & ANNUAL TECHNOLOGY COSTS DISCOUNTED BACK TO 2012

[millions of 2010 dollars]

Calendar year	Cars	Truck	Total annual costs
2017	$2,060	$334	$2,440
2020	6,530	2,320	8,860
2030	21,400	12,200	33,700
2040	24,100	13,300	37,400
2050	27,100	14,900	42,000
NPV, 3%	336,000	186,000	521,000
NPV, 7%	149,000	81,900	231,000

Annual costs represent undiscounted values; net present values represent annual costs discounted to 2012.

Looking at these costs by model year gives us the technology costs as shown in Table III–74.

TABLE III–74—MODEL YEAR LIFETIME PRESENT VALUE TECHNOLOGY COSTS, DISCOUNTED BACK TO THE 1ST YEAR OF EACH MY AT 3% AND 7% DISCOUNT RATES

[Millions of 2010 dollars]

NPV at		2017	2018	2019	2020	2021	2022	2023	2024	2025	Sum
3%	Car	$2,030	$3,650	$5,020	$6,430	$7,940	$11,400	$14,700	$18,000	$19,600	$88,800
	Truck	330	1,100	1,670	2,290	4,280	6,670	8,750	10,700	11,600	47,400
	Fleet	2,400	4,780	6,720	8,730	12,200	18,100	23,400	28,700	31,200	136,000
7%	Car	1,990	3,580	4,930	6,320	7,800	11,200	14,400	17,700	19,300	87,200
	Truck	323	1,080	1,640	2,250	4,200	6,540	8,590	10,500	11,400	46,500
	Fleet	2,360	4,690	6,590	8,570	12,000	17,700	23,000	28,100	30,600	134,000

ii. Maintenance Costs

New for this final rule is consideration and quantification of maintenance costs associated with the new technologies added to comply with the standards. In the proposal, we requested comment on maintenance and repair costs and whether they might increase or decrease with the new technologies. We did not receive many comments, but NADA did comment that the agencies should include maintenance and repair costs in estimates of total cost of ownership (i.e., in our payback analyses).[825] NADA offered their Web site as a place to find useful information on maintenance and repair costs that might be used in our final analyses.

Here we summarize what we have done for the final rule with respect to maintenance costs. To make clear, we distinguish maintenance from repair costs as follows: maintenance costs are those costs that are required to keep a vehicle properly maintained and, as such, are usually recommended to occur by auto makers on a regular, periodic schedule. Examples of maintenance costs are oil and air filter changes, tire replacements, etc. Repair costs are those costs that are unexpected and, as such, occur randomly and uniquely for every driver, if at all. Examples of repair costs would be parts replacement following an accident, turbocharger replacement following a mechanical failure, etc.

In the joint TSD (see Chapter 3.6), we present our estimates for maintenance cost impacts along with how we derived them. For most technologies that we expect will be added to comply with the final standards, we expect no impact on maintenance costs. In other words, the new technologies have identical maintenance intervals and identical costs per interval as the technologies they will replace. However, for a few technologies, we do expect some maintenance costs changes. As detailed in the Joint TSD, those technologies expected to result in a change in maintenance costs are low rolling resistance tires levels 1 and 2 since they cost more than traditional tires and must be replaced at similar intervals, diesel fuel filters since they must be replaced more frequently and at higher cost than gasoline fuel filters, and several items for full EVs (oil changes, air filter changes, engine coolant flushes, spark plug replacements, etc.) since they do not need to be done on full EVs.

Using the maintenance costs and intervals presented in the Joint TSD, we can estimate the annual maintenance cost increases/decreases for each of these technologies relative to their reference case gasoline counterparts. Clearly, while in the year 2017 roughly 15–16 million vehicles will be sold, very few of those vehicles will experience any maintenance costs during their first year despite the fact that all will have low rolling resistance tires 1 or 2 (the typical replacement interval for tires is 40,000 miles). As such, the estimated maintenance costs are comparitively low in the year 2017. As more compliant vehicles enter the market in subsequent years, the annual maintenance costs increase as maintenance intervals begin to result in increasing numbers of vehicles incurring costs. The results are shown in Table III–75. We provide details of these maintenance costs in Chapter 5 of our RIA.

TABLE III–75—UNDISCOUNTED ANNUAL MAINTENANCE COSTS, AND ANNUAL MAINTENANCE COSTS DISCOUNTED BACK TO 2012

[Millions of 2010 dollars]

Calendar year	Cars	Trucks	Total annual costs
2017	$22	$16	$37
2020	199	131	330
2030	1,430	836	2,260
2040	2,320	1,310	3,630
2050	2,860	1,680	4,540
NPV, 3%	24,900	14,500	39,500
NPV, 7%	9,830	5,760	15,600

Annual costs represent undiscounted values; net present values represent annual costs discounted to 2012.

We can also look at the costs on a model year basis by looking at the net present value of costs and savings over the full lifetime of each model year of vehicles. The net present value lifetime costs and savings for each MY 2017–2025 are shown in Table III–76.

TABLE III–76—MODEL YEAR LIFETIME PRESENT VALUE MAINTENANCE COSTS, DISCOUNTED BACK TO THE 1ST YEAR OF EACH MY AT 3% AND 7% DISCOUNT RATES

[2010 dollars]

NPV at		2017	2018	2019	2020	2021	2022	2023	2024	2025	Sum
3%	Car	$222	$406	$600	$819	$1,040	$1,150	$1,250	$1,380	$1,490	$8,360
	Truck	153	279	404	534	686	747	810	867	936	5,420
	Fleet	375	684	1,000	1,350	1,730	1,890	2,060	2,240	2,430	13,800
7%	Car	172	314	465	634	812	887	977	1,060	1,160	6,480
	Truck	118	214	310	411	523	570	620	669	718	4,150
	Fleet	290	528	775	1,050	1,330	1,460	1,600	1,730	1,880	10,600

[825] See NADA (EPA–HQ–OAR–2010–0799–9575, p.10).

iii. Vehicle Program Costs

Annual costs of the vehicle program are the annual technology costs shown in Table III–73 and the annual maintenance costs shown in Table III–75. Those results are shown in Table III–77.

TABLE III–77—UNDISCOUNTED ANNUAL PROGRAM COSTS, AND ANNUAL COSTS DISCOUNTED BACK TO 2012

[Millions of 2010 dollars]

Calendar year	Cars	Trucks	Total annual costs
2017	$2,080	$350	$2,470
2020	6,730	2,450	9,190
2030	22,900	13,100	35,900
2040	26,400	14,600	41,000
2050	29,900	16,600	46,500
NPV, 3%	361,000	200,000	561,000
NPV, 7%	159,000	87,700	247,000

Annual costs represent undiscounted values; net present values represent annual costs discounted to 2012.

Model year lifetime costs of the vehicle program are the lifetime technology costs shown in Table III–74 and the lifetime maintenance costs shown in Table III–76. Those results are shown in Table III–78.

TABLE III–78—MODEL YEAR LIFETIME PRESENT VALUE PROGRAM COSTS, DISCOUNTED BACK TO THE 1ST YEAR OF EACH MY AT 3% AND 7% DISCOUNT RATES

[Millions of 2010 dollars]

NPV at		2017	2018	2019	2020	2021	2022	2023	2024	2025	Sum
3%	Car	$2,250	$4,050	$5,620	$7,250	$8,990	$12,600	$15,900	$19,400	$21,100	$97,200
	Truck	483	1,370	2,070	2,820	4,960	7,410	9,560	11,600	12,500	52,800
	Fleet	2,770	5,460	7,720	10,100	14,000	19,900	25,400	30,900	33,600	150,000
7%	Car	2,170	3,890	5,400	6,950	8,610	12,100	15,400	18,700	20,400	93,600
	Truck	441	1,290	1,950	2,660	4,720	7,110	9,210	11,200	12,100	50,600
	Fleet	2,650	5,220	7,370	9,610	13,300	19,200	24,600	29,900	32,500	144,000

3. Cost per Ton of Emissions Reduced

EPA has calculated the cost per ton of GHG reductions associated with the GHG standards on a CO_2eq basis using the annual program costs presented above and the emissions reductions described in Section III.F. These values are presented in Table III–79 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–79—ANNUAL COST PER METRIC TON OF CO_2EQ REDUCED

[2010 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	$6,730	$6,000	21	$316	$34
	2030	22,900	56,700	179	128	−189
	2040	26,400	102,000	300	88	−252
	2050	29,900	138,000	374	80	−289
Trucks	2020	2,450	1,430	6	430	179
	2030	13,100	29,700	92	142	−180
	2040	14,600	53,400	155	94	−251
	2050	16,600	73,700	196	85	−292
Combined	2020	9,190	7,430	27	340	65
	2030	35,900	86,400	271	132	−186
	2040	41,000	155,000	455	90	−251
	2050	46,500	212,000	569	82	−291

4. Reduction in Fuel Consumption and its Impacts

a. What Are the Projected Changes in Fuel Consumption?

The 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 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 ''VMT rebound effect,'' which is discussed in Section III.H.4.c and in Chapter 4 of the 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–80. The gallons reduced and kilowatt hours increased (kWh) as shown in the tables reflect impacts from the CO_2 standards, including the A/C credit program, and include increased consumption resulting from the VMT rebound effect.

TABLE III–80—FUEL CONSUMPTION IMPACTS OF THE 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	128,136	197	125
2020	124,513	2,149	1,242
2030	129,995	22,986	14,026
2040	150,053	38,901	24,661
2050	177,323	48,743	30,943
Total	5,464,349	903,298	564,873

[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 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 2012 Early Release.[826] These estimates do not 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 $85 million in 2017 and $4.7 billion by 2025. These results are shown in Table III–81. Note that in Section III.H.9, the overall benefits and costs of the rule are presented and, for that reason, only the pre-tax fuel savings are presented there.

TABLE III–81—UNDISCOUNTED ANNUAL FUEL SAVINGS, & ANNUAL FUEL SAVINGS DISCOUNTED BACK TO 2012

[Millions of 2010 dollars]

Calendar year	Gasoline savings (pre-tax)	Gasoline savings (taxed)	Electricity costs	Total fuel savings (pre-tax)	Total fuel savings (taxed)
2017	$662	$747	$11.5	$651	$735
2020	7,540	8,440	114	7,430	8,320
2030	87,900	97,000	1,450	86,400	95,500
2040	158,000	172,000	2,800	155,000	169,000
2050	216,000	233,000	3,800	212,000	229,000
NPV, 3%	1,630,000	1,780,000	28,100	1,600,000	1,750,000
NPV, 7%	617,000	677,000	10,600	607,000	666,000

Annual values represent undiscounted values; net present values represent annual costs discounted to 2012.

[826] In the Executive Summary to AEO2012 Early Release, the Energy Information Administration describes the reference case. They state that, ''Projections * * * in the Reference case focus on the factors that shape U.S. energy markets in the long term, under the assumption that current laws and regulations remain generally unchanged throughout the projection period. The AEO2012 Reference case provides the basis for examination and discussion of energy market trends and serves as a starting point for analysis of potential changes in U.S. energy policies, rules, or regulations or potential technology breakthroughs.''

As shown in Table III–81, the agencies are projecting that consumers would realize very large fuel savings as a result of the 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 VMT rebound effect refers to the increase in vehicle use that results if an increase in fuel efficiency lowers the cost per mile of driving. Consistent with the proposal, EPA is using an estimate of 10 percent for the VMT rebound effect for this final rule (i.e., we assume a 10 percent decrease in fuel cost per mile from our standards would result in a 1 percent increase in VMT).

As we discussed in the proposed rule, in the MYs 2012–2016 rulemaking, and more fully in Chapter 4 of the Joint TSD, this value was not derived from a single point estimate or from a particular study, but instead represents a reasonable compromise between historical estimates and projected future estimates. This value is consistent with the VMT rebound estimate for the most recent time period analyzed in the Small and Van Dender 2007 paper,[827] and falls within the range of the larger body of historical work on the VMT rebound effect.[828] Recent work by David Greene on the VMT rebound effect for light-duty vehicles in the U.S. supports the hypothesis that the rebound effect is decreasing over time,[829] 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 proposition that the VMT rebound effect is declining over time, although the Hymel et al. estimates are higher than the 2007 Small and Van Dender estimates.[830] Furthermore, by using an estimate of the future VMT rebound effect, analysis by Small and Greene show that the rebound effect could be in the range of 5 percent or lower.[831]

We received four comments suggesting values both lower and higher than our proposed value of the VMT rebound effect. The Consumer Federation of America suggested that we use 5 percent in our national analysis since it would better reflect the income effect (consumers having more money in their pockets to spend on driving) and not the price effect (consumers wanting to drive more because it costs less) associated with lower driving costs. The International Council for Clean Transportation (ICCT) suggested we should rely solely on projected estimates that account for future incomes and fuel prices, which tend to be lower than 10 percent for the years covered by this rule. The Defour Group suggested using an estimate of 20 percent or higher; it commented that it believes there are potential methodological shortcomings in recent studies and suggested using the elasticity of demand for gasoline as a basis for estimating the VMT rebound effect. Finally Plant Oil Powered Diesel Fuel Systems, Inc. (POP Diesel) cited a recent study in Germany based on household survey data as evidence that EPA had underestimated the VMT rebound effect. POP Diesel also suggested that EPA should account for the energy and GHG emissions impact associated with the so-called ''indirect rebound effects'' of consumers using their increased disposable income from fuel savings to purchase goods and services that were produced with energy or that consume energy. POP Diesel also commented that there is a potential for consumers to shift to larger, more powerful vehicles that are less fuel-efficient in response to our standards. POP Diesel described this as a direct rebound effect; however, since this behavior does not influence VMT, we would classify it as another type of indirect effect unrelated to the direct VMT rebound effect.

Commenters did not provide any persuasive new data or analysis that justify revising the 10 percent value at this time. We relied on a wide range of peer-reviewed literature to inform our estimate of the VMT rebound effect (as discussed above and in Chapter 4 of the Joint TSD), including recent studies and projected estimates as well as a larger body of historic literature using both aggregate and household level data. Most of the literature we reviewed controls for income (since all sources of income, not just income associated with fuel savings, can influence VMT) and, therefore, only captures the price effect. We recognize the merit of projected estimates of the VMT rebound effect that take into account future incomes, fuel efficiency, and fuel prices over the period impacted by our rulemaking, particularly since recent studies have found evidence that the VMT rebound effect is declining over time. Estimates of the elasticity of demand for gasoline, while a useful point of comparison, are not appropriate for measuring the VMT rebound effect because they reflect consumer selection of vehicle fuel efficiency in addition to VMT.[832] In response to the comment that we should consider the rebound effect estimates from a German study, we focused on U.S.-based studies of the VMT rebound effect to inform our analysis because driver behavior in the U.S. differs from driver behavior in other countries (e.g., there is likely to be less elastic demand for VMT in the U.S. than Germany because of longer driving distances and fewer transportation alternatives).[833]

We are not aware of any data on potential indirect rebound effects (distinct from the VMT rebound effect), if any, from this rule associated with consumer purchase of energy-intensive goods and services with the disposable income they gain from fuel savings. Research on indirect rebound effects is nascent and POP Diesel did not provide analysis in its comments indicating an appropriate method or value to use to estimate these putative effects from our rule. We believe it is unreasonable to consider potential indirect rebound effects, if any, from our rule based on

[827] 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–2010–0799–0755).

[828] 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).

[829] Greene, David, 2012. ''Rebound 2007: Analysis of National Light-Duty Vehicle Travel Statistics,'' Energy Policy, vol. 41, pp. 14–28. (Docket EPA–HQ–OAR–2010–0799)

[830] 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)

[831] 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, 2012.

[832] We sought comment in the MYs 2012–2016 rulemaking on using the elasticity of demand for gasoline to estimate the VMT rebound effect. We received one comment during that rulemaking, from ICCT, that this elasticity should not be used to guide the choice of a value for the VMT rebound effect.

[833] Frondel, Manuel and Vance, Colin, 2011. ''Re-Identifying the Rebound—What About Asymmetry?'', Ruhr Economic Papers #276. (Docket EPA–HQ–OAR–2010–0799).

the commenter's speculative assertions. As to the comment that consumers may shift to larger, more powerful vehicles that are less fuel-efficient as a type of indirect rebound response to our standards, we note that we have explained above that there is persuasive evidence that the standards do not create an incentive to upsize vehicles and that the footprint attribute provides incentives to make fuel economy and greenhouse gas emission improvements across the entire spectrum of vehicle footprints. See preamble sections III.D.7 (analysis of car and truck trading) and joint TSD section 2.1. If the comment refers solely to potential consumer purchasing behavior, we note that predictions of such behavior are highly uncertain. We recognize that there is a potential for consumers to shift to larger, more powerful vehicles that are less fuel-efficient just as there is a potential for consumers to buy even more fuel-efficient vehicles than we predict in our analysis [834]; these are potential consumer responses to our standards (unrelated to the VMT rebound effect) that we plan to monitor (see Section III.H.1.a for a discussion of the challenge of predicting consumer vehicle purchase decisions, section II.C and TSD Chapter 2.1 and 2.2. for a discussion of how our rule sets attribute-based standards that reduce incentives to change the size distribution of vehicles in the fleet, and section II.B.5 for information on the mid-term evaluation).

We sought comment on the potential that the VMT rebound effect could be lower than estimates in the literature if drivers respond more to changes in fuel prices than fuel efficiency, price rises than decreases, and price shocks than gradual changes (discussed more fully in Chapter 4.2.5.2 of the Joint TSD), but we did not receive any comments on these topics. See 76 FR 75126.

We also sought comment on whether there may be differences in the way consumers respond to changes in the cost per mile of driving that result from driving an electric-powered vehicle instead of a conventional gasoline vehicle. We did not receive any comments on this topic and therefore continue to assume in this final rule that the VMT rebound effect will be the same whether a consumer is driving a conventional gasoline vehicle or a vehicle powered by grid electricity.

Chapter 4.2.5 of the Joint TSD reviews the relevant literature and discusses in more depth the reasoning for the VMT rebound value used here. The VMT rebound effect is also discussed in Section II.E of the preamble. A summary of comments on the rebound effect and our more detailed response to those comments is available in section 15 of EPA's Response to Comments document.

5. Cost of Ownership, Payback Period and Lifetime Savings on New Vehicle Purchases

Here we look at the cost of owning a new vehicle complying with the standards and the payback period—the point at which savings exceed costs. For example, a new 2025 MY vehicle is estimated to cost roughly $1,800 more (on average, and relative to the reference case vehicle) due to the addition of new GHG reducing/fuel economy improving technology. This new technology will result in lower fuel consumption and, therefore, savings in fuel expenditures. But how many months or years would pass before the fuel savings exceed the upfront costs?

Table III–82 presents our estimate of increased costs associated with owning a new 2025MY vehicle. The table uses annual miles driven (vehicle miles traveled, or VMT) and survival rates consistent with the emission and benefits analyses presented in Chapter 4 of the Joint TSD. The control case includes fuel savings associated with A/C controls. Newly included here as opposed to our proposed analysis, are estimated maintenance costs that owners of these vehicles will likely incur. 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 and those factors that result in more or fewer dollars in their pockets. To estimate the upfront vehicle cost (i.e., the lifetime increased cost discounted back to purchase), we have included not only the sales tax on the new car purchase but also the increased insurance premiums that would result from the more valuable vehicle. Car/truck fleet weighting is handled as described in Chapter 1 of the Joint TSD. The present value of the increased vehicle costs shown in the table are $2,389 at a 3% discount rate and $2,300 at a 7% discount rate.

TABLE III–82—INCREASED COSTS ON A 2025MY NEW VEHICLE PURCHASE VIA CASH (2010$)

Year of ownership	Increased purchase costs [a]	Increased insurance costs	Increased maintenance costs	Total increased costs	Cumulative discounted increased costs at 3% [b]	Cumulative discounted increased costs at 7%
1	−$1,937	−$34	−$14	−$1,984	−$1,984	−$1,984
2	0	−33	−13	−46	−2,029	−2,027
3	0	−31	−13	−44	−2,070	−2,065
4	0	−29	−12	−41	−2,108	−2,099
5	0	−28	−12	−39	−2,143	−2,129
6	0	−26	−11	−38	−2,175	−2,156
7	0	−25	−11	−35	−2,205	−2,179
8	0	−23	−10	−33	−2,232	−2,200
↓	↓	↓	↓	↓	↓	↓
NPV, 3%	−1,937	−313	−139	−2,389	−2,389	....
NPV, 7%	−1,937	−254	−109	−2,300	....	−2,300

[a] [insert necessary notes].

[834] Comments from the Institute for Policy Integrity suggest our rule could make fuel-efficient vehicles more popular and that we have therefore underestimated the benefits of our rule (see their discussion of ''positionality'' and the ''bandwagon effect'' in EPA–HQ–OAR–2010–0799–9480–A1, pp. 19–21).

However, 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. The national average interest rate for a 4 or 5 year new car loan was 5.35 percent.[835] For the credit purchase, the increased costs would look like that shown in Table III–83.

TABLE III–83—INCREASED COSTS ON A 2025 MY NEW VEHICLE PURCHASE VIA CREDIT (2010$)

Year of ownership	Increased purchase costs [a]	Increased insurance costs	Increased maintenance costs	Total increased costs	Cumulative discounted increased costs at 3% [b]	Cumulative discounted increased costs at 7% [b]
1	−$452	−$34	−$14	−$500	−$500	−$500
2	−452	−33	−13	−497	−982	−964
3	−452	−31	−13	−495	−1,449	−1,397
4	−452	−29	−12	−493	−1,900	−1,799
5	−452	−28	−12	−491	−2,337	−2,174
6	0	−26	−11	−38	−2,369	−2,201
7	0	−25	−11	−35	−2,399	−2,224
8	0	−23	−10	−33	−2,425	−2,245
↓	↓	↓	↓	↓	↓	↓
NPV, 3%	−2,131	−313	−139	−2,583	−2,583	
NPV, 7%	−1,982	−254	−109	−2,345		−2,345

[a] This uses the same increased cost as Table III-82 but spreads it out over 5 years assuming a 5 year car loan at 5.35 percent.
[b] Calculated using AEO 2012 early release reference case fuel prices including taxes.

The above discussion covers costs, but what about the fuel savings side. Of course, fuel savings are the same whether a vehicle is purchased using cash or credit. Table III–84 shows the fuel savings for a 2025MY vehicle while excluding rebound driving.

TABLE III–84—FUEL SAVINGS FOR A 2025MY VEHICLE (2010$)

Year of ownership	Fuel price	Miles driven	Reference fuel	Control fuel	Fuel savings	Cumulative discounted fuel savings at 3%	Cumulative discounted fuel savings at 7%
1	$3.87	16,779	$2,407	$1,702	$705	$695	$682
2	3.91	16,052	2,325	1,644	681	1,347	1,298
3	3.94	15,539	2,265	1,601	664	1,964	1,859
4	3.96	14,902	2,183	1,543	640	2,541	2,365
5	4.00	14,424	2,134	1,508	626	3,089	2,827
6	4.04	13,941	2,082	1,471	611	3,608	3,248
7	3.96	13,106	1,912	1,350	562	4,072	3,610
8	3.96	11,866	1,739	1,229	510	4,480	3,917
↓	↓	↓	↓	↓	↓	↓	↓
NPV, 3%			25,261	17,859	7,402	7,402	
NPV, 7%			19,354	13,680	5,674		5,674

Note: Fuel prices include taxes; miles driven exclude rebound miles.

We can now compare the cumulative discounted costs to the cumulative discounted fuel savings to determine the point at which savings begin to exceed costs. This comparison is shown in Table III–85 for the 3% discounting case and in Table III–86 for the 7% discounting case.

TABLE III–85—PAYBACK PERIOD FOR CASH & CREDIT PURCHASES—3% DISCOUNT RATE (2010$)

Year of ownership	Cumulative discounted increased costs—cash purchase[b]	Cumulative discounted increased costs—credit purchase[b]	Cumulative discounted fuel savings	Cumulative discounted net savings—cash purchase	Cumulative discounted net savings—credit purchase
1	−$1,984	−$500	$695	−$1,290	$195
2	−2,029	−982	1,347	−682	365
3	−2,070	−1,449	1,964	−106	515
4	−2,108	−1,900	2,541	433	641
5	−2,143	−2,337	3,089	946	752
6	−2,175	−2,369	3,608	1,433	1,239
7	−2,205	−2,399	4,072	1,867	1,673
8	−2,232	−2,425	4,480	2,249	2,055

[835] "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.

TABLE III–85—PAYBACK PERIOD FOR CASH & CREDIT PURCHASES—3% DISCOUNT RATE (2010$)—Continued

Year of ownership	Cumulative discounted increased costs—cash purchase[b]	Cumulative discounted increased costs—credit purchase[b]	Cumulative discounted fuel savings	Cumulative discounted net savings—cash purchase	Cumulative discounted net savings—credit purchase
↓	↓	↓	↓	↓	↓
NPV, 3%	−2,389	−2,583	7,402	5,013	4,819

TABLE III–86—PAYBACK PERIOD FOR CASH & CREDIT PURCHASES—7% DISCOUNT RATE (2010$)

Year of ownership	Cumulative discounted increased costs—cash purchase[b]	Cumulative discounted increased costs—credit purchase[b]	Cumulative discounted fuel savings	Cumulative discounted net savings—cash purchase	Cumulative discounted net savings—credit purchase
1	−$1,984	−$500	$682	−$1,302	$183
2	−2,027	−964	1,298	−729	334
3	−2,065	−1,397	1,859	−206	462
4	−2,099	−1,799	2,365	266	565
5	−2,129	−2,174	2,827	697	653
6	−2,156	−2,201	3,248	1,092	1,047
7	−2,179	−2,224	3,610	1,431	1,386
8	−2,200	−2,245	3,917	1,717	1,672
↓	↓	↓	↓	↓	↓
NPV, 7%	−2,300	−2,345	5,674	3,375	3,330

Table III–85 shows that early in the 4th year of ownership (3.2 years), the savings have started to outweigh the costs of the cash purchase. More interestingly, the savings immediately outweigh the cost of a credit purchase and, in fact, this is true even in the first month of ownership when the increased cost on the monthly car loan payment at $42 and the first month's fuel savings are $59 and, presumably, no maintenance costs have yet been incurred (none of these values are shown since the tables present annual values). So, for a new car purchaser who does not keep the vehicle for the full lifetime, the increased costs will payback within 4 years. For that rare owner that keeps the vehicle for its full life, the payback period would be the point at which the savings outweigh the full lifetime costs which occurs somewhat later since more costs are being included. For this case, referring again to Table III–85, we want the point at which the fuel savings exceed $2,389 or $2,583 for cash and credit purchases, respectively. Those payback periods would be 3.7 years for the cash purchase and 4.1 years for the credit purchase. Note that the full lifetime net savings amount to $5,013 for the cash purchase and $4,819 for the credit purchase. These very large net savings may not be realized by many individual owners since very few people keep vehicles for their full lifetime. However, those savings would be realized in combination by all owners of the vehicle.

Table III–86 shows the same information using a 7 percent discount rate. Here, the fuel savings being to outweigh the costs in 3.4 years for the cash purchase and within the first year for the credit purchase. For the full lifetime owner, the lifetime payback period would be 3.9 years for the cash purchase and 4.0 years for the credit purchase. The full lifetime net savings would be $3,375 for the cash purchase and $3,330 for the credit purchase.

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.

Note also that the insurance costs and sales taxes included here in the cost of ownership analysis have not been included in the benefit-cost analysis (BCA) because those costs are transfer payments and have no net impact on the societal costs of interest in a BCA. Likewise, the fuel savings presented here include taxes since those are the cost incurred by drivers. However, fuel taxes are not included in the BCA since, again, they are transfer payments. Lastly, in this cost of ownership analysis, we have not included rebound miles in determining maintenance costs or fuel savings, and we have not included other private benefits/costs such as the value of driving rebound miles or reduced time spent refueling since we do not believe that consumers consider such impacts in their daily lives. In the BCA, we always include rebound miles in estimating maintenance costs and fuel savings, and we include the other private benefits/costs listed here.

6. 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) in the primary benefits analysis for this rule. 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. The interagency group focused on global SCC values because emissions of CO_2 involve a global externality: Greenhouse gases contribute to damages around the world wherever they are emitted. Consequently, to address the global nature of the climate change problem, the SCC must incorporate the full (global) damages caused by GHG emissions. Furthermore, climate change occurs over very long time horizons and represents a problem that the United States cannot solve independently. We first used these SCC estimates in the benefits analysis for the 2012–2016 light-duty GHG rulemaking; see 75 FR 25520. We have continued to use these estimates in other rulemaking analyses, including the heavy-duty GHG rulemaking; see 76 FR 57332. The SCC Technical Support Document (SCC TSD) provides a complete discussion of the methods used to develop these SCC estimates.[836]

The interagency group selected four SCC values for use in regulatory analyses, which we have applied in this analysis: $5, $22, $37, and $68 per metric ton of CO_2 emissions in 2010, in 2010 dollars.[837] 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 in all three models. Treating climate sensitivity probabilistically allows the estimation of SCC at higher temperature outcomes, which 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–87 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.[838] 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. As noted in the SCC TSD, 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.

The Environmental Defense Fund (EDF), the Institute for Policy Integrity (IPI), and the Natural Resources Defense Council (NRDC) discussed these limitations and stated that EPA should update the SCC estimates. These commenters provided specific methodological recommendations that focused on issues such as discount rate selection, evaluation of catastrophic impacts and non-monetized impacts, and risk aversion. EPA has considered each of the commenters' recommendations to update the SCC estimates and to modify the methodology in the context of this rulemaking. However, EPA has determined that these recommendations require additional research, review, and public comment before we can apply them to a rulemaking context. EPA has therefore continued to use the SCC estimates developed through the 2009–2010 interagency process in this rulemaking, consistent with the proposal. See the EPA Response to Comments document, Section 18.4.1, for detailed responses to these recommendations.

On the other hand, the Institute for Energy Research disagreed with the use of SCC in general to value GHG benefits, describing it as an unsupportable metric. EPA disagrees with this comment and notes that the SCC estimates were developed through an extensive, interagency process using a defensible set of input assumptions that are grounded in the existing literature. In this way, key uncertainties and model differences more transparently and consistently inform the range of SCC estimates used in the rulemaking process. In addition, these estimates have been subject to public comment through multiple rulemaking processes.[839] See EPA's Response to Comments document for a more detailed response to this comment.

Another limitation of the primary benefits analysis is that it does not include the valuation of non-CO_2 GHG impacts (i.e., CH_4, N_2O, and HFCs). The interagency group did not directly estimate the social costs of non-CO_2 GHG emissions when it developed the current social cost of CO_2 values. One way to approximate the value of marginal non-CO_2 GHG emission reductions in the absence of direct model estimates is to convert the reductions to CO_2-equivalents which may then be valued using the SCC. Conversion to CO_2-e is typically done

[836] Docket ID EPA–HQ–OAR–2010–0799–0737, *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://www.epa.gov/oms/climate/regulations/scc-tsd.pdf.*

[837] The SCC estimates were converted from 2008 dollars to 2010 dollars using a GDP price deflator (1.02). (EPA originally updated the interagency SCC estimates from 2007 to 2008 dollars in the 2012–2016 light-duty GHG rulemaking using a GDP price deflator of 1.021). All price deflators were obtained from the Bureau of Economic Analysis, National Income and Product Accounts Table 1.1.4, *Prices Indexes for Gross Domestic Product.*

[838] National Research Council (2009). *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* National Academies Press. See docket ID EPA–HQ–OAR–2010–0799–0738.

[839] For example, see: (1) EPA/DOT Rulemaking to establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards (75 FR 25324; 5/7/10); (2) Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (76 FR 57106; 9/15/11); and (3) Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews (77 FR 49490; August 16, 2012).

using the global warming potential (GWP) for the non-CO_2 gas. We refer to this as the ''GWP approach.''

Recognizing that non-CO_2 GHG impacts associated with this rulemaking (net reductions in CH_4, N_2O, and HFCs) would provide economic benefits to society, EPA requested comment on a methodology to value such impacts. The Center for Biological Diversity, EDF, IPI, and NRDC strongly encouraged EPA to value non-CO_2 GHG impacts associated with this final rule. EDF and NRDC suggested that EPA use the GWP approach, and EDF also recommended using direct model estimates and presenting a range of estimates in the final rule. Aside from the Institute for Energy Research, which disagreed with use of SCC in general to value GHG impacts, none of the commenters opposed the valuation of non-CO_2 GHG impacts.

While the GWP approach would provide an approximation of the monetized value of the non-CO_2 GHG reductions anticipated from this rule, for a variety of reasons it produces estimates that are less accurate than those obtained from direct model computations (see RIA Chapter 7.1 for detailed discussion). These reasons include the differences in atmospheric lifetime of non-CO_2 gases relative to CO_2. This is a potentially confounding issue given that the social cost of GHGs is based on a discounted stream of damages that are non-linear in temperature. For example, CH_4 has an expected adjusted atmospheric lifetime of about 12 years and associated GWP of 25 (IPCC Fourth Assessment Report (AR4) 100-year GWP estimate). Gases with a relatively shorter lifetime, such as methane, have impacts that occur primarily in the near term and thus are not discounted as heavily as those caused by longer-lived gases, such as CO_2, while the GWP treats additional forcing the same independent of when it occurs in time. Furthermore, the baseline temperature change is lower in the near term and therefore the additional warming from relatively short lived gases will have a lower marginal impact relative to longer lived gases that have an impact further out in the future when baseline warming is higher. In addition, impacts other than temperature change also vary across gases in ways that are not captured by GWP. For instance, CO_2 emissions, unlike CH_4, N_2O, or HFCs, will result in CO_2 passive fertilization to plants.

A limited number of studies in the published literature explore the implications of using a GWP versus a direct estimation approach to quantify the benefits of changes in non-CO_2 GHG emissions from a given policy.[840] One recent working paper (Marten and Newbold, 2011), found that the GWP-weighted benefit estimates for CH_4 and N_2O are likely to be lower than those that would be derived using a directly modeled social cost of these gases for a variety of reasons.[841] The GWP reflects only the integrated radiative forcing of a gas over 100 years. In contrast, the directly modeled social cost differs from the GWP because the differences in timing of the warming between gases are explicitly modeled, the non-linear effects of temperature change on economic damages are included, and rather than treating all impacts over a hundred years equally, the modeled social cost applies a discount rate but calculates impacts through the year 2300.

In the absence of direct model estimates from the interagency analysis, EPA has used the GWP approach to estimate the dollar value of the non-CO_2 benefits of this rule in a sensitivity analysis. Specifically, the EPA converted each non-CO_2 GHG (CH_4, N_2O, HFC–134a) to CO_2 equivalents using the GWP of each gas, then multiplied these CO_2 equivalent emission reductions by the social cost of carbon developed by the 2009–2010 interagency process. EPA has presented these estimates for illustrative purposes in a sensitivity analysis, i.e., the estimates are not included in the total benefit estimate of this rulemaking. EPA views the GWP approach as an interim method for analysis until we develop values for non-CO_2 GHGs. EPA also recently used this approach to estimate the CH_4 co-benefits in a sensitivity analysis for the New Source Performance Standards final rule for oil and gas exploration.[842] The methane co-benefits were presented for illustrative purposes and therefore not included in the total benefit estimate for the rulemaking.

Applying the global SCC estimates, shown in Table III–87, to the estimated reductions in CO_2 emissions under the final standards, we estimate the dollar value of the CO_2-related benefits for our primary benefits analysis (see EPA's RIA for estimates in each 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%.[843] These estimates are provided in Table III–88.

TABLE III–87—SOCIAL COST OF CO_2, 2017–2050 [a]

[in 2010 dollars per metric ton]

Year	Discount rate and statistic			
	5% Average	3% Average	2.5% Average	3% 95th Percentile
2017	$6	$26	$41	$79
2020	7	27	43	84
2030	10	34	52	104
2040	13	41	61	124
2050	16	47	68	142

[a] The SCC values are dollar-year and emissions-year specific.

[840] For example: Hope, C. (2005) ''The climate change benefits of reducing methane emissions.'' *Climatic Change,* 68(1–2):21–39. See also Stephanie Waldhoff, David Anthoff, Steven Rose, and Richard S.J. Tol (2011). The Marginal Damage Costs of Different Greenhouse Gases: An Application of FUND. Economics Discussion Papers, No 2011–43, Kiel Institute for the World Economy. *http://www.economics-ejournal.org/economics/discussionpapers/2011-43.*

[841] Marten, A. and S. Newbold. 2011. ''Estimating the Social Cost of Non-CO_2 GHG Emissions: Methane and Nitrous Oxide.'' *NCEE Working Paper Series* #11–01. *http://yosemite.epa.gov/ee/epa/eed.nsf/WPNumber/2011-01?opendocument.* Accessed May 24, 2012.

[842] EPA signed final rule on 4/17/12; publication of the official version in the **Federal Register** is forthcoming. For internet version of final rule, see *http://www.epa.gov/airquality/oilandgas/pdfs/20120417finalrule.pdf.*

[843] 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–88—UNDISCOUNTED ANNUAL MONETIZED CO_2 BENEFITS OF VEHICLE PROGRAM, ANNUAL CO_2 EMISSION REDUCTIONS [a] AND CO_2 BENEFITS DISCOUNTED BACK TO 2012

[Dollar values in millions of 2010$]

Year	CO_2 emissions reduction (MMT)	Benefits			
		Avg SCC at 5% ($6–$16) [a]	Avg SCC at 3% ($26–$47) [a]	Avg SCC at 2.5% ($41–$68) [a]	95th percentile SCC at 3% ($79–$142) [a]
2017	2.1	$14	$55	$87	$167
2020	23.1	164	633	1,000	1,940
2030	246.7	2,500	8,410	12,900	25,700
2040	417.0	5,510	17,000	25,400	51,800
2050	522.4	8,540	24,400	35,400	74,100
Net Present Value [b]		32,400	170,000	290,000	519,000

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.

We also apply the GWP approach in a sensitivity analysis to estimate the benefits associated with reductions of three non-CO_2 GHGs. Estimates are given for illustrative purposes and represent the CO_2-e estimate of CH_4, N_2O, and HFC reductions multiplied by the SCC estimates (''GWP approach''), as described further above. CO_2-e is calculated using the AR4 100-year GWP of each gas: CH_4 (25), N_2O (298), and HFC–134a (1,430).[844] The total net present value of the annual 2017 through 2050 GHG benefits for this rulemaking would increase by about $3 billion to $50 billion, depending on discount rate used for the SCC estimate, or roughly 10 percent if these non-CO_2 estimates were included (an amount which is small in the context of the total costs and benefits considered in this rule, and which would not affect any of the decisions regarding the appropriateness of the standards EPA is adopting here). The estimates are provided in the table below.

TABLE III–89—UNDISCOUNTED ANNUAL MONETIZED NON-CO_2 GHG BENEFITS OF MY 2017–2025 STANDARDS IN ANNUAL CO_2 EQUIVALENTS [a] AND CO_2 EQUIVALENTS BENEFITS DISCOUNTED BACK TO 2012

[Dollar values in millions of 2010$]

Year	Non–CO_2 GHG emissions reduction (MMT CO_2-e)	Benefits			
		Avg SCC at 5% ($6–$16) [a]	Avg SCC at 3% ($26–$47) [a]	Avg SCC at 2.5% ($41–$68) [a]	95th percentile SCC at 3% ($79–$142) [a]
2017	0.28	$2	$7	$12	$22
2020	3.92	28	107	170	330
2030	24.6	250	838	1,280	2,560
2040	38.0	503	1,550	2,310	4,720
2050	46.9	767	2,190	3,170	6,650
Net Present Value [b]		3,120	16,300	27,700	49,600

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 non-CO_2 emissions changes 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.

7. Non-Greenhouse Gas Health and Environmental Impacts

This section presents EPA's analysis of the criteria pollutant-related health and environmental impacts that will occur as a result of the final standards. Light-duty vehicles and fuels are significant sources of mobile source air pollution such as direct PM, NO_X, SO_X, VOCs and air toxics. The impact that improved fuel economy will have on rebound driving will affect exhaust and evaporative emissions of these pollutants from vehicles. In addition, increased fuel savings associated with improved fuel economy achieved under the standards will affect emissions from upstream sources (see Section III.G for a complete description of emission impacts associated with the final standards). Emissions of NO_X (a precursor to ozone formation and secondarily-formed $PM_{2.5}$), SO_X (a precursor to secondarily-formed $PM_{2.5}$), VOCs (a precursor to ozone formation and, to a lesser degree, secondarily-formed $PM_{2.5}$) and directly-emitted

[844] As in the MY 2012–2016 LD rules and in the MY 2014–2018 MD and HD rule, the global warming potentials (GWP) used in this rulemaking 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 1995 IPCC Second Assessment Report (SAR) are used in the official U.S. GHG inventory submission to the United Nations Framework Convention on Climate Change (UNFCCC) (per the reporting requirements under that international convention). The UNFCCC recently agreed on revisions to the national GHG inventory reporting requirements, and will begin using the 100-year GWP values from AR4 for inventory submissions in the future. According to the AR4, CH_4 has a 100-year GWP of 25, N_2O has a 100-year GWP of 298, and HFC–134a has a 100-year GWP of 1430.

$PM_{2.5}$ contribute to ambient concentrations of $PM_{2.5}$ and ozone. Exposure to ozone and $PM_{2.5}$ is linked to adverse human health impacts such as premature deaths as well as other important public health and environmental effects.

As many commenters noted, it is important to quantify the health and environmental impacts associated with the final rule because it allows us to more accurately assess the net costs and benefits of the standards. 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.

This section is split into two sub-sections: the first presents the PM- and ozone-related health and environmental impacts associated with the final rule in calendar year (CY) 2030; the second presents the PM-related dollar-per-ton values used to monetize the PM-related co-benefits associated with the model year (MY) analysis (i.e., over the lifetimes of the MY 2017–2025 vehicles) of the final rule.[845]

EPA did receive adverse comments regarding the omission of some non-GHG impacts in the proposal. In that analysis, we used ''dollar-per-ton'' estimates to monetize the health-related impacts of reduced exposure to $PM_{2.5}$. We continue to apply these values in the MY analysis for the final rule. No ''dollar-per-ton'' method exists for ozone or toxic air pollutants due to complexity associated with atmospheric chemistry (for ozone and toxics) and a lack of economic valuation data/methods (for air toxics). However, we have conducted full-scale photochemical air quality modeling to estimate the change in ambient concentrations of ozone, $PM_{2.5}$ and air toxics for the CY analysis in 2030 and used these modeling results as the basis for estimating the human health impacts and their economic value of the rule in 2030. EPA had neither the time nor resources to conduct such modeling for the Model Year analysis.

a. Quantified and Monetized Non-GHG Human Health Benefits of the 2030 Calendar Year (CY) Analysis

This analysis reflects the impact of the final light-duty GHG rule in 2030 compared to a future-year reference scenario without the rule in place.

We estimate that the final rule will lead to a small net reduction in $PM_{2.5}$-related health impacts—the reduction in population-weighted national average $PM_{2.5}$ exposure results in a small net reduction in adverse PM-related human health impacts (the reduction in national population-weighted annual average $PM_{2.5}$ is 0.0065 μg/m3).

The air quality modeling also projects a very small increase in ozone concentrations in many areas (population-weighted maximum 8-hour average ozone increases by 0.0009 ppb). While the ozone-related impacts are very small, the increase in population-weighted national average ozone exposure results in a very small increase in ozone-related health impacts.

We base our analysis of the final rule's impact on human health in 2030 on peer-reviewed studies of air quality and human health effects.[846,847] These methods are described in more detail in the RIA that accompanies this action. Our benefits methods are also consistent with recent rulemaking analyses such as the proposed Portland Cement National Emissions Standards for Hazardous Air Pollutants (NESHAP) RIA,[848] the final NO_2 NAAQS,[849] and the final Category 3 Marine Engine rule,[850] and the final Cross State Air Pollution Rule.[851] To model the ozone and PM air quality impacts of the final rule, we used the Community Multiscale Air Quality (CMAQ) model (see Section III.G.4). The modeled ambient air quality data serves as an input to the Environmental Benefits Mapping and Analysis Program (BenMAP).[852] BenMAP is a computer program developed by the U.S. EPA that integrates a number of the modeling elements used in previous analyses (e.g., interpolation functions, population projections, health impact functions, valuation functions, analysis and pooling methods) to translate modeled air concentration estimates into health effects incidence estimates and monetized benefits estimates.

The range of total monetized ozone- and PM-related health impacts is presented in Table III–90. We present total benefits (the sum of morbidity-related benefits and mortality-related benefits) based on the PM- and ozone-related premature mortality function used. The benefits ranges therefore reflect the addition of each estimate of ozone-related premature mortality (across six selected studies, each with its own row in Table III–90) to each estimate of PM-related premature mortality (based on either Pope et al., 2002 or Laden et al., 2006), along with all morbidity-related benefits. These estimates represent EPA's preferred approach to characterizing a best estimate of monetized impacts. As is the nature of Regulatory Impact Analyses (RIAs), the assumptions and methods used to estimate air quality impacts evolve to reflect the Agency's most current interpretation of the scientific and economic literature.

[845] EPA typically analyzes rule impacts (emissions, air quality, costs and benefits) in the year in which they occur; for this analysis, we selected 2030 as a representative future year. We refer to this analysis as the ''Calendar Year'' (CY) analysis. EPA also conducted a separate analysis of the impacts over the model year lifetimes of the 2017 through 2025 model year vehicles. We refer to this analysis as the ''Model Year'' (MY) analysis. In contrast to the CY analysis, the MY lifetime analysis shows the lifetime impacts of the program on each MY fleet over the course of its lifetime.

[846] 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. Retrieved March, 26, 2009 at *http://www.epa.gov/ttn/ecas/ria.html*.

[847] U.S. Environmental Protection Agency. (2008). *Final Ozone NAAQS Regulatory Impact Analysis.* Prepared by: Office of Air and Radiation, Office of Air Quality Planning and Standards. Retrieved March, 26, 2009 at *http://www.epa.gov/ttn/ecas/ria.html*.

[848] U.S. Environmental Protection Agency (U.S. EPA). 2009a. Regulatory Impact Analysis: National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry. Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. Available on the Internet at *http://www.epa.gov/ttn/ecas/regdata/RIAs/portlandcementria_4–20–09.pdf*. Accessed March 15, 2010.

[849] U.S. Environmental Protection Agency (U.S. EPA). 2010. Final NO2 NAAQS Regulatory Impact Analysis (RIA). Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. Available on the Internet at *http://www.epa.gov/ttn/ecas/regdata/RIAs/FinalNO2RIAfulldocument.pdf*. Accessed March 15, 2010.

[850] U.S. Environmental Protection Agency. 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. EPA–420–R–09–019, December 2009. Prepared by Office of Air and Radiation. *http://www.epa.gov/otaq/regs/nonroad/marine/ci/420r09019.pdf*. Accessed February 9, 2010.

[851] U.S. Environmental Protection Agency. 2011. Regulatory Impact Analysis for the Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone in 27 States; Correction of SIP Approvals for 22 States. EPA–HQ–OAR–2009–0491, June 2011. Prepared by Office of Air and Radiation. *http://www.epa.gov/airtransport/pdfs/FinalRIA.pdf*. Accessed May 16, 2012.

[852] Information on BenMAP, including downloads of the software, can be found at *http://www.epa.gov/ttn/ecas/benmodels.html*.

TABLE III–90—ESTIMATED 2030 MONETIZED PM-AND OZONE-RELATED HEALTH IMPACTS [a]

2030 total ozone and PM benefits—PM mortality derived from American Cancer Society analysis and six-cities analysis [a]

Premature ozone mortality function	Reference	Total benefits (billions, 2010$, 3% discount rate) [b,c,d]	Total benefits (billions, 2010$, 7% discount rate) [b,c,d]
Multi-city analyses	Bell et al., 2004	Total: \$1.0–\$2.6	Total: \$0.92–\$2.3.
		PM: \$1.1–\$2.6	PM: \$0.95–\$2.3.
		Ozone: −\$0.006	Ozone: −\$0.006.
	Huang et al., 2005	Total: \$1.0–\$2.6	Total: \$0.92–\$2.3.
		PM: \$1.1–\$2.6	PM: \$0.95–\$2.3.
		Ozone: −\$0.006	Ozone: −\$0.006.
	Schwartz, 2005	Total: \$1.0–\$2.6	Total: \$0.92–\$2.3.
		PM: \$1.1–\$2.6	PM: \$0.95–\$2.3.
		Ozone: −\$0.009	Ozone: −\$0.009.
Meta-analyses	Bell et al., 2005	Total: \$1.0–\$2.6	Total: \$0.92–\$2.3.
		PM: \$1.1–\$2.6	PM: \$0.95–\$2.3.
		Ozone: −\$0.019	Ozone: −\$0.019.
	Ito et al., 2005	Total: \$1.0–\$2.6	Total: \$0.92–\$2.3.
		PM: \$1.1–\$2.6	PM: \$0.95–\$2.3.
		Ozone: −\$0.026	Ozone: −\$0.026.
	Levy et al., 2005	Total: \$1.0–\$2.6	Total: \$0.92–\$2.3.
		PM: \$1.1–\$2.6	PM: \$0.95–\$2.3.
		Ozone: −\$0.027	Ozone: −\$0.027.

Notes:

[a] Total includes premature mortality-related and morbidity-related ozone and $PM_{2.5}$ benefits. Range was developed by adding the estimate from the ozone premature mortality function to the estimate of $PM_{2.5}$-related premature mortality derived from either the ACS study (Pope et al., 2002) or the Six-Cities study (Laden et al., 2006).

[b] Note that totals presented here do not include a number of unquantified health impact categories. A detailed listing of unquantified health and welfare effects is provided in Table III–91.

[c] Results reflect the use of both a 3 and 7 percent discount rate, as recommended by EPA's Guidelines for Preparing Economic Analyses and OMB Circular A–4. Results are rounded to two significant digits for ease of presentation and computation.

[d] Negatives indicate a disbenefit, or an increase in health effect incidence. Monetized impacts are rounded to two significant digits. Totals may not sum due to rounding.

The monetized impacts in Table III–90 include all of the human health impacts we are able to quantify and monetize at this time. However, the full complement of human health and welfare effects associated with PM, ozone and other criteria pollutants remain unquantified because of current limitations in methods or available data. We have not quantified a number of known or suspected health effects linked with ozone, PM and other criteria pollutants for which appropriate health impact functions are not available or which do not provide easily interpretable outcomes (e.g., changes in heart rate variability). Additionally, we are unable to quantify a number of known welfare effects, including reduced acid and particulate deposition damage to cultural monuments and other materials, and environmental benefits due to reductions of impacts of eutrophication in coastal areas. These are listed in Table III–91. As a result, the health benefits quantified in this section do not reflect the full range of possible impacts attributable to the final rule.

TABLE III–91—UNQUANTIFIED AND NON-MONETIZED POTENTIAL EFFECTS

Pollutant/effects	Effects not included in analysis—changes in:
Ozone Health [a]	Chronic respiratory damage.[b]
	Premature aging of the lungs.[b]
	Non-asthma respiratory emergency room visits.
	Exposure to UVb (+/−).[e]
Ozone Welfare	Yields for
	—commercial forests.
	—some fruits and vegetables.
	—non-commercial crops.
	Damage to urban ornamental plants.
	Impacts on recreational demand from damaged forest aesthetics.
	Ecosystem functions.
	Exposure to UVb (+/−).[e]
PM Health [c]	Premature mortality—short term exposures.[d]
	Low birth weight.
	Pulmonary function.
	Chronic respiratory diseases other than chronic bronchitis.
	Non-asthma respiratory emergency room visits.
	Exposure to UVb (+/−)[e]
PM Welfare	Residential and recreational visibility in non-Class I areas.
	Soiling and materials damage.
	Damage to ecosystem functions.
	Exposure to UVb (+/−)[e]
Nitrogen and Sulfate Deposition Welfare	Commercial forests due to acidic sulfate and nitrate deposition.
	Commercial freshwater fishing due to acidic deposition.

TABLE III–91—UNQUANTIFIED AND NON-MONETIZED POTENTIAL EFFECTS—Continued

Pollutant/effects	Effects not included in analysis—changes in:
	Recreation in terrestrial ecosystems due to acidic deposition.
	Existence values for currently healthy ecosystems.
	Commercial fishing, agriculture, and forests due to nitrogen deposition.
	Recreation in estuarine ecosystems due to nitrogen deposition.
	Ecosystem functions.
	Passive fertilization.
CO Health	Behavioral effects.
HC/Toxics Health [f]	Cancer (benzene, 1,3-butadiene, formaldehyde, acetaldehyde)
	Anemia (benzene).
	Disruption of production of blood components (benzene).
	Reduction in the number of blood platelets (benzene).
	Excessive bone marrow formation (benzene).
	Depression of lymphocyte counts (benzene).
	Reproductive and developmental effects (1,3-butadiene).
	Irritation of eyes and mucus membranes (formaldehyde).
	Respiratory irritation (formaldehyde).
	Asthma attacks in asthmatics (formaldehyde).
	Asthma-like symptoms in non-asthmatics (formaldehyde).
	Irritation of the eyes, skin, and respiratory tract (acetaldehyde).
	Upper respiratory tract irritation and congestion (acrolein).
HC/Toxics Welfare	Direct toxic effects to animals.
	Bioaccumulation in the food chain.
	Damage to ecosystem function.
	Odor.

Notes:

[a] The public health impact of biological responses such as increased airway responsiveness to stimuli, inflammation in the lung, acute inflammation and respiratory cell damage, and increased susceptibility to respiratory infection are likely partially represented by our quantified endpoints.

[b] The public health impact of effects such as chronic respiratory damage and premature aging of the lungs may be partially represented by quantified endpoints such as hospital admissions or premature mortality, but a number of other related health impacts, such as doctor visits and decreased athletic performance, remain unquantified.

[c] In addition to primary economic endpoints, there are a number of biological responses that have been associated with PM health effects including morphological changes and altered host defense mechanisms. The public health impact of these biological responses may be partly represented by our quantified endpoints.

[d] While some of the effects of short-term exposures are likely to be captured in the estimates, there may be premature mortality due to short-term exposure to PM not captured in the cohort studies used in this analysis. However, the PM mortality results derived from the expert elicitation do take into account premature mortality effects of short term exposures.

[e] May result in benefits or disbenefits.

[f] Many of the key hydrocarbons related to this rule are also hazardous air pollutants listed in the CAA.

While there will be impacts associated with air toxic pollutant emission changes that result from the final rule, we do not attempt to monetize those impacts. This is primarily because currently available tools and methods to assess air toxics risk from mobile sources at the national scale are not adequate for extrapolation to incidence estimations or benefits assessment. The best suite of tools and methods currently available for assessment at the national scale are those used in the National-Scale Air Toxics Assessment (NATA). The EPA Science Advisory Board specifically commented in their review of the 1996 NATA that these tools were not yet ready for use in a national-scale benefits analysis, because they did not consider the full distribution of exposure and risk, or address sub-chronic health effects.[853] While EPA has since improved the tools, there remain critical limitations for estimating incidence and assessing benefits of reducing mobile source air toxics. EPA continues to work to address these limitations; however, we did not have the methods and tools available for national-scale application in time for the analysis of the final rule.[854]

EPA is also unaware of specific information identifying any effects on listed endangered species from the small fluctuations in pollutant concentrations associated with this rule (see Section III.G.4). Furthermore, our current modeling tools are not designed to trace fluctuations in ambient concentration levels to potential impacts on particular endangered species.

i. Quantified Human Health Impacts

Table III–92 and Table III–93 present the annual $PM_{2.5}$ and ozone health impacts in the 48 contiguous U.S. states associated with the final rule for 2030. For each endpoint presented in Table III–92 and Table III–93, we provide both the mean estimate and the 90% confidence interval.

Using EPA's preferred estimates, based on the American Cancer Society (ACS) and Six-Cities studies and no threshold assumption in the model of mortality, we estimate that the final rule will reduce between 110 and 280 cases of $PM_{2.5}$-related premature mortality annually in 2030. For ozone-related premature mortality in 2030, we estimate a range of between 1 to 3 cases of additional premature mortality.

[853] 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*.

[854] 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.

TABLE III–92—ESTIMATED $PM_{2.5}$-RELATED HEALTH IMPACTS [a]

Health effect	2030 Annual reduction in incidence (5th%–95th%ile)
Premature Mortality—Derived from epidemiology literature: [b]	
Adult, age 30+, ACS Cohort Study (Pope et al., 2002)	110 (30–190)
Adult, age 25+, Six-Cities Study (Laden et al., 2006)	280 (130–440)
Infant, age <1 year (Woodruff et al., 1997)	0 (0–1)
Chronic bronchitis (adult, age 26 and over)	76 (1–150)
Non-fatal myocardial infarction (adult, age 18 and over)	130 (32–230)
Hospital admissions–respiratory (all ages) [c]	20 (8–32)
Hospital admissions–cardiovascular (adults, age >18) [d]	50 (33–60)
Emergency room visits for asthma (age 18 years and younger)	72 (34–110)
Acute bronchitis, (children, age 8–12)	160 (−42–370)
Lower respiratory symptoms (children, age 7–14)	2,100 (770–3,400)
Upper respiratory symptoms (asthmatic children, age 9–18)	1,600 (260–2,900)
Asthma exacerbation (asthmatic children, age 6–18)	3,500 (−120–9,700)
Work loss days	14,000 (12,000–16,000)
Minor restricted activity days (adults age 18–65)	81,000 (65,000–96,000)

Notes:

[a] Incidence is rounded to two significant digits. Estimates represent incidence within the 48 contiguous United States.

[b] PM-related adult mortality based upon the American Cancer Society (ACS) Cohort Study (Pope et al., 2002) and the Six-Cities Study (Laden et al., 2006). Note that these are two alternative estimates of adult mortality and should not be summed. PM-related infant mortality based upon a study by Woodruff, Grillo, and Schoendorf, (1997).[855]

[c] Respiratory hospital admissions for PM include admissions for chronic obstructive pulmonary disease (COPD), pneumonia and asthma.

[d] Cardiovascular hospital admissions for PM include total cardiovascular and subcategories for ischemic heart disease, dysrhythmias, and heart failure.

TABLE III–93—ESTIMATED OZONE-RELATED HEALTH IMPACTS [a]

Health effect	2030 Annual reduction in incidence (5th%–95th%ile)
Premature Mortality, All ages [b]	
Multi-City Analyses:	
Bell et al. (2004)—Non-accidental	−1 (−4–3)
Huang et al. (2005)—Cardiopulmonary	−1 (−5–4)
Schwartz (2005)—Non-accidental	−1 (−6–4)
Meta-analyses:	
Bell et al. (2005)—All cause	−2 (−10–6)
Ito et al. (2005)—Non-accidental	−3 (−11–6)
Levy et al. (2005)—All causes	−3 (−10–4)
[c] Hospital admissions—respiratory causes (adult, 65 and older)	−6 (−30–15)
Hospital admissions—respiratory causes (children, under 2)	−3 (−12–6)
Emergency room visit for asthma (all ages)	−1 (−18–15)
Minor restricted activity days (adults, age 18–65)	−930 (−18,000–16,000)
School absence days	−850 (−6,700–5,100)

Notes:

[a] Negatives indicate a disbenefit, or an increase in health effect incidence. Incidence is rounded to two significant digits. Estimates represent incidence within the 48 contiguous U.S.

[b] Estimates of ozone-related premature mortality are based upon incidence estimates derived from several alternative studies: Bell et al. (2004); Huang et al. (2005); Schwartz (2005); Bell et al. (2005); Ito et al. (2005); Levy et al. (2005). The estimates of ozone-related premature mortality should therefore not be summed.

[c] Respiratory hospital admissions for ozone include admissions for all respiratory causes and subcategories for COPD and pneumonia.

ii. Monetized Impacts

Table III–94 presents the estimated monetary value of changes in the incidence of ozone and $PM_{2.5}$-related health effects. All monetized estimates are stated in 2010$. These estimates account for growth in real gross domestic product (GDP) per capita between the present and 2030. Our estimate of total monetized impacts in 2030 for the final rule, using the ACS and Six-Cities PM mortality studies and the range of ozone mortality assumptions, is between $1.0 and $2.6 billion, assuming a 3 percent discount rate, and between $0.92 and $2.3 billion, assuming a 7 percent discount rate. As the results below indicate, monetized impacts are driven primarily by the change in premature fatalities in 2030.

[855] Woodruff, T.J., J. Grillo, and K.C. Schoendorf. 1997. ''The Relationship Between Selected Causes of Postneonatal Infant Mortality and Particulate Air Pollution in the United States.'' *Environmental Health Perspectives* 105(6):608–612.

TABLE III–94—ESTIMATED MONETARY VALUE OF CHANGES IN INCIDENCE OF HEALTH AND WELFARE EFFECTS

[In millions of 2010$] [a b]

	2030 (5th and 95th %ile)
$PM_{2.5}$-Related Health Effect	
Premature Mortality—Derived from Epidemiology Studies: [c d]	
Adult, age 30+—ACS study (Pope et al., 2002):	
3% discount rate	$980 ($110–$2,600)
7% discount rate	$880 ($97–$2,400)
Adult, age 25+—Six-Cities study (Laden et al., 2006):	
3% discount rate	$2,500 ($340–$6,300)
7% discount rate	$2,300 ($310–$5,700)
Infant Mortality, <1 year—(Woodruff et al. 1997)	$3.8 (−$3.9–$15)
Chronic bronchitis (adults, 26 and over)	$42 ($0.4–$140)
Non-fatal acute myocardial infarctions:	
3% discount rate	$14 ($2.3–$36)
7% discount rate	$12 ($1.8–$30)
Hospital admissions for respiratory causes	$0.32 ($0.13–$0.51)
Hospital admissions for cardiovascular causes	$0.73 ($0.07–$1.4)
Emergency room visits for asthma	$0.03 ($0.01–$0.05)
Acute bronchitis (children, age 8–12)	$0.08 (−$0.02–$0.21)
Lower respiratory symptoms (children, 7–14)	$0.04 ($0.01–$0.09)
Upper respiratory symptoms (asthma, 9–11)	$0.05 ($0.009–$0.12)
Asthma exacerbations	$0.20 (−$0.007–$0.58)
Work loss days	$2.2 ($1.9–$2.6)
Minor restricted-activity days (MRADs)	$5.6 ($3.2–$8.1)
Ozone-related Health Effect	
Premature Mortality, All ages—Derived from Multi-city analyses:	
Bell et al., 2004	−$5.8 (−$45–$27)
Huang et al., 2005	−$6.2 (−$60–$41)
Schwartz, 2005	−$8.7 (−$71–$44)
Premature Mortality, All ages—Derived from Meta-analyses:	
Bell et al., 2005	−$19 (−$120–$38)
Ito et al., 2005	−$26 (−$140–$58)
Levy et al., 2005	−$27 (−$120–$38)
Hospital admissions—respiratory causes (adult, 65 and older)	−$0.16 (−$0.77–$0.39)
Hospital admissions—respiratory causes (children, under 2)	−$0.03 (−$130–$0.07)
Emergency room visit for asthma (all ages)	−$0.0003 (−$0.007–$0.006)
Minor restricted activity days (adults, age 18–65)	−$0.06 (−$1.3–$1.1)
School absence days	−$0.08 (−$0.65–$0.49)

Notes:

[a] Negatives indicate a disbenefit, or an increase in health effect incidence. Monetized impacts are rounded to two significant digits for ease of presentation and computation. PM and ozone benefits are nationwide.

[b] Monetary benefits adjusted to account for growth in real GDP per capita between 1990 and the analysis year (2030).

[c] Valuation assumes discounting over the SAB recommended 20 year segmented lag structure. Results reflect the use of 3 percent and 7 percent discount rates consistent with EPA and OMB guidelines for preparing economic analyses.

iii. What Are the Limitations of the Benefits Analysis?

Every benefit-cost analysis examining the potential effects of a change in environmental protection requirements is limited to some extent by data gaps, limitations in model capabilities (such as geographic coverage), and uncertainties in the underlying scientific and economic studies used to configure the benefit and cost models. Limitations of the scientific literature often result in the inability to estimate quantitative changes in health and environmental effects, such as potential increases in premature mortality associated with increased exposure to carbon monoxide. Deficiencies in the economics literature often result in the inability to assign economic values even to those health and environmental outcomes which can be quantified. These general uncertainties in the underlying scientific and economics literature, which can lead to valuations that are higher or lower, are discussed in detail in the RIA and its supporting references. Key uncertainties that have a bearing on the results of the benefit-cost analysis of the final rule include the following:

- The exclusion of potentially significant and unquantified benefit categories (such as health, odor, and ecological benefits of reduction in air toxics, ozone, and PM);
- Errors in measurement and projection for variables such as population growth;
- Uncertainties in the estimation of future year emissions inventories and air quality;
- Uncertainty in the estimated relationships of health and welfare effects to changes in pollutant concentrations including the shape of the concentration-response function, the

size of the effect estimates, and the relative toxicity of the many components of the PM mixture;

- Uncertainties in exposure estimation; and
- Uncertainties associated with the effect of potential future actions to limit emissions.

As Table III–94 indicates, total benefits are driven primarily by the reduction in premature mortalities each year. Some key assumptions underlying the premature mortality estimates include the following, which may also contribute to uncertainty:

- Inhalation of fine particles is causally associated with premature death at concentrations near those experienced by most Americans on a daily basis. Although biological mechanisms for this effect have not yet been completely established, the weight of the available epidemiological, toxicological, and experimental evidence supports an assumption of causality. The impacts of including a probabilistic representation of causality were explored in the expert elicitation-based results of the 2006 p.m. NAAQS RIA.
- All fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because PM produced via transported precursors emitted from stationary sources may differ significantly from PM precursors released from mobile sources and other industrial sources. However, no clear scientific grounds exist for supporting differential effects estimates by particle type.
- The C–R function for fine particles is approximately linear within the range of ambient concentrations under consideration. Thus, the estimates include health benefits from reducing fine particles in areas with varied concentrations of PM, including both regions that may be in attainment with $PM_{2.5}$ standards and those that are at risk of not meeting the standards.
- There is uncertainty in the magnitude of the association between ozone and premature mortality. The range of ozone impacts associated with the final standards is estimated based on the risk of several sources of ozone-related mortality effect estimates. In a 2008 report on the estimation of ozone-related premature mortality published by the National Research Council, a panel of experts and reviewers concluded that short-term exposure to ambient ozone is likely to contribute to premature deaths and that ozone-related mortality should be included in estimates of the health benefits of reducing ozone exposure.[856] EPA has requested advice from the National Academy of Sciences on how best to quantify uncertainty in the relationship between ozone exposure and premature mortality in the context of quantifying benefits.

Acknowledging the data limitations and uncertainties, we present a best estimate of the total monetized health impacts based on our interpretation of the best available scientific literature and methods supported by EPA's technical peer review panel, the Science Advisory Board's Health Effects Subcommittee (SAB–HES). The National Academies of Science (NRC, 2002) has also reviewed EPA's methodology for analyzing the health benefits of measures taken to reduce air pollution. EPA addressed many of these comments in the analysis of the final PM NAAQS.[857,858] The analysis in this final rule incorporates this most recent work to the extent possible.

b. PM-Related Monetized Benefits of the Model Year (MY) Analysis

As described in Section III.G, the final standards will in some cases increase and other cases decrease emissions of several criteria and toxic air pollutants and precursors. In the MY analysis, EPA estimates the economic value of the human health impacts associated with $PM_{2.5}$ exposure. Due to analytical limitations, this analysis does not estimate impacts related to other criteria pollutants (such as ozone, NO_2 or SO_2) or toxics pollutants, nor does it monetize all of the potential health and welfare effects associated with $PM_{2.5}$.

The MY analysis uses a ''dollar-per-ton'' method to estimate a selected suite of $PM_{2.5}$-related health impacts described below. These $PM_{2.5}$ dollar-per-ton estimates provide the total monetized human health impacts (the sum of premature mortality and premature morbidity) of reducing/increasing 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 impacts associated with the MY analysis would be estimated based on changes in ambient $PM_{2.5}$ as determined by full-scale air quality modeling.

The agency did receive adverse comments regarding the omission of these impacts in the analysis, however, no ''dollar-per-ton'' method exists for ozone or toxic air pollutants due to complexity associated with atmospheric chemistry (for ozone and toxics) and a lack of economic valuation data/methods (for air toxics). However, EPA also conducted full scale, photochemical air quality modeling to estimate the change in ambient concentrations of both ozone and $PM_{2.5}$ and used this as a basis for estimating the human health impacts and their economic value of the rule in 2030. Section III.G.4 presents these impact estimates.

The dollar-per-ton estimates used in this analysis are provided in Table III–95. In the summary of costs and benefits, Section III.H.10 of this preamble, EPA presents the monetized value of PM-related improvements associated with the rule.

TABLE III–95—$PM_{2.5}$-RELATED DOLLAR-PER-TON VALUES

[2010$][a b]

Year	All sources [d]	Upstream (non-EGU) sources [d]		Mobile sources	
	SO_2	NO_X	Direct $PM_{2.5}$	NO_X	Direct $PM_{2.5}$
Dollar-per-ton Derived from American Cancer Society Analysis (Pope et al., 2002) Using a 3 Percent Discount Rate [c]					
2015	$30,000	$4,900	$230,000	$5,100	$280,000
2020	33,000	5,400	250,000	5,600	310,000

[856] National Research Council (NRC), 2008. Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution. The National Academies Press: Washington, DC.

[857] National Research Council (NRC). 2002. Estimating the Public Health Benefits of Proposed Air Pollution Regulations. The National Academies Press: Washington, DC.

[858] U.S. Environmental Protection Agency. October 2006. *Final Regulatory Impact Analysis (RIA) for the Proposed National Ambient Air Quality Standards for Particulate Matter.* Prepared by: Office of Air and Radiation. Available at *http://www.epa.gov/ttn/ecas/ria.html.*

TABLE III–95—$PM_{2.5}$-RELATED DOLLAR-PER-TON VALUES—Continued

[2010$][a b]

Year	All sources [d]	Upstream (non-EGU) sources [d]		Mobile sources	
	SO_2	NO_X	Direct $PM_{2.5}$	NO_X	Direct $PM_{2.5}$
2030	38,000	6,400	290,000	6,700	370,000
2040	45,000	7,600	340,000	8,000	440,000
Dollar-per-ton Derived from American Cancer Society Analysis (Pope et al., 2002) Estimated Using a 7 Percent Discount Rate [c]					
2015	27,000	4,500	210,000	4,600	250,000
2020	30,000	4,900	230,000	5,100	280,000
2030	35,000	5,800	270,000	6,100	330,000
2040	41,000	6,900	310,000	7,300	400,000
Dollar-per-ton Derived from Six Cities Analysis (Laden et al., 2006) Estimated Using a 3 Percent Discount Rate [c]					
2015	73,000	12,000	560,000	12,000	680,000
2020	80,000	13,000	620,000	14,000	750,000
2030	94,000	16,000	720,000	16,000	900,000
2040	110,000	19,000	840,000	20,000	1,100,000
Dollar-per-ton Derived from Six Cities Analysis (Laden et al., 2006) Estimated Using a 7 Percent Discount Rate [c]					
2015	66,000	11,000	510,000	11,000	620,000
2020	72,000	12,000	560,000	12,000	680,000
2030	84,000	14,000	650,000	15,000	810,000
2040	99,000	17,000	760,000	18,000	960,000

[a] Total dollar-per-ton estimates include monetized $PM_{2.5}$-related premature mortality and morbidity endpoints. Range of estimates are a function of the estimate of $PM_{2.5}$-related premature mortality derived from either the ACS study (Pope et al., 2002) or the Six-Cities study (Laden et al., 2006).

[b] Dollar-per-ton values were estimated for the years 2015, 2020, and 2030. For 2040, EPA extrapolated exponentially based on the growth between 2020 and 2030.

[c] The dollar-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.

[d] Note that the dollar-per-ton value for SO_2 is based on the value for Stationary (Non-EGU) sources; no SO_2 value was estimated for mobile sources.

The dollar-per-ton technique has been used in previous analyses, including EPA's recent Ozone National Ambient Air Quality Standards (NAAQS) RIA,[859] the Portland Cement National Emissions Standards for Hazardous Air Pollutants (NESHAP) RIA,[860] and the final NO_2 NAAQS.[861] Table III–96 shows the quantified and unquantified $PM_{2.5}$-related co-benefits captured in those benefit-per-ton estimates.

[859] U.S. Environmental Protection Agency (U.S. EPA). 2008. Regulatory Impact Analysis, 2008 National Ambient Air Quality Standards for Ground-level Ozone, Chapter 6. Office of Air Quality Planning and Standards, Research Triangle Park, NC. March. Available at *http://www.epa.gov/ttn/ecas/regdata/RIAs/6-ozoneriachapter6.pdf*. Accessed March 15, 2010.

[860] U.S. Environmental Protection Agency (U.S. EPA). 2009. Regulatory Impact Analysis: National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry. Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. Available on the Internet at *http://www.epa.gov/ttn/ecas/regdata/RIAs/portlandcementria_4-;20-09.pdf*. Accessed March 15, 2010.

[861] 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.

TABLE III–96—HUMAN HEALTH AND WELFARE EFFECTS OF $PM_{2.5}$

Quantified and Monetized in Dollar-per-ton Estimates:
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.
Unquantified Effects Changes in:
Subchronic bronchitis cases.
Low birth weight.
Pulmonary function.
Chronic respiratory diseases other than chronic bronchitis.
Non-asthma respiratory emergency room visits.
Visibility.
Household soiling.

Consistent with the NO_2 NAAQS,[862] the dollar-per-ton estimates utilize the concentration-response functions as reported in the epidemiology literature. To calculate the total monetized impacts associated with quantified health impacts, EPA applies values derived from a number of sources. For premature mortality, EPA applies a value of a statistical life (VSL) derived from the mortality valuation literature. For certain health impacts, such as chronic bronchitis and a number of respiratory-related ailments, EPA applies willingness-to-pay estimates derived from the valuation literature. For the remaining health impacts, EPA applies values derived from current cost-of-illness and/or wage estimates.

Readers interested in reviewing the complete methodology for creating the dollar-per-ton estimates used in this analysis can consult the Technical Support Document (TSD)[863] accompanying the final ozone NAAQS RIA. Readers can also refer to Fann et al. (2009)[864] for a detailed description of the dollar-per-ton methodology.[865] A more detailed description of the dollar-per-ton estimates is also provided in the Joint TSD that accompanies this rulemaking.

As described in the documentation for the dollar-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 changes in tons from those specific pollutant/source combinations (e.g., NO_2 emitted from mobile sources; direct PM emitted from stationary sources). Our estimate of $PM_{2.5}$-related impacts is therefore based on the total direct $PM_{2.5}$ and PM-related precursor emissions changes by sector and multiplied by each per-ton value.

The dollar-per-ton estimates are subject to a number of assumptions and uncertainties.

○ Dollar-per-ton estimates do not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors that might lead to an overestimate or underestimate of the actual impacts of fine particulates. In Section III.G, we describe the full-scale air quality modeling conducted for the 2030 calendar year analysis in an effort to capture this variability.

○ There are several health impact categories that EPA was unable to quantify in the MY analysis due to limitations associated with using dollar-per-ton estimates. Because NO_X and VOC emissions are also precursors to ozone, changes in NO_X and VOC would also impact ozone formation and the health effects associated with ozone exposure. Dollar-per-ton estimates for ozone, however, do not exist due to issues associated with the complexity of the atmospheric air chemistry and nonlinearities associated with ozone formation. The PM-related dollar-per-ton estimates also do not include any human welfare or ecological impacts. Please refer to Chapter 6 of the RIA that accompanies this rule for a description of the quantification and monetization of health impacts for the CY analysis and a description of the unquantified non-GHG impacts associated with this rulemaking.

○ The dollar-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 dollar-per-ton estimates.

As mentioned above, emissions changes and dollar-per-ton estimates alone are not a good indication of local or regional air quality and health impacts, as there may be localized impacts associated with this rulemaking. Additionally, the atmospheric chemistry related to ambient concentrations of $PM_{2.5}$, ozone and air toxics is very complex. Full-scale photochemical modeling is therefore necessary to provide the needed spatial and temporal detail to more completely and accurately estimate the changes in ambient levels of these pollutants and their associated health and welfare impacts. Timing and resource constraints precluded EPA from conducting full-scale photochemical air quality modeling for the MY analysis. We have, however, conducted national-scale air quality modeling for the CY analysis to analyze the impacts of the standards on $PM_{2.5}$, ozone, and selected air toxics (see the preceding section, Section III.7.a).

8. Energy Security Impacts

The 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 rule. 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 2011, the United States imported 45 percent of the petroleum it consumed,[866] while the transportation sector accounted for 70 percent of total U.S. petroleum consumption.[867]

[862] Although we summarize the main issues in this chapter, we encourage interested readers to see the benefits chapter of the NO_2 NAAQS for a more detailed description of recent changes to the PM benefits presentation and preference for the no-threshold model.

[863] U.S. Environmental Protection Agency (U.S. EPA). 2008b. Technical Support Document: Calculating Benefit Per-Ton estimates, Ozone NAAQS Docket #EPA–HQ–OAR–2007–0225–0284. Office of Air Quality Planning and Standards, Research Triangle Park, NC. March. Available on the Internet at *http://www.regulations.gov*.

[864] 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.

[865] 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*

[866] *http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_3.pdf*.

[867] *http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_3.pdf*.

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 these standards are discussed in Section III.H.4 and in EPA's RIA.

Based on analysis of historical and projected future variation in U.S. petroleum consumption and imports, EPA estimates that approximately 50 percent of the reduction in fuel consumption resulting from adopting improved GHG emission standards is likely to be reflected in lower 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 our final standards is anticipated to reduce total U.S. imports of petroleum by 0.95 gallons.[868] Table III–97 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–97—PROJECTED IMPORT REDUCTIONS FROM THIS RULE 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 rule (mmbd)	U.S. total petroleum-based imports without the rule (mmbb)
2020 ..	0.133	9.26
2030 ..	1.42	8.94
2040 ..	2.41	NA
2050 ..	3.02	NA

Note: NA—Not available, forecasts reported in EIA's Annual Energy Outlook 2012 (Early Release) extend only to 2035.

b. Overview of EPA's Analysis of Energy Security Benefits

U.S. consumption of imported petroleum products imposes costs on the domestic economy that are not reflected in the market price for crude oil, or in the prices paid by consumers of petroleum products such as gasoline (i.e., energy security costs). 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 effect''); (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. (i.e., ''macroeconomic disruption and adjustment costs''); 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 (i.e., ''military/SPR costs'').[869]

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 energy security implications of oil use. The energy security estimates or ''premiums'' 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 rule.[870,871]

When conducting its analysis, ORNL estimated energy security premiums by quantifying two components of the economic cost of importing petroleum into the U.S. (in addition to the purchase price of petroleum itself): Monopsony and macroeconomic disruption costs. For this rule, EPA worked with ORNL to update the energy security premiums by incorporating the AEO 2012 Early Release oil price forecasts and market trends.[872] Energy security premiums for the selected years are presented in Table III–2 as well as a breakdown of the components of the energy security premiums for each of these years.[873,874] The components of ORNL's energy security premiums and their values are discussed in detail in the Joint TSD Chapter 4.2.8. EPA did not include the monopsony cost component in our cost-benefit analysis (see discussion in Section III.H.8.c). The ORNL analysis did not include military or SPR costs nor did EPA quantify them for this rule (see discussion in Section III.H.8.e).

TABLE III–98—ENERGY SECURITY PREMIUMS IN SELECTED YEARS

[2010$/Barrel]

	Monopsony	Macroeconomic disruption/adjustment costs	Total
2020	$10.02 ($3.35–$17.09)	$7.63 ($3.71–$11.00)	$17.64 ($9.83–$25.00)
2025	$9.77 ($3.25–$16.69)	$8.26 ($4.03–$11.92)	$18.03 ($10.15–$25.47)
2030	$9.28 ($3.10–$18.03)	$8.77 ($4.33–$12.60)	$18.05 ($10.29–$25.20)

[868] This figure is calculated as 0.50 + 0.50*0.9 = 0.50 + 0.45 = 0.95.

[869] 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.

[870] 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).

[871] The ORNL study ''*The Energy Security Benefits of Reduced Oil Use, 2006–2015,*'' completed in March 2008, is an updated version of the approach used for estimating the energy security benefits of U.S. oil import reductions developed in an ORNL 1997 Report by Leiby, Paul N., Donald W. Jones, T. Randall Curlee, and Russell Lee, entitled ''*Oil Imports: An Assessment of Benefits and Costs.*'' (Docket EPA–HQ–OAR–2010–0162).

[872] Leiby, Paul. Oak Ridge National Laboratory. ''*Approach to Estimating the Oil Import Security Premium for the MY 2017–2025 Light Duty Vehicle Rule*'' 2012.

[873] AEO 2012 (Early Release) forecasts energy market trends and values only to 2035. The energy security premium estimates post-2035 were assumed to be the 2035 estimate. Due to timing constraints, the energy security premiums ($/gallon) were derived using estimates of the gasoline consumption reductions projected from this rule proposal.

[874] Due to timing constraints, this analysis was conducted with preliminary estimates of the fuel savings projected from this rule, which were highly similar to the final estimates for the rule.

TABLE III–98—ENERGY SECURITY PREMIUMS IN SELECTED YEARS—Continued

[2010$/Barrel]

	Monopsony	Macroeconomic disruption/adjustment costs	Total
2035+	$9.73 ($3.24–$16.68)	$9.46 ($4.72–$13.61)	$19.19 ($10.94–$26.78)

Note: The main values in Table III–2 represent the mid-point of the ranges (90% confidence levels) of the values presented in the parentheses.

Numerous private citizens and commenters from a large number of consumer groups, environmental organizations, and energy security advocacy organizations expressed strong support in both written comments and at the agencies' public hearings that these standards will have significant benefits for U.S. energy and national security, including energy independence. For example, the BlueGreen Alliance commented that ''[s]trong standards will keep more of the dollars here in the United States * * *'' and ''[t]hey will also set the stage for weaning America off oil dependence * * *'' Similarly, a Michigan State Senator, District 18 commented that ''[g]reater fuel economy benefits all of us in four ways: firstly, it benefits our environment by reducing greenhouse gas emissions; secondly, it secures our energy independence; thirdly, its saves us money at the pump; and finally, it creates high-quality U.S. jobs that strengthen the economy.'' The Pew Charitable Trusts stated that ''[o]ur bipartisan poll commissioned in July 2011 found that 91 percent of Americans identify U.S. dependence on foreign oil as a threat to our national security, and significant bipartisan majorities in every region of the country believe that adopting stronger fuel economy standards is the best way to lessen that dependence.'' Finally, the Union of Concerned Scientist estimated that ''* * * the cumulative oil savings of the National Program (MYs 2012–2025) could result in a total reduction in U.S. oil consumption of nearly 3.5 mbd in 2030, nearly double the amount the U.S. currently imports from the entire Persian Gulf. No other federal policy has delivered greater oil savings, energy security benefits, or greenhouse gas emissions reductions to the country.''

In contrast, the Defour Group commented that there is no relationship between the energy security benefits of the U.S. and reduced oil consumption by the U.S., since the world economies are all tied together, thus calling into question estimates of the energy security benefits of the rule. Moreover, the Defour Group believes there is too much uncertainty in generating energy security premiums.

EPA sponsored an extensive peer review of the methodology on which the proposed energy security benefits for this rule were based. The peer reviewers were generally highly supportive of the energy security methodology developed by ORNL and used by EPA. Also, EPA used this same energy security methodology in a number of previous rulemakings including the MYs 2012–2016 light duty vehicle GHG rule and the MYs 2014–2018 medium- and heavy-duty vehicle GHG rule, with numerous commenters to those rules supporting the use of the methodology. Thus, while EPA considered all these comments, we continue to believe that the peer-reviewed, well scrutinized methodology used at proposal is reasonable and we are continuing to use it in this final rule for estimating the energy security benefits of this rule.

EPA also solicited comments in the proposal on how to estimate the energy security benefits of the wider use of PHEVs and EVs including any relevant studies or research that have been published on these issues. Tesla Motors, Inc. commented that ''[r]educing our dependence on petroleum in the transportation sector is a national imperative.'' They go on to state that shifting the transportation sector to electricity would lessen the U.S. dependence on foreign oil and increase national security. However, no commenter provided EPA with a robust methodology for estimating the energy security benefits of the wider use of PHEVs and EVs as a result of this rule. Thus, due to timing constraints and the technical complexity of examining this issue, EPA was unable to conduct such an analysis for this rule. This is an issue that EPA will continue to study and will evaluate as part of the midterm review work.

c. Monopsony Component

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 (discussed in III.H.6), 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. reduces 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 reduced demand in the U.S. also represents a loss to other countries. Given the redistributive nature of this monopsony effect from a global perspective, EPA excluded monopsony costs from the quantified energy security benefits for the proposed rule. The Union of Concerned Scientists recommended that the monopsony benefits of the rule be included in EPA's overall estimates of the energy security benefits, since it is a benefit to the U.S. EPA continues to view energy security from a global perspective, and therefore excludes monopsony benefits to the U.S. in this final rule since these benefits are offset by losses to foreign oil producers. However, we present the monopsony energy security premiums in Table III–97 to show the general magnitude of their effects.

One potential result of the potential decline in the world price of oil as a result of this rule 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 GHGs, 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 GHG emissions. Therefore, any assessment of the impacts on GHG emissions and other pollutants from a potential increase in world oil demand would need to take into account the impacts on all portions of global energy sector. EPA has not attempted to estimate these effects.

d. Macroeconomic Disruption Component

In contrast to monopsony costs, 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 we include the estimated reduction in their expected value stemming from reduced U.S. petroleum imports in our energy security benefits estimated for this rule (as discussed in sections III.H.8.b and III.H.8.f).

e. Military and SPR Components

The energy security benefits EPA presented in the NPRM 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. A number of commenters, including consumer advocacy and environmental organizations (e.g. Consumer Federation of America, Environmental Defense Fund, and National Wildlife Federation), natural gas organizations (e.g. America's Natural Gas Alliance, and American Gas Association), as well as energy security advocates (Center for Naval Analysis) and numerous private individuals, felt that EPA should quantify, to the extent possible, a military component of the energy security benefits associated with this rulemaking. These commenters felt that, although they understand that EPA would have difficulties in determining a point estimate of the energy security benefits from reduced military costs as a result of the rule, that even ranges would be useful. The American Petroleum Institute commented that military expenditures will not likely change with a reduction in U.S. oil imports, and therefore should not be included in the assessment of this rulemaking.

Like most of the commenters, EPA believes that there is an evident connection between U.S. oil imports and a military presence to secure those imports and that this presence is influenced by the extent of importing. As Lt. Gen (Ret.) Zilmer stated at the Philadelphia public hearing on the proposed rule: ''The United States uses about 20 million barrels of oil a day, 11 million of that is imported'' and ''its often imported from customers who would rather not have to work with you * * * We have not gotten any closer to energy independence, and it becomes an increasing national security issue when we have to constantly have forces deployed in that region of the world, the Middle East and southwest Asia.'' [875]

EPA has examined methodologies for estimating the military component of the energy security benefits of our rule and has faced two major challenges: ''attribution'' and ''incremental'' analysis. The attribution analysis challenge is to determine which military programs and expenditures can properly be attributed to oil supply protection, rather than to some other objective. The incremental analysis challenge is to estimate how much the supply protection costs might vary if U.S. oil use is reduced or eliminated.

We reviewed a number of recent studies that attempt to overcome these challenges.[876] Although these recent studies provide significant, useful insights into the military components of U.S. energy security, they do not provide enough substantive analysis to develop a robust methodology for quantifying the military components of energy security for this rulemaking. Thus, while EPA plans to continue to review new studies that provide better estimates of the military components of U.S. energy security benefits, for this rulemaking EPA continues to exclude military cost components in our quantified energy security benefits. Additional discussion of this issue can be found in Chapter 4.2.8 of the Joint TSD.

A further potential component of the full economic costs of oil imports is the costs of building and maintaining the Strategic Petroleum Reserve (SPR). The SPR is clearly related to U.S. oil use and imports. Indeed, a stated purpose of the Energy Policy Conservation Act is ''to provide for the creation of a Strategic Petroleum Reserve capable of reducing the impact of severe energy supply interruptions'', a provision enacted following the 1973–74 Arab oil embargo.[877] However, these costs have not varied historically in response to changes in U.S. oil import levels. Thus, although the influence of the SPR on oil price increases resulting from a disruption of U.S. oil imports is reflected in the ORNL estimate of the macroeconomic and adjustment cost component of the oil import premium, potential changes in the cost of maintaining the SPR associated with variation in U.S. petroleum imports are excluded.

f. Total Energy Security Benefits

To summarize, EPA has included *only* the macroeconomic disruption and adjustment costs portion of potential energy security benefits to estimate the monetary value of the total energy security benefits of this rule. The energy security premium values in this final rule have been updated since the proposal to reflect the AEO2012 Early Release Reference Case world oil prices. Otherwise, the methodology for estimating the energy security benefits is consistent with that used in the proposal. Based on an 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 GHG rulemakings, we estimate that each gallon of fuel saved will reduce expected macroeconomic disruption and adjustment costs of sudden reductions in the supply of imported oil to the U.S. economy by $0.182 in 2020, $0.197 in 2025, $0.208 in 2030 and $0.225 in 2035, in 2010 dollars.

Using our fuel consumption analysis in conjunction with the macroeconomic disruption and adjustment cost component of ORNL's energy security premium estimates,[878] [879] we developed estimates of the total energy security benefits of this rule for the years 2017 through 2050 as shown in Table III–99.[880]

[875] Transcript of Philadelphia public hearing, pp. 172–73.

[876] More information, including citations for these recent studies, is available in Leiby, Paul. ''Military Costs of Energy Security'', 2012.

[877] See 42 U.S.C section 6201 (2) and *Center for Auto Safety* v. *NHTSA,* 739 F. 2d 1322, 1324 (DC Cir. 1986).

[878] AEO 2012 (Early Release) forecasts energy market trends and values only to 2035. The energy security premium estimates post-2035 were assumed to be the 2035 estimate.

[879] Due to timing constraints, the energy security premiums ($/gallon) were derived using estimates of the gasoline consumption reductions projected from this rule proposal.

[880] Estimated reductions in U.S. imports of finished petroleum products and crude oil are 95 percent of 54.2 million barrels (MMB) in 2020, 609 MMB in 2030, 962 MMB in 2040, and 1,140 MMB in 2050.

TABLE III–99—UNDISCOUNTED ANNUAL ENERGY SECURITY BENEFITS & PROGRAM BENEFITS DISCOUNTED BACK TO 2012

[2010$]

Year	Oil imports reduced (mmb)	Benefits ($ millions)
2017	4.5	$33
2018	14.0	105
2019	28.6	216
2020	48.6	371
2021	77.7	601
2022	114	896
2023	158	1,260
2024	207	1,680
2025	263	2,170
2030	520	4,560
2040	880	8,320
2050	1,103	10,400
NPV, 3%		84,500
NPV, 7%		32,200

9. 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 VMT 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–100 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–100—ADDITIONAL IMPACTS ASSOCIATED WITH THE LIGHT-DUTY VEHICLE GHG PROGRAM

[Millions of 2010 dollars]

	2017	2020	2030	2040	2050	NPV, 3%	NPV, 7%
Accidents, Noise, Congestion Costs [a]	−$54	−$564	−$5,710	−$9,650	−$12,100	−$101,000	−$39,200
Benefits of Increased Driving [b]	79	865	9,560	17,000	14,500	167,000	64,800
Benefits of Less Frequent Refueling	25	282	3,360	6,350	8,870	64,900	24,500

[a] Note that accidents, congestion and noise are costs, so the negative values shown represent increased costs which we treat as negative benefits.

[b] Calculated using post-tax fuel prices.

10. Summary of Costs and Benefits

In this section, the agencies present a summary of costs, benefits, and net benefits of the final program. Table III–101 shows the estimated annual monetized costs of the final 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.[881] Table III–102 shows the undiscounted annual monetized fuel savings of the final 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 final standards.

TABLE III–101—UNDISCOUNTED ANNUAL COSTS & COSTS OF THE FINAL PROGRAM DISCOUNTED BACK TO 2012 AT 3% AND 7% DISCOUNT RATES

[Millions, 2010$] [a]

	2017	2020	2030	2040	2050	NPV, years 2012–2050, 3% discount rate	NPV, years 2012–2050, 7% discount rate
Technology Costs	$2,440	$8,860	$33,700	$37,400	$42,000	$521,000	$231,000
Maintenance Costs	37	330	2,260	3,630	4,540	39,500	15,600
Vehicle Program Costs	2,470	9,190	35,900	41,000	46,500	561,000	247,000

Note:

[a] Technology costs for separate light-duty vehicle segments can be found in Section III.H.2. Annual costs shown are undiscounted values.

[881] 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–102—UNDISCOUNTED ANNUAL FUEL SAVINGS & FINAL PROGRAM FUEL SAVINGS DISCOUNTED BACK TO 2012 AT 3% AND 7% DISCOUNT RATES

[Millions, 2010$] [a]

	2017	2020	2030	2040	2050	NPV, years 2012–2050, 3% discount rate	NPV, years 2012–2050, 7% discount rate
Fuel Savings (pre-tax)	$651	$7,430	$86,400	$155,000	$212,000	$1,600,000	$607,000

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–103 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–103—MONETIZED UNDISCOUNTED ANNUAL BENEFITS & BENEFITS OF THE FINAL PROGRAM DISCOUNTED BACK TO 2012 AT 3% AND 7% DISCOUNT RATES

[Millions, 2010$]

	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)	$14	$164	$2,500	$5,510	$8,540	$32,400	$32,400
3% (avg SCC)	55	633	8,410	17,000	24,400	170,000	170,000
2.5% (avg SCC)	87	1,000	12,900	25,400	35,400	290,000	290,000
3% (95th %ile)	167	1,940	25,700	51,800	74,100	519,000	519,000
Energy Security Benefits (macro-disruption costs)	33	371	4,560	8,320	10,400	84,500	32,200
Accidents, Congestion, Noise Costs [g]	−54	−564	−5,710	−9,650	−12,100	−101,000	−39,200
Increased Travel Benefits [h]	79	865	9,560	17,000	14,500	167,000	64,800
Refueling Time Savings	25	282	3,360	6,350	8,870	64,900	24,500
Non-GHG Related Health Impacts [c,d,e]	B	B	920–1,000	920–1,000	920–1,000	9,190	3,050
Non-CO_2 GHG Impacts [f]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total Annual Benefits at Each Assumed SCC Value [b]							
5% (avg SCC)	97	1,120	15,300	28,500	31,300	257,000	118,000
3% (avg SCC)	138	1,590	21,200	40,000	47,200	395,000	256,000
2.5% (avg SCC)	171	1,960	25,600	48,400	58,100	515,000	376,000
3% (95th %ile)	250	2,890	38,500	74,800	96,900	743,000	604,000

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 "B" indicates unquantified criteria pollutant benefits in years prior to 2030 (2017–2029). For the final rule, EPA only conducted full-scale photochemical air quality modeling to estimate the rule's $PM_{2.5}$- and ozone-related impacts in the calendar year 2030. For the purposes of estimating a stream of future-year criteria pollutant benefits associated with the final standards, we assume that the annual benefits out to 2050 are equal to, and no less than, those modeled in 2030 as reflected by the stream of estimated future emission reductions. The NPV of criteria pollutant-related benefits should therefore be considered a conservative estimate of the potential benefits associated with the final rule.

[d] The $PM_{2.5}$-related portion of the health benefits presented in this table are based on an estimate of premature mortality derived from the ACS study (Pope et al., 2002). However, EPA's primary method of characterizing PM-related premature mortality is to use both the ACS and the Six Cities study (Laden et al., 2006) to generate a co-equal range of benefits estimates. The decision to present only the ACS-based estimate in this table does not convey any preference for one study over the other. We note that this is also the more conservative of the two estimates—PM-related benefits would be approximately 245 percent (or nearly two-and-a-half times) larger had we used the per-ton benefit values based on the Six Cities study instead. Refer to Section III.H.7 to see the full range of non-GHG related health benefits in Calendar Year 2030.

[e] The range of calendar year non-GHG benefits presented in this table assume either a 3% discount rate in the valuation of PM-related premature mortality ($1,000 million) or a 7% discount rate ($920 million) to account for a twenty-year segmented cessation lag. Note that the benefits estimated using a 3% discount rate were used to calculate the NPV using a 3% discount rate and the benefits estimated using a 7% discount rate were used to calculate the NPV using a 7% discount rate.

[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* RIA 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] Negative values for Accidents, Congestion, and Noise costs represent disbenefits.

[h] Refer to Chapter 4.2.6 of the joint TSD for a description of how increased travel benefits are derived.

Table III–104 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–104—UNDISCOUNTED ANNUAL MONETIZED NET BENEFITS & NET BENEFITS OF THE FINAL PROGRAM DISCOUNTED BACK TO 2012 AT 3% AND 7% DISCOUNT RATES

[Millions, 2009$]

	2017	2020	2030	2040	2050	NPV, 3%[a]	NPV, 7%[a]
Vehicle Program Costs	$2,470	$9,190	$35,900	$41,000	$46,500	$561,000	$247,000
Fuel Savings	651	7,430	86,400	155,000	212,000	1,600,000	607,000
Total Annual Benefits at Each Assumed SCC Value[b]							
5% (avg SCC)	97	1,120	15,300	28,500	31,300	257,000	118,000
3% (avg SCC)	138	1,590	21,200	40,000	47,200	395,000	256,000
2.5% (avg SCC)	171	1,960	25,600	48,400	58,100	515,000	376,000
3% (95th %ile)	250	2,890	38,500	74,800	96,900	743,000	604,000
Monetized Net Benefits at Each Assumed SCC Value[c]							
5% (avg SCC)	−1,690	−316	68,000	146,000	201,000	1,290,000	478,000
3% (avg SCC)	−1,650	153	73,900	158,000	217,000	1,430,000	616,000
2.5% (avg SCC)	−1,610	524	78,300	166,000	228,000	1,550,000	736,000
3% (95th %ile)	−1,530	1,460	91,200	192,000	267,000	1,780,000	964,000

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–101 through Table III–104, the model year lifetime analysis below shows the impacts of the final 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–105 and Table III–106 at both 3 percent and 7 percent discount rates, respectively.

TABLE III–105—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
Vehicle Program Costs	$2,770	$5,460	$7,720	$10,100	$14,000	$19,900	$25,400	$30,900	$33,600	$150,000
Fuel Savings (pre-tax)	7,040	15,500	24,300	34,100	50,400	64,900	78,500	92,800	107,000	475,000
Energy Security Benefits (macro-disruption costs)	365	807	1,260	1,780	2,650	3,430	4,170	4,950	5,750	25,200

TABLE III–105—MONETIZED TECHNOLOGY COSTS, FUEL SAVINGS, BENEFITS, AND NET BENEFITS ASSOCIATED WITH THE LIFETIMES OF 2017–2025 MODEL YEAR LIGHT-DUTY VEHICLES—Continued

[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
Accidents, Congestion, Noise Costs [f]	−548	−1,150	−1,770	−2,440	−3,480	−4,420	−5,270	−6,160	−7,040	−32,300
Increased Travel Benefits [i]	1,000	2,180	3,390	4,700	6,840	8,650	10,200	11,900	13,600	62,500
Refueling Time Savings	273	604	945	1,330	1,970	2,550	3,100	3,680	4,280	18,700
$PM_{2.5}$ Related Health Impacts [c,d,e]	74	171	271	385	606	776	928	1,090	1,250	5,540
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)	152	344	551	794	1,210	1,590	1,970	2,380	2,820	11,800
3% (avg SCC)	642	1,440	2,270	3,230	4,850	6,330	7,740	9,260	10,800	46,600
2.5% (avg SCC)	1,040	2,320	3,660	5,190	7,760	10,100	12,300	14,700	17,100	74,100
3% (95th %ile)	1,970	4,390	6,950	9,880	14,800	19,300	23,600	28,300	33,000	142,000
Monetized Net Benefits at Each Assumed SCC Value [a,b]										
5% (avg SCC)	5,590	13,000	21,200	30,500	46,200	57,500	68,100	79,700	94,400	416,000
3% (avg SCC)	6,080	14,100	22,900	33,000	49,900	62,200	73,900	86,600	102,000	451,000
2.5% (avg SCC)	6,480	15,000	24,300	34,900	52,800	66,000	78,500	92,000	109,000	479,000
3% (95th %ile)	7,400	17,100	27,600	39,600	59,800	75,200	89,800	106,000	125,000	547,000

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 non-GHG 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 non-GHG 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 for the Model Year analysis. Full scale air quality modeling was conducted for the Calendar Year analysis. See Section III.G and III.H.7 for a discussion of that analysis.

[d] The $PM_{2.5}$-related health 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). However, EPA's primary method of characterizing PM-related premature mortality is to use both the ACS and the Six Cities study (Laden et al., 2006) to generate a co-equal range of benefits estimates. The decision to present only the ACS-based estimate in this table does not convey any preference for one study over the other. We note that this is also the more conservative of the two estimates—PM-related benefits would be approximately 245 percent (or nearly two-and-a-half times) larger had we used the per-ton benefit values based on the Six Cities study instead. See Joint TSD 4 for a detailed description of the dollar-per-ton values used in this analysis.

[e] The $PM_{2.5}$-related health 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] Negative values for Accidents, Congestion, and Noise costs represent disbenefits.

[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* RIA 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.

[i] Refer to Chapter 4.2.6 of the joint TSD for a description of how increased travel benefits are derived.

TABLE III–106—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
Vehicle Program Costs	$2,650	$5,220	$7,370	$9,610	$13,300	$19,200	$24,600	$29,900	$32,500	$144,000
Fuel Savings (pre-tax)	5,410	11,900	18,600	26,100	38,600	49,700	60,100	71,100	82,300	364,000
Energy Security Benefits (macro-disruption costs)	279	615	964	1,360	2,020	2,620	3,180	3,780	4,400	19,200

TABLE III–106—MONETIZED TECHNOLOGY COSTS, FUEL SAVINGS, BENEFITS, AND NET BENEFITS ASSOCIATED WITH THE LIFETIMES OF 2017–2025 MODEL YEAR LIGHT-DUTY VEHICLES—Continued

[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
Accidents, Congestion, Noise Costs [f]	−425	−893	−1,370	−1,890	−2,690	−3,410	−4,070	−4,760	−5,440	−24,900
Increased Travel Benefits [i]	761	1,650	2,550	3,530	5,120	6,470	7,640	8,870	10,100	46,700
Refueling Time Savings	209	461	721	1,020	1,500	1,940	2,360	2,800	3,260	14,300
$PM_{2.5}$ Related Health Impacts [c,d,e]	59	136	215	305	478	607	721	840	959	4,320
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)	152	344	551	794	1,210	1,590	1,970	2,380	2,820	11,800
3% (avg SCC)	642	1,440	2,270	3,230	4,850	6,330	7,740	9,260	10,800	46,600
2.5% (avg SCC)	1,040	2,320	3,660	5,190	7,760	10,100	12,300	14,700	17,100	74,100
3% (95th %ile)	1,970	4,390	6,950	9,880	14,800	19,300	23,600	28,300	33,000	142,000
Monetized Net Benefits at Each Assumed SCC Value [a,b]										
5% (avg SCC)	3,800	9,010	14,900	21,600	32,900	40,300	47,300	55,100	65,800	291,000
3% (avg SCC)	4,290	10,100	16,600	24,100	36,500	45,000	53,100	62,000	73,800	326,000
2.5% (avg SCC)	4,690	11,000	18,000	26,000	39,400	48,800	57,600	67,400	80,100	353,000
3% (95th %ile)	5,610	13,100	21,300	30,700	46,500	58,000	69,000	81,000	96,100	421,000

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 non-GHG 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 non-GHG 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 for the Model Year analysis. Full scale air quality modeling was conducted for the Calendar Year analysis. See Section III.G and III.H.7 for a discussion of that analysis.

[d] The $PM_{2.5}$-related health 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). However, EPA's primary method of characterizing PM-related premature mortality is to use both the ACS and the Six Cities study (Laden et al., 2006) to generate a co-equal range of benefits estimates. The decision to present only the ACS-based estimate in this table does not convey any preference for one study over the other. We note that this is also the more conservative of the two estimates—PM-related benefits would be approximately 245 percent (or nearly two-and-a-half times) larger had we used the per-ton benefit values based on the Six Cities study instead. See Joint TSD 4 for a detailed description of the dollar-per-ton values used in this analysis.

[e] The $PM_{2.5}$-related health 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] Negative values for Accidents, Congestion, and Noise costs represent disbenefits.

[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* RIA 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.

[i] Refer to Chapter 4.2.6 of the joint TSD for a description of how increased travel benefits are derived.

11. U.S. Vehicle Sales Impacts and Affordability of New Vehicles

a. Vehicle Sales Impacts

Predicting the effects of this rule on vehicle sales entails comparing two effects. On the one hand, the vehicles designed to meet the standards will become more expensive, which would, by itself, discourage sales. On the other hand, the vehicles will have improved fuel economy and thus lower operating costs due to significant fuel savings, which could encourage sales. Which of these effects dominates for potential vehicle buyers when they are considering a purchase will determine the effect on sales. Assessing the net effect of these two competing effects is uncertain, as it rests on how consumers value fuel savings at the time of purchase and the extent to which manufacturers and dealers reflect technology costs in the purchase price. The empirical literature does not provide clear evidence on how much of the value of fuel savings consumers consider at the time of purchase. It also generally does not speak to the efficiency of manufacturing and dealer pricing decisions. Thus, we do not provide quantified estimates of potential sales impacts in this final rule.

An additional source of uncertainty in the analysis is understanding what would happen in the absence of this rule. Standard economic theory would suggest that, if automakers could profitably increase sales by adding more fuel-saving technologies to their vehicles, then manufacturers' profit motives would lead them to voluntarily add those technologies in the absence of this rule. As discussed in Preamble Section III.D.1, we project, based on historical patterns, that auto makers would not go beyond the MY 2016 standards in the absence of this rule. Yet, if consumers consider just over three years' worth of fuel savings in their vehicle purchase decisions and our assumptions about technology costs and future gas prices are correct, the payback period analysis in Section III.H.5 suggests that sales would increase in response to this rule.

Although it is possible that manufacturers would not find it profitable to add at least some of the vehicle technologies in the absence of the rule (see Section III.H.1.a for a discussion), there may be the potential for increases in vehicle sales as a result of the rule. These explanations focus on conditions where the rule stimulates investments that would not happen in the rule's absence. The explanations posed below raise possibilities that the rule, by requiring all automakers to meet the standards, may lead to mutually beneficial outcomes that might not happen in the absence of the rule. Consumers would then have the opportunity to purchase vehicles that would not be available in the absence of the rule; if consumers consider at least as many years of fuel savings when buying new vehicles as the payback period for the new technologies, and if manufacturers nonetheless would not have produced these vehicles in the absence of the rule, positive sales impacts could occur as a result of these final standards. The three possibilities we suggest for such outcomes are promotion of social learning, reduction of risk and uncertainty for manufacturers, and promotion of innovation.

i. Social Learning

For many years, fuel economy standards did not change (see Preamble III.D.1).[882] As discussed in Preamble III.H.1.a, consumers may not have focused on fuel economy, or may have found it difficult to do calculations involving the tradeoffs between fuel economy and increased vehicle costs, or may not have found vehicles with their preferred combination of fuel economy and other features. In recent years, though, fuel economy standards have started to increase.[883] In addition, high fuel prices have helped to focus consumer attention toward vehicle fuel economy. Finally, the recently revised fuel economy label, with prominent information on fuel savings, are starting to appear on new vehicles. These factors may contribute to consumers gaining experience with the benefits that accrue to them from owning and operating vehicles with greater fuel efficiency. Consumer households that include vehicles with a fairly wide range of fuel economy have an opportunity to learn about the value of fuel economy on their own. Consumer demand may be shifting 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.

Today's rule, combined with the new and easier-to-understand fuel economy labels required to be on all new vehicles in MY 2013, may increase sales by hastening this very type of consumer learning. As more consumers experience the savings in time and expense from owning more fuel efficient vehicles, demand may shift yet further in the direction of the vehicles with improved fuel economy and reduced GHG emissions 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, marketing and advertising, 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 may better reflect such efficiency, further reducing the cost of owning more efficient vehicles for the buyers of new vehicles (since the resale price may increase). If these induced learning effects are strong, the rule could potentially increase total vehicle sales over time. This 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 could (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 more efficient vehicles to increase consumer learning because no individual company can fully internalize the potential future boost to demand. 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 could 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.[884] These positive externalities may lead to benefits for manufacturers as a whole if they increase the demand for vehicles. We emphasize that this discussion has been tentative and qualified. It is not possible to quantify these learning effects years in advance, and these effects may be speeded or slowed by other factors that enter into a consumer's valuation of fuel efficiency in selecting vehicles. To be sure, social learning of related kinds has been identified in a number of contexts.[885] We asked for comments on the discussion offered here, with particular reference to any relevant empirical findings. 76 FR 75150. We continue to explore this issue but did not receive any comments on the role of social learning, except in the context (discussed in Section III.H.1.a) of the effect of the rule on the visibility of and

[882] Car CAFE standards did not change from MYs 1990 through 2010. Truck CAFE standards did not change from MYs 1996 through 2004, and changed only 0.5 mpg cumulatively from MYs 1991 through 2004. See ''Summary of Fuel Economy Performance,'' March 12, 2012, DOT/NHTSA, *http://www.nhtsa.gov/fuel-economy*.

[883] Truck CAFE standards began to rise in MY 2005 and have risen every year since. Car CAFE standards began to rise in MY 2011. *Ibid.*

[884] 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.

[885] 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* (Docket EPA–HQ–OAR–0799–0825); Christophe Chamley, Rational Herds: Economic Models of Social Learning (Cambridge, 2003) (Docket EPA–HQ–OAR–0799–1110).

status associated with owning vehicles with improved fuel economy.

ii. Reduction in Risk and Uncertainty for Manufacturers

As discussed in Preamble III.H.1.a, there appears to be a great deal of uncertainty about how consumers will respond to increases in fuel economy. Automakers may be cautious about adding more fuel-saving technology to vehicles if they are uncertain how buyers will respond. Even if they believe that buyers will respond positively, if a company is risk-averse, it may nevertheless hesitate to make the substantial major investments in new technologies and in research that would lead to increases in fuel economy across its fleet.[886] If a manufacturer invests substantially in fuel efficient technologies expecting higher consumer demand than realized, then the manufacturer has incurred the costs of investment but not reaped the benefits of those investments. On the other hand, if a manufacturer does not invest in fuel-efficient technologies, then the manufacturers may lose some sales in the short run if demand for fuel economy is higher than expected, but it still retains the option of investing in fuel-efficient technologies in the longer run. If its investments proved unsuccessful, the company might face substantial losses. Even if the probability of being unsuccessful is low, the manufacturer may nevertheless perceive the losses in that scenario as a substantial risk. If the investment proved successful, the company would, of course, take market share from other companies—but, assuming that there are not brand-loyalty or other advantages to being first in the market with new fuel-saving technologies, only until the other auto companies caught up. In other words, for a risk-averse company, being a first mover may appear to have a greater downside risk than upside risk, even if the investment, on an expected-value basis, would pay off. If all companies are risk-averse, then they may all seek a strategy of waiting for some other company to be the first mover. In this case, caution about these major investments may lead to a lack of adoption of new technologies, in the absence of the rulemaking, consistent with the flat baseline assumption. This rulemaking, by requiring that all companies act at the same time, removes the scenario of one company bearing all the risk.

In addition, there may be risk aversion on the consumer side. The simultaneous investment by all companies may also encourage consumer confidence in the new technologies. If only one company adopted new technologies, early adopters might gravitate toward that company, but early adopters tend to be a relatively small portion of the public. More cautious buyers, who are likely to be more numerous, might wait for greater information before moving away from well-known technologies. If all companies adopt advanced technologies at the same time, though, potential buyers may perceive the new technologies as the new norm rather than as a risky innovation. They will then be more willing to move to the new technologies. As some commenters have pointed out, simultaneous action required by the rule may change buyers' expectations (their reference points) for fuel economy, and investing in more fuel economy may seem less risky than in the absence of the rule.

The rule, then, may reduce manufacturers' risk of making significant investments in fuel-saving technologies by requiring that all companies produce more fuel-efficient vehicles. Under this outcome, it is possible for the rule to facilitate investment that would not happen in the absence of the rule, and vehicle sales could increase as a result of the rule.

iii. Promotion of Innovation

Research among multiple parties can be a synergistic process: Ideas by one researcher may stimulate new ideas by others, and more and better results occur than if the one researcher operated in isolation.[887] Collaboration between automotive companies or automotive suppliers does occur; for example, in 2011 Toyota and Ford announced a new effort to collaborate on the development of hybrid technology for pickup trucks.[888] Another example was the four-year joint development effort between General Motors and Ford from 2002–2006 for the development of a new six-speed automatic transmission.[889] One function that standards can serve is to promote research into low-CO_2 technologies that would not take place in the absence of the standards. Because all companies (both auto firms and auto suppliers) will have incentives to find better, less expensive ways of meeting the standards in this rule, the possibilities for synergistic interactions may increase. Thus, the rule, by focusing all companies on finding more efficient ways of achieving the standards, may lead to better outcomes than if any one company operated on its own.

An additional aspect of the standards is the possibility of greater standardization. As more companies adopt new technologies, the incentives increase for additional suppliers and more availability of after-market replacement parts; these suppliers would be likely to find ways to increase compatibility across vehicle types. For example, though electric vehicles (EVs) are not expected to be more than a few percent of the vehicles produced in response to this rule, their adoption depends on such factors as batteries and charging methods that are compatible across different companies. These are examples of ''network externalities,'' where use of a technology by one party has greater benefits if more people are also using the technology. In this case, just as the ability to buy gasoline from any station facilitates owning a gasoline-based vehicle, the ability to recharge an EV or get replacement parts easily facilitates ownership of an EV. In the absence of the rule, fewer companies would be pursuing this technology, and it would be considered a specialty product; the incentives to coordinate might be low. If EVs become more common, though, compatible infrastructure and batteries may become more desirable, as potential buyers are likely to be encouraged toward this technology if they can easily find places to charge batteries.

Thus, the rule may direct and promote innovation and standardization that would not happen in the absence of this rule. Such changes could reduce the cost increases associated with the rule and improve the qualities of the technologies, which could result in an

[886] Sunding, David, and David Zilberman, ''The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector,'' Chapter 4 in *Handbook of Agricultural Economics,* Volume 1, edited by B. Gardner and G. Rausser (Elsevier, 2001) show how delaying adoption of a new technology in order to gain more information may be a more profitable activity than adopting a technology, even if it has positive net benefits, when a potential adopter is risk-averse.

[887] Powell, Walter W., and Eric Giannella, ''Collective Invention and Inventor Networks,'' Chapter 13 in *Handbook of the Economics of Innovation,* Volume 1, edited by B. Hall and N. Rosenberg (Elsevier, 2010) (EPA Docket EPA–HQ–OAR–2010–0799) discuss how a ''collective momentum'' has led uncoordinated research efforts among a diverse set of players to develop advances in a number of technologies (such as electricity and telephones). They contrast this view of technological innovation with that of proprietary research in corporate laboratories, where the research is part of a corporate strategy. Such momentum may result in part from alignment of economic, social, political, and other goals.

[888] ''Ford and Toyota To Work Together on Hybrid System for Trucks'', New York Times, August 22, 2011. (EPA Docket EPA–HQ–OAR–2010–0799).

[889] ''Ford, GM Launch Joint 6-speed Automatic,'' Wards Automotive, August 31, 2006.

increase in vehicle sales. Further, the certainty of the regulations reduces the costs of meeting them, because there will be more economies of scale and more learning curve benefits due to greater cumulative production of fuel-efficient technologies.

Several commenters requested that we conduct a quantitative vehicle sales analysis. As discussed in the proposal, 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; the direction of vehicle sales would depend on whether up-front costs exceeded fuel savings (in which case sales would be expected to decline), or vice versa (in which case sales would be expected to increase).[890] Some commenters specifically requested that we use the method found in the MYs 2012–16 rule; some specifically supported the five-year payback period; others argued for the importance of conducting the analysis without recommending methods. Ceres estimates that the rule will increase vehicle sales by 4.7 percent; [891] the Defour Group provided estimates that the rule will decrease vehicle sales by 6–10 percent.[892] The differences in the results appear to depend on the cost estimates used and on assumptions made about how vehicle buyers think about fuel savings when deciding on vehicle purchases. The Defour Group, for instance, uses cost estimates of about $3000 per vehicle based on summing costs (but not benefits) across multiple rules (an estimate we consider to be unfounded for reasons explained in this section below and also in TSD Chapter 3.1.2) and the assumption that consumers consider only 25 percent of fuel savings in their vehicle purchase decisions (see discussion in Section III.H.1.a). Other commenters wanted specific information on the effect of the rule on vehicle costs and whether consumers will be willing to buy the new vehicles, while consumer and environmental organizations indicated that consumers want more fuel-efficient vehicles, even if the up-front costs of the vehicles increase. The costs of the rule are discussed in Preamble Section III.H.2. As discussed in Preamble Section III.H.1.a, we do not at this point have sufficient confidence in the estimates of the role of fuel economy in consumers' vehicle purchases to come to definitive conclusions about the impacts of the rule on vehicle sales. We do not, however, consider this uncertainty grounds for delaying the rule, as one comment suggested. The midterm evaluation provides an opportunity to revisit the impact of the rule on vehicle sales and consumer acceptance of the new technologies.

This rule takes effect for MY 2017–2025. In the intervening years, it is possible that the assumptions underlying a quantitative analysis, as well as market conditions, might change. As the United Auto Workers points out, the state of the economy is a major, if not the primary, determinant of total vehicle sales. The impact of the rule on sales may therefore depend, among other factors, on changes in the state of the economy. Other commenters discussed the importance of consumer confidence, fuel prices, and even of publicity over fuel prices, in consumers' interest in additional fuel economy. Sales could be negatively affected if gasoline prices are lower than expected or technology costs are higher than expected. In these cases, it is possible that the standards could require manufacturers to produce cars with higher levels of fuel economy than consumers would wish to buy. On the other hand, manufacturers' marketing of increased fuel economy levels is also likely to play a role in consumer response to these vehicles. EPA agrees that these factors are important, but we are not sufficiently confident in quantitative estimates of the impacts of those factors to develop numerical estimates. We instead provide this qualitative assessment to highlight the factors important for understanding the effects of this rule on vehicle sales.

As several commenters point out, 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, the used vehicle market may increase in volume as new vehicle buyers sell their older vehicles, and scrappage rates of used vehicles may increase slightly. This will cause both an influx of more efficient vehicles into the used vehicle market and an increase in the turnover of the vehicle fleet (i.e., the retirement of used vehicles and their replacement by new models), 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, the used vehicle market may decrease in volume as people hold onto their vehicles longer, and there will be a reduction in the rate at which used vehicles are retired from service. These effects will partly reduce the anticipated effects of this rule on fuel use and emissions. Because we do not have good estimates of the relationships between the new and used vehicle markets, we have not attempted to estimate explicitly the effects of the rule on the used vehicle market, scrappage of older vehicles, and the turnover of the vehicle fleet.

Consumer, environmental, and investor organizations, the United Auto Workers, as well as a citizens' campaign suggested that the rule will help the domestic auto industry, including the domestic supply base, compete in the global marketplace, through its encouragement of advanced technologies that may be useful in meeting emissions standards and consumer demands in foreign markets. We agree that this is likely for all global automakers, as generally the emission standards established in this rule are similar in stringency to emissions and fuel economy standards being considered by Japan, the European Union, South Korea, Canada, China and other international markets. Global manufacturers also design vehicles using a common platform in order to reduce costs. Vehicles built on these common platforms are sold in many markets around the world. To the extent the domestic OEMs and suppliers can focus their limited research and product development efforts on the same technologies for the U.S. market as for international markets, this should enable the companies to compete more effectively outside the U.S.

Chapter 8 of EPA's RIA has further discussion of methods for examining the effects of this rule on vehicle sales.

[890] For instance, see U.S. Environmental Protection Agency (April 2010). ''final rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards: Regulatory Impact Analysis.'' EPA–420–R–10–009, Chapter 8.1.1, pp. 8–1 to 8–4.

[891] Comments on this rule from Ceres, Docket EPA–HQ–OAR–2010–0799–9475, referring to a forthcoming report, Citi Investment Research and Analysis, ''U.S. Autos and Auto Parts: Fuel Economy Focus: Industry Perspectives on 2020,'' April 3, 2012, Docket EPA–HQ–OAR–2010–0799.

[892] Walton, Thomas F., and Dean Drake, Defour Group, LLC. ''Comments on the Notice of Proposed Rulemaking and Preliminary Regulatory Impact Analysis for MY 2017 to 2025 Fuel Economy Standards.'' February 13, 2012. Docket EPA–HQ–OAR–2010–0799–9319–A1.

b. Impact of the Rule on Affordability of Vehicles and Low-Income Households

Several organizations provided comments about the effect of the rule on the affordability of new vehicles, as well as the impacts of the rule specifically on low-income households.

Comments from Consumer Federation of America (CFA) and 23 other consumer groups, as well as Consumers Union (CU) and several environmental organizations, argued that low-income households will benefit from the rule. These commenters cite Bureau of Labor Statistics data that low-income households spend more on fuel than they do on new vehicles each year and are thus more vulnerable to fuel costs. CU comments that low-income households pay a disproportionately large portion of their income on fuel and are thus most vulnerable to price spikes in gasoline. CFA reported that in 2010, households with incomes below $20,000 spent 7.3 times as much on gasoline as on new car payments, compared with 1.2 times as much for households with incomes above $70,000. This commenter believes that consumers will benefit greatly from the fuel savings that come with improved fuel economy. These organizations note that low-income households account for a very small portion of new car buyers, since they primarily purchase used cars, and are therefore less affected by the up-front costs of the more efficient vehicles than those who buy new vehicles. CU further comments that Consumers Reports survey data show that low-income households support improved fuel economy. In a recent survey, 71% of low-income households responded that they expect to choose a model with better fuel economy, compared to 59% of moderate and high-income respondents. In addition, 79% of low-income respondents to the survey reported that they were willing to pay extra for a more fuel efficient vehicle if they can recover the additional cost through lower fuel costs within five years, compared to 86% of moderate and high-income respondents.

In addition, these commenters agreed with EPA's assessment in the NPRM that consumers who buy their vehicles with loans save more in fuel each month than they do in increased loan payments. CU points out that this is especially true for buyers of future, more fuel-efficient used vehicles: The increase in up-front cost is much lower on a used vehicle, due to depreciation, while the fuel economy of the vehicle is unlikely to change over time. Because low-income households disproportionately buy used vehicles, they will benefit from this more rapid cost recovery. Because most of the increased vehicle cost depreciates after five years, the payback period for improved fuel economy in used MY 2017 and later vehicles will be shorter than the payback period for these vehicles when newly purchased (under two years for some examples). EPA agrees that more efficient vehicles will reduce operating costs for buyers of used vehicles as well as new vehicles, because the fuel-saving technologies maintain their effectiveness over time; indeed, GHG standards continue to apply in-use. As shown in RIA Chapter 5.5, our estimate of the payback period for five-year-old MY 2025 vehicles is approximately 1.1 years, less than the payback period of about 3.2–3.4 years for new MY 2025 vehicles. We also note that depreciation rates may be affected by the rule: increases in reliability would decrease depreciation, and decreases in reliability would increase depreciation. Finally, CU points out that some auto lenders take into consideration the fuel economy of new vehicles, and offer discounted rates for more efficient vehicles.[893] As discussed further below, EPA also finds that a number of financial institutions give a discount on loans for more fuel-efficient vehicles.

The National Automobile Dealers Association (NADA) and the Institute for Energy Research emphasized that the increase in the up-front vehicle costs would be a factor in consumers' abilities to purchase. In particular, they stated that, if vehicle buyers are not able to get loans for vehicles that have become more expensive as a result of new standards, because they cannot get access to credit for the additional cost, then they will be unable to participate in the new vehicle market even if the new vehicles offer significant fuel savings. This argument is based on the statement from NADA that auto lenders do not take into account the fuel economy of the vehicles when they are deciding on providing loans; the lenders consider only consumers' debt-to-income ratios. NADA provided an analysis that concludes that 6.8 million licensed drivers may no longer have access to new vehicles. According to NADA's analysis, this estimate is the number of licensed drivers who live in the 3.1–4.2 million households that could borrow $11,750, the loan amount for the least expensive new vehicle in 2011 after a $1000 down payment, but could not borrow $14,750.[894] This difference of $3,000 is meant to represent what NADA views as the cost increase of new fuel economy standards, which EPA believes is incorrect and responds to further below.

In assessing these comments, EPA finds that the NADA study does not provide a usable estimate of those consumers in the market for new vehicles who might have trouble getting loans, and is not a usable estimate of the impacts of the rule on the new vehicle market. Because the NADA study does not separate consumers who might consider new vehicles from consumers who are not in the market for new vehicles, the 6.8 million licensed driver figure significantly overestimates any impact of this rule on the new vehicle market.

The NADA study suffers from a number of inaccuracies and weaknesses. First, it is important to understand what NADA's 6.8 million estimate actually represents. NADA simply looked at the 113 million households in the U.S. who could afford to borrow $11,750 and estimated which ones of those could not afford to take out a loan of $14,750.[895] NADA's analysis unfortunately neglects a fundamental factor that could make this analysis relevant to this rulemaking—how many of those households would in fact even be in the market for a new vehicle. EPA believes that the vast majority of these households would not be in the market for new vehicles (for context, the total new vehicle market is estimated to be 17.2 million vehicles in 2025; see TSD Chapter 1.3.2.1). As documented by many other commenters and as can be found in the Federal Reserve Board's Survey of Consumer Finances,[896] low-

[893] See, for instance, Ladika, Susan (2009). ''`Green' auto loans offer lower rates,'' Bankrate.com, *http://www.bankrate.com/finance/auto/green-auto-loans-offer-lower-rates-1.aspx*, accessed 2/28/12.

[894] Wagner, D., P. Nusinovich, and E. Plaza-Jennings, National Automobile Dealers Association (February 13, 2012). ''The Effect of Proposed MY 2017–2025 Corporate Average Fuel Economy (CAFE) Standards on the New Vehicle Market Population.'' Docket EPA–HQ–OAR–0799.

[895] The Bureau of Labor Statistics' Consumer Expenditure Survey, on which the Wagner et al. paper is based, measures 121,000 households in the U.S. in 2010. Wagner et al. find that ''an estimated 93% of all consumer units have a financial profile that would allow them to meet the 40% maximum debt to income ratio after purchasing the current minimum cost new vehicle ($12,750).'' (See footnote 894, p. 4.) Ninety-three percent of 121 million households is about 113 million households; Wagner et al.'s estimate of 3.1 to 4.2 million of those who can borrow $11,750 but not $14,750 is 2.8 to 3.7 percent of that total.

[896] In the Federal Reserve Board's 2007 Survey of Consumer Finances, households with income below $35,200 (about the lower 40% of population by income) bought about 17% of new vehicles; those in the bottom quintile of income bought fewer than 2% of new vehicles. See Federal Reserve Board, 2007 Survey of Consumer Finances, *http://*

income households account for a very small portion of new car buyers, since they primarily purchase used cars. Thus, the NADA estimate is severely flawed and does not contribute usable information to identify the impacts of this rule on the vehicle market or on low-income households.

Second, the NADA estimate is based, not on people who are considering purchasing new vehicles, but on the number of licensed drivers in households in the U.S. who could theoretically qualify to borrow $11,750, but not $14,750, based purely on debt-to-income ratio.[897] Even accepting NADA's study at face value, the relevant unit for the financial decision would be the number of households—not every licensed driver in a low income household would purchase a separate vehicle. The number of households in the NADA study is 3.1 to 4.2 million, already far lower than the estimate of 6.8 million drivers.

Third, NADA's assumption of a $3,000 cost increase per vehicle is based on summing the costs of MY 2011, MY 2012–16, and MY 2017–25 rules. This estimate does not correspond to EPA's estimate, an average cost of about $1,800 per vehicle by MY 2025, in several ways. For analyzing the effects of this rulemaking, it is appropriate to focus on the costs and benefits associated with this rulemaking, not those of previous rulemakings. The impacts of the other rules are included in the reference case for this rule. The NADA cost estimate, based on a MY 2011 vehicle, appears to double-count MY 2011 costs, because those should already be included in the price of the MY 2011 vehicle used in its study. Further, the costs of meeting MY 2016 standards in 2025 are expected to be lower than the costs of meeting those standards in 2016, the value used by NADA, due to manufacturer learning. Moreover, EPA's costs estimates are based on industry-wide averages, not applicable to specific vehicle models. As discussed further below, impacts of the rule on the prices of low-price vehicles may well be less than these averages.

Fourth, the estimate does not take into account, as pointed out by CU and as EPA has documented, that some lenders currently give discounts for loans to purchase more fuel-efficient vehicles.[898] It is possible (though unknown at this time) that the auto loan market may evolve to include further consideration of fuel savings, as those savings play a significant factor in offsetting the increase in up-front costs of vehicles.

Fifth, the NADA analysis is based on the cost of the least expensive vehicle in the MY 2011 market, but the market size for low-priced vehicles is only about one-tenth the size of NADA's estimate of 6.8 million affected people. The agencies' baseline estimates of the vehicle fleet in 2025 finds that total sales of vehicles costing less than $15,000 (a price point that low income consumers in the new car market would most likely be pursuing) in the absence of the rule are estimated to be well below 1 million in MY 2025; there is also no relationship between the NADA estimate and the potential impact of this rule on sales of low-priced vehicles.

Sixth, if NADA's estimate reflected a measurable effect of the rule, that effect would be reflected in a commensurate reduction in vehicle sales. Yet there is no connection between any vehicle sales estimates provided in comments on this rule and the NADA estimate. As discussed in section III.H.11.a, many commenters predict an increase in vehicle sales as a result of the rule, though others predict decreases.[899] However, even the most negative estimate provided in public comments of the GHG rule's impact on vehicle sales, from the Defour Group (which we address in detail in Section III.H.11.a), is a reduction of 1.8 million vehicles. The NADA estimate appears significantly overstated even compared to this commenter's most negative estimate of vehicle sales impacts.

For these reasons, we find the NADA study does not provide a usable estimate of consumers in the market for new vehicles who might have trouble getting new vehicle loans, nor do we find it a usable estimate of the impacts of the rule on the new vehicle market.

It is possible that future trends in the auto loan market may affect future vehicle sales. It is also possible that some people who have significant debt loads may not be able to get financing for some of these new vehicles; they may have to buy different vehicles (including used vehicles) or delay purchase. For others who borrow on credit, though, as discussed in Section III.H.5, the fuel savings are expected to outweigh the increased loan costs from the time of vehicle purchase. As some comments suggest, the rule thus may make vehicles more affordable to the public, by reducing consumers' vulnerability to fuel price jumps. Some comments raised concerns about the impacts of the rule specifically on low-priced vehicles. EPA agrees that vehicles in the low-priced (economy-class) segment will bear technology costs needed to meet the new standards, but it is not known how manufacturers will decide to pass on these costs across their vehicle fleets, including in the low-priced vehicle segment. If manufacturers decide to pass on the full cost of compliance in this segment, then it is possible that consumers who might barely afford new vehicles may be priced out of the new-vehicle market or may not have access to loans. As just discussed, the rule's impacts on availability of loans are unclear, because some lenders do factor fuel economy into their loans, and it is possible that this trend may expand. In addition, as the Union of Concerned Scientists comments, auto makers have some flexibility in how both technologies and price changes are applied to these vehicles; auto makers have ways to keep some vehicles in the low-priced vehicle segment if they so choose. Though the rule is expected to increase the prices of these vehicles, the degrees of price increase and the impacts of the price increases, especially when combined with the fuel savings that will accompany these changes, are much less clear.

The Defour Group suggests that the standards are regressive, with adverse impacts falling disproportionately on low-income households, and possibly limiting their ability to obtain employment because of limited mobility. The commenter's regressivity assessment is based on a study of a non-footprint-based fuel economy program;[900] the disproportionate impact on low-income households is based on the increased prices of used vehicles and the shift toward smaller vehicles. As discussed above in Section III.H.11.a,

www.federalreserve.gov/econresdata/scf/scf_2007.htm.

[897] As noted, these amounts are based on the cost of the least expensive vehicle in 2011, with $1,000 down payment, with the assumption that it will become $3,000 more expensive as the result of three rulemakings, for MYs 2011, 2012–16, and 2017–25 (see Wagner et al., footnote 894).

[898] See footnote 893, above. An Internet search on the term ''green auto loan'' produced more than 50 lending institutions that provide reduced rates for more efficient vehicles. See Helfand, Gloria (2012). ''Memorandum: Lending institutions that provide discounts for more fuel-efficient vehicles.'' Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, Docket EPA–HQ–OAR–0799.

[899] We note that the role of vehicle financing in vehicle purchase decisions is not a separate factor in typical studies of the determinants of vehicle sales. Estimates of vehicle sales in the literature, which commonly are dependent on both up-front vehicle costs and fuel costs, implicitly account for effects of the loan market.

[900] Jacobsen, Mark. ''Evaluating U.S. Fuel Economy Standards in a Model With Producer and Household Heterogeneity.'' Working paper, University of California, San Diego, September 2010. Docket EPA–HQ–OAR–0799–0829.

EPA finds that the impact on the used vehicle market depends on the impact of the rule on new vehicle sales, which we have not quantified. Because the footprint-based standard reduces incentives to downsize vehicles, we do not accept the conclusion that the rule will result in buyers of used vehicles getting smaller ones with a consequent welfare loss. For these reasons, the regressivity finding from Jacobsen's paper is not applicable to the effects of this rule.

In summary, the net effect of the rule on low-income households depends on several factors: The way that manufacturers choose to translate cost increases into price increases; the effects on sales of used vehicles, which depend on the effects on sales of new vehicles; the fuel savings that the new (and used) vehicles will provide; and any effects on access to credit for new and used vehicles. For reasons outlined above, we do not at this time have quantitative assessments of how these effects interact and affect low-income households. However, due to the significant effect of the rule on fuel savings, especially for used vehicles (see RIA Chapter 5.5), we expect low-income households to benefit from the more rapid payback period for used vehicles, though some of this benefit may be affected by the net effect of this rule on the prices and availability of used vehicles, which we have not estimated.

In addition, the net effect of the rule on low-priced vehicles is difficult to assess; though we expect the prices of these vehicles to increase, it is also possible that auto makers may find ways to preserve the entry-vehicle segment, by adding less additional technology to these vehicles or through pricing strategies. The net effect of the rule on access to credit is also difficult to assess: though some consumers may find themselves credit-constrained, some auto lenders are already giving interest rate discounts for more fuel-efficient vehicles, and the loan market may continue to evolve.

12. 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 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.''[901] 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 rule on domestic employment in the auto manufacturing and parts sectors, while qualitatively discussing how it may affect employment in other sectors more generally. Several commenters specifically pointed to the desirability of our conducting employment analyses, to provide insights into the effects of the rule on economic recovery and the health of the auto industry; we did not receive comments opposed to the inclusion of employment impacts.

This rule 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 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 standards.[902] The employment effects of this rule are expected to expand beyond the regulated sector. Though some of the parts used to achieve the 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.11, could affect employment for auto dealers. As discussed in Section III.H.4, this rule 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 rule 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.[903] 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.[904] 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

[901] 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.*

[902] U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages, as accessed on August 9, 2011.

[903] Masur and Posner, 2011. ''Regulation, Unemployment, and Cost-Benefit Analysis.'' *http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1920441* (Docket EPA–HQ–OAR–2010–0799–1222).

[904] 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–2010–0799–0676).

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 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.[905] 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.

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 on the overall change in national employment due to Federal regulation.

The NPRM included a discussion of different methods for conducting employment analysis (see the discussion in RIA Chapter 8.2.2), including computable general equilibrum models, input-output models, hybrid models, and single-sector models, and requested comment on those methods. See 76 FR 75155–156. That discussion noted that all potential methods of estimating employment impacts of a rule have advantages and limitations. We did not receive comments about methods, except for some support for EPA's approach in the NPRM, and some support (discussed further below) for including multiplier impacts.

We received a number of comments (from the Defour Group and from some private individuals) asserting that there will be decreases in employment as a result of the costs of the rule, and a number of comments (from the United Auto Workers, environmental organizations, sustainable business groups, some private individuals, and others) asserting increases in employment, based on the development of advanced technologies and the reduction in net costs due to fuel savings. An assessment by the Defour Group predicts a loss of 155,000 jobs in manufacturing and supply, plus another 50,000 in distribution.[906] A study by Ceres predicts job gains of 43,000 in the auto industry and 484,000 economy-wide.[907] Some comments cite a study by the Natural Resources Defense Council, National Wildlife Federation, and United Auto Workers that 150,000 auto workers already are working to supply clean, fuel-efficient technologies.[908] The differences in results for quantitative employment impacts are due to factors such as those discussed above. Estimates of decreases in employment commonly come from studies that use cost estimates higher than those of EPA, and sometimes lower benefits estimates, resulting in reductions in vehicle sales. For instance, some comments from individuals cite the National Automobile Dealers Association and Center for Automotive Research for cost estimates of $5000 to $6000 per vehicle, much higher than those estimated in Section III.H.2; EPA does not endorse those alternative cost estimates, as discussed in Section 18.2 of the Response to Comments. The NADA estimates inappropriately include the costs of other rulemakings and use indirect cost estimates which we consider inappropriate (see TSD Chapter 3.1.2.2). The Center for Automotive Research estimates do not take into account expected technological advances, do not reflect the use of air conditioning credits in this rule, and calculate costs from a baseline of 2008 instead of MY 2016 standards. Those studies commonly look at the employment associated with vehicle sales, but not the employment associated with producing the technologies needed to comply with the standards, or changes in labor intensity of production. Analyses that find increases in employment commonly start with increased vehicle sales as a result of the rule, and take into consideration the employment effects associated with additional technologies. In both cases, ''multiplier'' effects, which extend employment impacts beyond the auto sector to impacts on suppliers, other sectors, and expenditure changes by workers, lead to large estimates, either positive or negative, of the employment effects of the rule. We received the suggestion to include in our analysis an alternative scenario where there is less than full employment; the implication of less than full employment is that multiplier effects are more likely. We also requested comment on other sectors that warranted consideration in this rule, 76 FR 75157, but we did not receive suggestions.

After considering these comments, EPA is continuing with the employment approach in the NPRM, though with some updating of quantitative impacts in the auto sector. For impacts in the auto sector, EPA uses a conceptual framework that identifies employment impacts due to changes in vehicle sales, changes in costs, and changes in the labor intensity of production. For impacts in related sectors, EPA presents qualitative discussions. We do not quantify multiplier effects, due to uncertainty over the state of the economy at the time this rule takes effect as well as the market evolutions that are likely to occur between now and implementation.

b. Conceptual Framework for Employment Impacts in the Regulated Sector

A study by Morgenstern, Pizer, and Shih[909] provides a retrospective look at the impacts of regulation in employment in the regulated sectors by estimating the effects on employment of

[905] 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.

[906] Walton, Thomas F., and Dean Drake, Defour Group LLC (February 13, 2012). ''Comments on the Notice of Proposed Rulemaking and Preliminary Regulatory Impact Analysis for MY 2017 to 2025 Fuel Economy Standards.'' Docket EPA–HQ–OAR–2010–0799–9319.

[907] Management Information Services, Inc. (July 2011). ''More Jobs per Gallon: How Strong Fuel Economy/GHG Standards Will Fuel American Jobs.'' Boston, MA: Ceres. Docket EPA–HQ–OAR–2010–0799–0709.

[908] Natural Resources Defense Council, National Wildlife Federation, and United Auto Workers (August 2011). ''Supplying Ingenuity: U.S. Suppliers of Clean, Fuel-Efficient Vehicle Technologies.'' *http://www.nrdc.org/transportation/autosuppliers/files/SupplierMappingReport.pdf* (Docket EPA–HQ–OAR–2010–0799–).

[909] 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–2010–0799–1011).

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,[910] 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 magnitudes 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 for examining the impacts of the rule on the auto sector.

c. Employment Analysis of This Rule

As mentioned above, this program is expected to affect employment in the regulated sector (auto manufacturing) and other sectors directly affected by the rule: auto parts suppliers, auto dealers, and 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). Changes in consumer expenditures due to higher vehicle costs and lower fuel expenses will also affect employment. 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 rule 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 rule on other sectors. Focusing quantification of employment impacts on the regulated sector has some advantages over quantifying all impacts. 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 rule. 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 in other sectors to provide a broader perspective on the impacts of this rule.

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 rule 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.

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 rule 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 decreased employment, there are countervailing effects in the vehicle

[910] As will be discussed below, the demand effect 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?

market due to the fuel savings resulting from this program. On one hand, this rule will increase vehicle costs; by itself, this effect would reduce vehicle sales. On the other hand, this rule 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 the demand effect will depend on which of these effects dominates. This issue is discussed further in Sections III.H.1 and III.H.11. Some comments encouraged us to quantify this effect, once we quantified estimates for vehicle sales. Because, as described in Section III.H.11, we have not quantified the impact on sales for this rule, we do not quantify the demand effect.

(2) The Cost Effect

The demand effect measures employment changes due to new vehicle sales only. The cost effect measures employment impacts due to the development, manufacturing, and installation by auto suppliers and manufacturers of the new or additional technologies needed for vehicles to comply with the standards. As RIA Chapter 8.2.3.1.2 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. Several commenters mentioned the importance of this rule in encouraging employment related to the technologies expected to be used to comply with this rule. We received no comments criticizing the approach used here; the UAW commended EPA for it.

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 rule 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);[911] the Census Bureau's Annual Survey of Manufactures[912] (ASM); and the Census Bureau's Economic Census. RIA 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 (as supported by a commenter). The maximum value for employment impacts per $1 million expenditures (after accounting for the share of domestic production) in 2010 was estimated to be 1.809 if all the additional costs are in the parts sector; the minimum value is 0.402, 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 RIA, trends in the BLS ERM are used to estimate productivity improvements over time that are used to adjust these ratios over time. Table III–107 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 Economic Census 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.

While we estimate employment impacts, in job-years, beginning with the first year of the standard (2017), some of these employment gains may occur earlier as auto manufacturers and parts suppliers hire staff in anticipation of compliance with the standard. A job-years is a way to calculate the amount of work needed to complete a specific task. For example, a job-year is one year of work for one person, or 6 months of work for 2 people.

TABLE III–107—EMPLOYMENT EFFECTS DUE TO INCREASED EXPENDITURES ON VEHICLES AND PARTS, IN JOB-YEARS

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	$2,435	700	3,200
2018	4,848	1,300	6,200
2019	6,818	1,700	8,400
2020	8,858	2,100	10,500
2021	12,400	2,900	14,200
2022	18,323	4,100	20,200
2023	23,734	5,100	25,200

[911] *http://www.bls.gov/emp/ep_data_emp_requirements.htm.*

[912] *http://www.census.gov/manufacturing/asm/index.html.*

TABLE III–107—EMPLOYMENT EFFECTS DUE TO INCREASED EXPENDITURES ON VEHICLES AND PARTS, IN JOB-YEARS—Continued

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
2024	29,101	6,000	29,700
2025	31,678	6,300	31,100
Total		30,300	148,800

(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 standards. As discussed in RIA Chapter 8.2.3.1.3, for a subset of the technologies, EPA-sponsored research (discussed in Chapter 3.1.1.1 of the Joint TSD), which compared new technologies to existing ones at the level of individual components, found that labor use for those new technologies increased: those 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.[913] For a subset of the technologies likely to be used to meet the standards in this rule, 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. 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.

Comments supported this approach and encouraged development of these estimates for more technologies. Because of the complexity of the estimation process, we are not presenting additional estimates in the RIA.

(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 standards on employment for auto dealers depend principally on the effects of the standards on light duty vehicle sales: increases in sales are likely to contribute to employment at dealerships, while reductions in sales are likely to have the opposite effect. 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, and reductions are likely to decrease labor demand.

The Defour Group as part of its employment estimate (discussed in III.H.12.a) expressed concern about employment in this sector, due to the potential impacts of the rule on vehicle sales; they provide an estimate of 35,000 jobs lost at auto dealers due to their predicted sales reductions for MY 2025.[914] As discussed in III.H.11, we do not at this point provide a quantitative estimate of the effects of this rule on vehicle sales. The National Automobile Dealers Association encouraged additional information to help consumers better understand the benefits of investing in improved fuel economy, and noted the information provided by the new fuel economy label developed by the agencies.[915]

Although this rule predicts very small penetration of plug-in hybrids and electric 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. We agree with the comment that consumer information has the potential to play an important role in consumer acceptance of vehicles subject to this rule.

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 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

[913] 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–2010–0799–1101).

[914] See footnote 906.

[915] Information on the label may be found at *http://www.epa.gov/otaq/carlabel/index.htm.*

on the effects of the standards on vehicle sales and on the labor intensity of the new technologies, qualitatively in the same ways as for the auto manufacturing sector. The United Auto Workers, Blue-Green Alliance, environmental organizations, and various others specifically noted the employment gains associated with development and use of these advanced technologies.

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 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.4. 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. Comments from the United Auto Workers (UAW), Blue-Green Alliance, environmental organizations, and Investor Network on Climate Risk suggested that, because other sectors are more labor-intensive than gasoline production and sales, reducing expenditures on gasoline and making them available for other consumer goods may increase employment. EPA has not estimated this effect.

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 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.5); indeed, people who finance their vehicles are expected to find that their fuel savings per month exceed the increase in the loan cost (except at very high interest rate levels). As a result, consumers will have additional money to spend on other goods and services (for those consumers who pay cash for 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.

Environmental organizations, CFA, the National Association of Clean Air Agencies, American Council for an Energy-Efficient Economy (ACEEE), UAW, Business for Innovative Climate & Energy Policy (BICEP), Ceres, and some private citizens suggested in written comments and in public hearings that this rule would increase economic growth in the U.S. The Center for Biological Diversity, International Council for Clean Transportation, Natural Resources Defense Council, and Union of Concerned Scientists (UCS) recommended that EPA include an analysis of the economy-wide impacts of the rule, including impacts on U.S. gross domestic product (GDP) and consumption patterns. ACEEE, Ceres, BICEP, and UCS suggested that fuel savings from the rule would allow consumers to increase their spending on other goods and services in more productive sectors of the economy, which would likely increase GDP and consumption in the U.S. CFA specifically recommended that EPA use a GDP multiplier approach that recognizes that national output would increase from the rule as a result of reducing U.S. oil imports. Ceres, BICEP, UCS, and the National Wildlife Federation cited a report for Ceres by Management Information Services, Inc. that found that a 4% annual improvement in fuel economy would increase U.S. gross economic output by $21.3 billion, personal income by $14.2 billion, and revenue for federal, state, and local governments by $12.7 billion in 2030.[916] On the other hand, other private citizens suggested the economy could be harmed as a result of this rule, but did not offer any specific data to support the claim. Analyzing the economy-wide impacts from this rule is challenging due to the inherent uncertainty in projecting a myriad of economic parameters into the future (e.g., levels of employment of labor and capital, the structure of the economy, prices of goods and services) and determining an appropriate economic framework to model (e.g., supply equaling demand in all markets and specific forms of market interactions). EPA has not been able to identify a widely agreed upon methodology and thus we continue to not quantify the impacts of the rule on overall economic patterns in the U.S.

d. Summary

The primary employment effects of this rule 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 700–3,200 jobs-year 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

[916] Management Information Services, Inc., July 2011, ''More Jobs Per Gallon: How Strong Fuel Economy/GHG Standards Will Fuel American Jobs'', A Ceres Report, Washington, DC.

gains may occur earlier as auto manufacturers and parts suppliers hire staff to prepare to comply with the standard. 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.

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 Final 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 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 information collection requirements are not enforceable until OMB approves them.

The Agency is finalizing requirements for manufacturers to submit information to ensure compliance with the provisions in this rule. This includes a variety of requirements for vehicle manufacturers. Section 208(a) of the Clean Air Act requires that vehicle manufacturers provide information the Administrator may reasonably require to determine compliance with the regulations; submission of the information is therefore mandatory. We will consider confidential all information meeting the requirements of section 208(c) of the Clean Air Act.

As shown in Table III–108, the total annual reporting burden associated with this rule is about 5,700 hours and $1.4 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–108—ESTIMATED BURDEN FOR REPORTING AND RECORD-KEEPING REQUIREMENTS

Number of respondents	Annual burden hours	Annual costs
33	5,667	$1,399,632

An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9. In addition, EPA is amending the table in 40 CFR part 9 of currently approved OMB control numbers for various regulations to list the regulatory citations for the information requirements contained in this final rule.

The American Petroleum Institute commented that EPA must seek approval for the paperwork burden associated with the information collection that the 2017 car rule could impose on stationary sources newly subject to permitting requirements. In response, this rule does not contain any paperwork requirements for entities other than the auto manufacturers discussed above.

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–109 provides an overview of the primary SBA small business categories included in the light-duty vehicle sector:

TABLE III–109—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	811111, 811112, 811198
	$23 million annual sales	441120
	100 employees	423110
Alternative Fuel Vehicle Converters	750 employees	336312, 336322, 336399
	1,000 employees	335312
	$7 million annual sales	811198

[a] Light-duty vehicle entities that qualify as small businesses are not subject to this rule. We are exempting small business entities from the GHG standards.
[b] North American Industrial Classification System.

After considering the economic impacts of today's rule on small entities, EPA certifies that this action will not have a significant economic impact on a substantial number of small entities. Consistent with the MY 2012–2016 GHG standards, EPA is exempting 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.

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 24 entities that fit the Small Business Administration (SBA) criterion of a small business. There are about 5 small manufacturers; including three electric vehicle manufacturers, 8 ICIs, and 11 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 exemption will have a negligible impact on the GHG emissions reductions from the standards.

As discussed in Section III.B.7, EPA is allowing small businesses to waive their small entity exemption and optionally certify to the GHG standards. This will allow small business 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. Manufacturers may choose to opt-in as early as MY 2013. Once the small business manufacturer opting into the GHG program in MY 2013 completes certification for MY 2013, the company will also be eligible to generate GHG credits for their MY 2012 production. Manufacturers waiving their small entity exemption must 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 standards would impose no significant adverse impact on small entities.

The American Petroleum Institute commented 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 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.[917]

Since the rule regulates exclusively large motor vehicle manufacturers and small vehicle manufacturers are exempted from the standards, EPA is properly certifying that the 2017–2025 standards will 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.

d. Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), P.L. 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 rule contains no Federal mandates (under the regulatory provisions of Title II of the UMRA) for State, local, or tribal governments. The rule imposes no enforceable duty on any State, local or tribal governments. 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 rule contains a Federal mandate that may result in expenditures of $100 million or more for the private sector in any one year. EPA believes that the rule represents the least costly, most cost-effective approach to revise the light duty vehicle standards as authorized by section 202(a)(1). The costs and benefits associated with the rule are discussed above and in the Final Regulatory Impact Analysis, as required by the UMRA.

e. Executive Order 13132: ''Federalism''

This action does not have federalism implications. It will not have substantial

[917] 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 rule.

direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. This rulemaking applies to manufacturers of motor vehicles and not to state or local governments; 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 solicited comments on the action from State and local officials. A number of State and local governments submitted public comments on the rule, the majority of which were supportive of the EPA's proposed action. However, these entities did not provide comments indicating there would be a substantial direct effect on State or local governments resulting from this rule.

f. Executive Order 13175: ''Consultation and Coordination With Indian Tribal Governments''

This action does not have tribal implications, as specified in Executive Order 13175 (65 FR 67249, November 9, 2000). This rule will be implemented at the Federal level and impose compliance costs only on vehicle manufacturers. Tribal governments will be affected only to the extent they purchase and use regulated vehicles; 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.

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 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 finalized 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.

h. Executive Order 13211: ''Energy Effects''

Executive Order 13211 [918] 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 action establishes passenger car and light truck fuel economy standards that will significantly reduce the consumption of petroleum, achieve energy security benefits, and have no adverse energy effects (Section III.H.8). 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 rulemaking action is not designated as a significant energy action as defined by E.O. 13211.

[918] 66 FR 28355 (May 18, 2001).

i. National Technology Transfer Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (''NTTAA''), Public Law 104–113, 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials, specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This rulemaking involves technical standards. Therefore the Agency conducted a search to identify potentially applicable voluntary consensus standards. For CO_2, emissions, we identified no such standards, and none were brought to our attention in comments. Therefore, for CO_2, emissions EPA is collecting 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 using 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 (EO) 12898 (59 FR 7629 (Feb. 16, 1994)) establishes federal executive policy on environmental justice. Its main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

With respect to GHG emissions, EPA has determined that this final rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases the level of environmental protection for all affected populations without having any disproportionately high and adverse human health or environmental effects on any population, including any minority or low-income population. The reductions in CO_2 and other GHGs associated with the standards will affect climate change projections, and EPA has estimated reductions in projected global mean surface temperatures 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.[919] 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 rule.

k. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 et. seq., as added by the Small Business Regulatory Enforcement Fairness Act of 1996, generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report, which includes a copy of the rule, to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States prior to publication of the rule in the **Federal Register**. A Major rule cannot take effect until 60 days after it is published in the **Federal Register**. This action is a ''major rule'' as defined by 5 U.S.C. 804(2). This rule will be effective [date], sixty days after date of publication in the **Federal Register**.

J. Statutory Provisions and Legal Authority

Statutory authority for the vehicle controls finalized today is found in section 202(a) (which authorizes standards for emissions of pollutants from new motor vehicles which emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare), 202(d), 203–209, 216, and 301 of the Clean Air Act, 42 U.S.C. 7521(a), 7521(d), 7522, 7523, 7524, 7525, 7541, 7542, 7543, 7550, and 7601. 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. 32904(c).

IV. NHTSA Final Rule for Passenger Car and Light Truck CAFE Standards for Model Years 2017 and Beyond

A. Executive Overview of NHTSA Final Rule

1. Introduction

The National Highway Traffic Safety Administration (NHTSA) is establishing Corporate Average Fuel Economy (CAFE) standards for passenger automobiles (passenger cars) and nonpassenger automobiles (light trucks) for model years (MY) 2017–2021. NHTSA's final CAFE standards would, on average, require manufacturers' passenger car and light truck fleets to achieve a combined 40.3–41.0 mpg in MY 2021. This represents an average annual increase of 3.3–3.5 percent from the estimated 34.3–34.5 mpg expected to be required, on average, in MY 2016. NHTSA is also presenting what we are describing as ''augural'' standards for MYs 2022–2025 in this final rule and accompanying regulatory documents. The National Program, of which this final rule is a part, covers 9 model years of standards—2017–2025—but NHTSA is directed by statute to set CAFE standards for ''at least 1, but not more than 5'' model years at a time.[920] To facilitate longer-term product planning by industry and in the interest of harmonization, NHTSA is presenting the augural standards for MYs 2022–2025 in these rulemaking documents as representative of what levels of stringency the agency currently believes would be appropriate in those model years, based on the information before us today. The augural standards, if finalized, would require manufacturers' passenger car and light truck fleets to achieve an average of 48.7–49.7 mpg in MY 2025. Thus, for the entire 2017–2025 period, the final standards plus the augural standards represent an average annual increase of 4.0–4.1 percent from the estimated 34.3–34.5 mpg expected to be required, on average, in MY 2016. The augural standards alone represent an average annual increase of 4.8–4.9 percent from the estimated 40.3–41.0 mpg expected to be required, on average, in MY 2021.

For brevity, information about the impacts of the standards will be provided throughout the document without distinguishing between the final standards and the augural standards, but we emphasize that the augural standards are not final, and that a future full rulemaking consistent with all applicable law will be necessary in order for NHTSA to establish final CAFE standards for MYs 2022–2025 passenger cars and light trucks.

Because the overarching goal of the CAFE program is energy conservation, two of the most important impacts of the standards are reductions in U.S. petroleum consumption and the corresponding benefits to society of avoiding that petroleum consumption. Due to the combined final and augural standards, we project total fuel savings of approximately 180–184 billion gallons over the lifetimes of the vehicles sold in model years 2017–2025, with corresponding net societal benefits of over $498–507 billion using a 3 percent discount rate,[921] or $372–377 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 final MYs 2017–2021 CAFE standards and augural MYs 2022–2025 CAFE standards are part of a National Program made up of complementary regulations by NHTSA and the Environmental Protection Agency. Today's 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

[919] 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*.

[920] 49 U.S.C. 32902(b)(3)(B).

[921] 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 2012 Early Release 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 constant 2010 dollars for emissions occurring in 2010, rising to $47/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.

carbon dioxide (CO_2) tailpipe emissions, a large majority of the projected benefits are achieved jointly with EPA's GHG rule, which is described in detail above in Section III of this preamble. These 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 CAFE standards and the analysis supporting them also respond to President 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.[922] 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.[923] Using vehicle technology to improve fuel economy, and thereby reducing tailpipe emissions of CO_2, is one of the three main measures of reducing those tailpipe emissions of CO_2.[924] 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.

a. 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. 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, and the need to reduce energy consumption is even more crucial today than it was when EPCA was enacted. Net petroleum imports accounted for approximately 45 percent of U.S. petroleum consumption in 2011.[925] 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.[926] Light-duty vehicles account for about 60 percent of transportation oil use,[927] 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 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.

[922] 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 Jun. 23, 2012).

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 Jun. 23, 2012).

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 Jun. 23, 2012).

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 Jun. 23, 2012).

''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 Jun. 23, 2012).

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 Jun. 23, 2012).

[923] Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010 (April 2012), EPA–430–R–12–001, pp. ES–4 (Table ES–2), ES–15, and 2–20 through 2–23. Available at *http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2012-Main-Text.pdf* (last accessed Jun. 23, 2012).

[924] 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 Jun. 23, 2012).

[925] Energy Information Administration, ''How dependent are we on foreign oil?'' *Available at http://www.eia.gov/cfapps/energy_in_brief/foreign_oil_dependence.cfm?featureclicked=3* (last accessed Jun. 23, 2012). EIA notes that U.S. dependence on imported oil has declined since peaking in 2005 as a result of a variety of factors, including improvements in efficiency as well as economic trends.

[926] Energy Information Administration, Annual Energy Outlook 2011, ''Oil/Liquids.'' *Available at http://www.eia.gov/forecasts/aeo/MT_liquidfuels.cfm* (last accessed Jun. 23, 2012).

[927] Energy Information Administration, ''Use of Energy in the United States Explained, Energy Use for Transportation.'' *Available at http://www.eia.gov/energyexplained/index.cfm?page=us_energy_transportation* (last accessed Aug. 9, 2012).

b. Reducing Petroleum Consumption To Reduce Climate Change Impacts

CO_2 is the natural by-product of the combustion of fossil 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.[928] 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. Transportation is 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 2010; passenger cars and light trucks make up 62 percent of transportation sector GHG emissions.[929] 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 Final Environmental Impact Statement (EIS) accompanying this final rule.

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 presenting 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.[930] 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.[931] The agencies began working immediately on the next phase of the National Program, work which has culminated in the standards for MYs 2017–2025 contained in this final rule.

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. There is a single pool of technologies for reducing fuel consumption and CO_2 emissions. Using these technologies to minimize 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 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. While the vast majority of commenters strongly supported this goal, the Institute for Energy Research (IER) argued that because the agencies' analysis showed that the proposed standards would reduce global climate change by roughly 2/100th of a degree Celsius in 2100, therefore EPA was not accomplishing the goal of reducing the risk of GHGs to public health and welfare, and should not be regulating GHGs for light-duty vehicles under the CAA.[932] Environmental Consultants of Michigan commented similarly, and suggested that EPA regulate fuels rather than vehicles to reduce emissions more effectively.[933] Competitive Enterprise Institute (CEI)[934] also argued, as did the

[928] 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 Jun. 23, 2012).

[929] EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010 (April 2012), p. 2–20. *Available at http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2012-Chapter-2-Trends.pdf* (last accessed Jun. 23, 2012).

[930] 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 promulgated final GHG and fuel efficiency standards for heavy duty vehicles and engines for MYs 2014–2018 in 2011. 76 FR 57106 (September 15, 2011).

[931] These commitment letters in response to the May 21, 2010 Presidential Memorandum are available at *http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/Stakeholder+Commitment+Letters* (last accessed August 5, 2012).

[932] IER, Docket No. EPA–HQ–OAR–2010–0799–9573, at 3–7.

[933] Environmental Consultants of Michigan, Docket No. NHTSA–2010–0131–0166, at 1–4.

[934] CEI, Docket No. EPA–HQ–OAR–2010–0799–9552, at 1–2.

U.S. Chamber of Commerce,[935] the National Automobile Dealers Association,[936] and joint comments from the American Petrochemical Institute (API), the National Manufacturers Association (NAM), and the American Fuel and Petrochemical Manufacturers Association (AFPM),[937] that NHTSA should be setting CAFE standards and that EPA should not be concurrently setting GHG standards under the CAA. Some commenters, such as CEI [938] and AFPM,[939] further argued that standards for MYs 2017–2025 should not be set at this time. Other commenters, such as the Natural Resources Defense Council (NRDC), strongly supported the joint action, pointing to EPA's relatively broad authority under the CAA to argue that a joint action can accomplish more than what NHTSA can accomplish under its EPCA/EISA authority.[940] Consumer Federation of America also supported the joint action, stating that coordinated national standards reflecting a steady rate of increase in stringency over a long time give consumers and the industry certainty and time to adapt to change.[941] Again, we note that of the hundreds of thousands of comments received to the proposals, the overwhelming majority were positive.

NHTSA believes that the benefits of the National Program extend far beyond the potential future reduction in global temperature that can be associated with the standards being finalized today. The fuel savings and related CO_2 emissions reductions that will occur as a result of the standards will be real, and the fact that this rulemaking cannot, by itself, solve our energy security and climate change challenges does not obviate the agencies' need to act.[942] NHTSA is required by Congress to set CAFE standards to promote energy conservation, and today's standards will meaningfully reduce consumers' future fuel expenses and the nation's exposure to economic and other risks related to petroleum consumption. Moreover, EPA, due to its Endangerment Finding, is required to prescribe standards under the CAA to reduce the risks associated with climate change. By setting harmonized Federal standards now 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 presented in this final rule for MYs 2022–2025 are augural, while EPA's standards for those model years will be legally binding when adopted in this round. As noted above, EISA requires NHTSA to issue CAFE standards for ''at least 1, but not more than 5, model years.'' To maintain the harmonization benefits of the National Program, NHTSA has finalized standards for MYs 2017–2021 and presented standards for MYs 2022–2025, but the last 4 years of standards are not 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—more than simply reviewing the analysis and findings in the present rulemaking to see whether they are still accurate and applicable, but taking a fresh look at all relevant factors based on the best and most current information available at that future time. Global Automakers commented that NHTSA should not include the passenger car and light truck standards for MYs 2022–2025 in its regulatory text for inclusion in the CFR, on the grounds that those standards must be finalized in the future *de novo* rulemaking.[943] We are continuing to include the augural standards for MYs 2022–2025 in the regulatory text as part of this final rule, but we have clarified, as will be evident in NHTSA's revisions to 49 CFR Part 531 and Part 533 at the end of this preamble, that they are separate from the final standards for MYs 2017–2021. The proposed regulatory text already explained that the standards for MYs 2022–2025 would only be applicable if NHTSA determines in the future rulemaking that they are maximum feasible; those provisions are made final in this rule. NAM and Toyota argued that the agencies should immediately rescind the standards for MYs 2022–2025 if they are determined to be inappropriate, leaving the MY 2021 standards in effect for those future model years until new standards are finalized.[944] Since NHTSA's standards for MYs 2022–2025 are augural and must be finalized in a subsequent *de novo* rulemaking, this concern is not an issue for the CAFE program. Toyota suggested that NHTSA simply enact standards at the MY 2021 levels for MYs 2022–2025 if the future rulemaking is not completed prior to 18 months before the start of MY 2022,[945] but NHTSA does not intend to prejudge the outcome of that future rulemaking, and at any rate fully expects to complete it well in advance of the statutory lead-time requirement.

To facilitate that future rulemaking effort, NHTSA and EPA will concurrently 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. Toyota commented that it supported the participation of the California Air Resources Board (CARB) in the mid-

[935] U.S. Chamber of Commerce, Docket No. EPA–HQ–OAR–2010–0799–9521, at 3–5.

[936] NADA, Docket No. NHTSA–2010–0131–0261, at 12.

[937] API/NAM/AFPM, Docket No. EPA–HQ–OAR–2010–0799–9509, at 8.

[938] CEI, Docket No. EPA–HQ–OAR–2010–0799–9552, at 1–2.

[939] AFPM, Docket No. EPA–HQ–OAR–2010–0799–9485, at 2.

[940] NRDC, Docket No. EPA–HQ–OAR–2010–0799–9472, at 2, 7–8.

[941] CFA, Docket No. EPA–HQ–OAR–2010–0799–9419, at 10.

[942] As the Supreme Court has stated, ''Agencies, like legislatures, do not generally resolve massive problems in one fell regulatory swoop. *See* Williamson v. Lee Optical of Okla, Inc., 349 U.S. 483, 489 (1955) (''[A] reform may take one step at a time, addressing itself to the phase of the problem which seems most acute to the legislative mind''). They instead whittle away at them overtime, refining their preferred approach as circumstances change and as they develop a more nuanced understanding of how best to proceed.'' *Massachusetts* v. *EPA*, 549 U.S. 497, 524 (2007).

[943] Global Automakers, Docket No. NHTSA–2010–0131–0237, at 12.

[944] NAM, Docket No. EPA–HQ–OAR–2010–0799–9587, at 3; Toyota, Docket No. EPA–HQ–OAR–2010–0799–9586, at 8–9.

[945] Toyota, Docket No. EPA–HQ–OAR–2010–0799–9586, at 8–9.

term evaluation process, and the conditioning of the CAA preemption waiver for CARB's MYs 2017–2025 GHG standards on CARB's acceptance of any changes to the EPA GHG standards for MYs 2022–2025 that may result from the mid-term evaluation.[946] The agencies fully expect to conduct the mid-term evaluation in close coordination with the CARB, consistent with the agencies' commitment to maintaining a single national framework for regulation of fuel economy and GHG emissions.[947] Prior to beginning NHTSA's rulemaking process and EPA's mid-term evaluation, the agencies plan to 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 plan to provide an opportunity for public comment on the draft TAR, and to arrange for appropriate peer review of underlying analyses, and to make the assumptions and modeling underlying the TAR available to the public to the extent consistent with law. The draft TAR is expected to be issued no later than November 15, 2017. The agencies plan to 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,[948] 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.

[946] Toyota, Docket No. EPA–HQ–OAR–2010–0799–9586, at 9.

[947] The agencies also fully expect that any adjustments to the standards as a result of NHTSA's rulemaking and 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.

[948] 49 U.S.C. 32902(a).

2. How has NHTSA developed the CAFE standards since the President's announcement, and what has changed between the proposal and the final rule?

The CAFE standards proposed in the NPRM and presented in this final rule are based on much more analysis conducted by the agencies since the TAR, including in-depth modeling analysis by DOT/NHTSA to support the CAFE standards, and further refinement of a number of our baseline, technology, and economic assumptions used to evaluate the standards and their impacts. While much of the analytical basis for the proposed standards was carried forward into the final rule analysis, some aspects of the final rule are different from the proposal, such as the following:

a. Programmatic Changes

- As discussed above and in more detail in Section IV.E below, NHTSA is clarifying in this final rule that the standards for MYs 2022–2025 are augural, and will be finalized in a future *de novo* rulemaking;
- Fuel consumption improvements due to A/C efficiency improvements—menu: the agencies had originally proposed that manufacturers must perform the A-to-B ''AC17'' test and report their full results in order to access the credit/fuel consumption improvement menu. For the final rule, manufacturers are required to report only results of the AC17 ''B'' testing for MY 2017–2019 in order to access the full menu credit for installed technologies. For MY 2020 and beyond, AC17 ''A'' test results or engineering analysis and AC17 ''B'' test results must be submitted to determine actual credit availability.[949]
- As proposed, a manufacturer could obtain credit for installation of off-cycle technologies but had to meet a 10% penetration threshold requirement. The minimum penetration rate requirements have been eliminated for this final rule.
- NHTSA is adding to its regulations a description of the process it plans to use provide its views to EPA related to manufacturers' applications to use off-cycle technologies to improve their average CAFE performance values.
- To obtain credits for implementation of mild hybrids on large pick-up trucks, the installation rate has been reduced in the final rule from 30% and 40% to 20% and 30% for MYs 2017 and 2018, respectively.

[949] The fuel consumption improvement values in the A/C efficiency menu have not changed, but this procedural change has the effect of making it easier for manufacturers to demonstrate improvements in their A/C systems.

  - Certain proposed definitions have been revised to address comments and add further clarification:
  - The base tire definition is revised to better align with the approach manufacturers use to determine model type target standards.
  - Mild hybrid and strong hybrid vehicle definitions are no longer limited to gasoline-electric vehicles but may include non-gasoline (i.e., diesel, ethanol, and CNG-fueled) hybrid vehicles.
- Proposed Part 537 reporting requirements have been revised to address comments and add further clarification:
  - Manufacturers will be required to submit pre- and mid-model year reports containing purported confidential business information on CD–ROM (2-copies) versus email to a secure agency email address as stated in the NPRM.
  - Aspects of the proposed requirement that manufacturers of light trucks provide specific data in the pre-model year report substantiating classification decisions have been clarified.
  - Manufacturers taking advantage of technology incentives (A/C efficiency, off-cycle and large pick-up hybrid and efficiency improvement technology) are required to report cumulatively for the application of its vehicles versus for each vehicle configuration as was proposed.
  - Modified requirements to include the provision that manufacturers can optionally report target standard values for each reported unique model type/footprint combination.

b. Analytical Changes

- NHTSA and EPA have revised the 2008-based baseline market forecast to correct some errors in the version used for the NPRM, and added a 2010-based baseline market forecast. Analysis throughout the NHTSA rulemaking documents reflects both forecasts.
- Battery costs: Argonne National Laboratories (ANL) updated its ''BatPaC'' battery cost model to include cost estimates of options for liquid or air thermal management with adequate surface area and cell spacing, the option of parallel subpacks or modules battery configuration, and NHTSA-estimated costs for a battery discharging system. Using these updates, EPA updated the battery costs for strong hybrids, PHEVs, and EVs, and the results are used in both agencies' analyses.
- Work with ANL: Between the NPRM and the final rule, DOT/NHTSA contracted with ANL (separately from the battery cost work described above) to study some aspects of advanced

transmission and hybrid technology effectiveness. Based on the results from the ANL study, NHTSA updated the certain transmission technology effectiveness values in the CAFE model when advanced transmissions are matched with naturally aspirated engines. Additionally, based on ANL's work for DOT/NHTSA, both agencies have added mild hybrids (similar to GM's Buick eAssist) as an enabling technology applicable to all vehicle classes in their analyses for this final rule. The cost for the mild hybrid technology is derived based on the teardown study performed by FEV for EPA and battery costs from ANL's BatPaC model.

- Amount of mass reduction: Between the NPRM and the final rule, NHTSA updated the amount of mass reduction applied in the CAFE model as a result of updates to the safety coefficients from the most recent Kahane study, in order to achieve the maximum amount of mass reduction while maintaining a safety-neutral outcome.
- Updates to economic inputs:
  - Fuel prices are now based on EIA's AEO 2012 Early Release forecasts
  - VMT schedules and vehicle survival rates have been updated
  - Changes to benefits associated with reduced refueling time
  - Accounting for maintenance costs during the warranty period (sensitivity analysis to consider repair costs beyond the warranty period)
  - Accounting for financing costs and insurance costs from the consumer perspective
  - Updating all costs and benefits to 2010$
- Changes to the CAFE model:
  - Corrections to incremental accounting for cost of diesel engines
  - For purposes of selecting among available options to add technology incrementally, corrections to model to look at fuel prices during years following vehicle's sale, rather than before vehicle's sale
  - Corrections to accounting for the fuel economy of dual-fueled E85-capable vehicles (often called "flexible fuel vehicles" or "FFVs") to recognize technologies' fuel economy effectiveness when operating on E85
  - Corrections to accounting for on-road energy consumption by EVs and PHEVs by removing Petroleum Equivalency Factor from on-road equivalent fuel economy
  - Corrections to account for mobility benefit (value of travel) to account for value of fuel for travel attributable to the rebound effect
  - Other changes to implement the analytic and programmatic changes listed above

This final rule, the joint TSD, and NHTSA's FRIA and EPA's RIA contain much more information about the analysis underlying the final standards. The following sections in this preamble provide the basis for NHTSA's final passenger car and light truck CAFE standards for MYs 2017–2021 and augural standards for MYs 2022–2025, the standards themselves, the estimated impacts of the 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 two "baseline" vehicle fleets representing those vehicles, based on the best available transparent information. The agencies then developed two "reference" fleets, 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.[950] These reference fleets are 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 Chapter 1 of the joint TSD, both agencies used baseline vehicle fleets constructed beginning with EPA fuel economy certification data for the 2008 and 2010 model years, the latter being the most recent model year for which final data is currently available from manufacturers. These data were used as the source for MY 2008 and MY 2010 production volumes and some vehicle engineering characteristics, such as fuel economy compliance ratings, engine sizes, numbers of cylinders, and transmission types.

Some information important for analyzing new CAFE standards is not contained in the EPA fuel economy certification data. EPA staff estimated vehicle wheelbase and track widths using data from Motortrend.com and Edmunds.com. This information is necessary for estimating vehicle footprint, which is required for the analysis of footprint-based standards.

Considerable additional information regarding vehicle engineering characteristics is also important for estimating the potential to add new technologies in response to new CAFE standards. In general, such information helps to avoid "adding" technologies to vehicles that already have the same or a more advanced technology. Examples include valvetrain configuration (*e.g.,* OHV, SOHC, DOHC), presence of cylinder deactivation, and fuel delivery (*e.g.,* MPFI, SIDI). To the extent that such engineering characteristics were not available in certification data, EPA staff relied on data published by Ward's Automotive, supplementing this with information from Internet sites such as Motortrend.com and Edmunds.com. NHTSA staff also added some more detailed engineering characteristics (*e.g.,* type of variable valve timing) using data available from ALLDATA® Online. Combined with the certification data, all of this information yielded the MY 2008 and MY 2010 baseline vehicle fleets. NHTSA also reviewed information from

[950] 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 data from a given model year. This given-model-year-based fleet includes vehicle sales volumes, GHG/fuel economy performance, and contains a listing of the base technologies on every vehicle sold in that model year. The second step was to project that given-model-year-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 the given-model-year vehicles in the future, taking into previously-promulgated standards, and assuming MY 2016 standards are extended through MY 2025. NHTSA accomplished this by using the CAFE model to add technologies to the MY 2008-based market forecast and the MY 2010-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. Section II above and Chapter 1 of the joint TSD provide additional information on development of the baseline and reference fleets for this final rule.

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. For the MY 2008-based forecast, the agencies used projected car and truck volumes for this period from Energy Information Administration's (EIA's) 2011 Interim Annual Energy Outlook (AEO).[951] For the MY 2010-based forecast, the agencies used EIA's AEO 2012 Early Release. 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, for the MY 2008-based forecast EPA purchased data from CSM–Worldwide in 2009 and used their projections of the number of vehicles of each type predicted to be sold by manufacturers in 2017–2025. 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. For the MY 2010-based forecast, EPA purchased data from LMC in 2011 and used its manufacturer- and segment-level forecasts.

The processes for constructing the MY 2008 and MY 2010 baseline vehicle fleets and subsequently adjusting sales volumes to construct the MY 2017–2025 baseline vehicle fleets are presented in detail in Chapter 1 of the joint TSD accompanying today's final rule.

In the main analysis, the agencies assume that without adoption of the proposed rule, manufacturers will not improve fuel economy levels during the 2017–2025 period 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 FRIA, NHTSA examines the impact of an alternative ''market-driven'' baseline, which estimates the potential that, insofar as sufficiently cost-effective opportunities to add technology are available, manufacturers might increase fuel economy beyond levels required by the MY 2016 standards. In the NPRM, NHTSA sought comment on what assumptions about fuel economy increases are most likely to accurately predict what would happen in the absence of the proposed rule. As discussed at greater length below in Section IV.G, some environmental organizations submitted comments relevant to this question, including (1) suggestions that buyers value fuel much more highly than assumed by NHTSA in either the main analysis or in the sensitivity analysis with the market-driven baseline; (2) suggestions that given stable standards, manufacturers might voluntarily increase fuel efficiency; (3) claims that the historical record indicates manufacturers would not voluntarily increase fuel economy; and (4) arguments that NHTSA should not account for voluntary fuel economy increase because doing so would reduce benefits attributable to the new standards. Having considered these comments, our central analysis follows the approach followed for the NPRM—that is, our central analysis and majority of our sensitivity analyses assume that manufacturers will never (*e.g.,* even if gasoline is much more expensive than assumed for our central analysis) apply more technology than necessary to achieve compliance with fuel economy standards that remain unchanged from MY 2016 through MY 2025.

In the NPRM, NHTSA also invited 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 necessary level of detail. While the agencies received comments on the characteristics of the market forecast supporting the NPRM, NHTSA did not receive any responses to our request for comments on the process for developing the market forecast. At this time, NHTSA, like EPA, is making use of market forecasts developed using the same process as applied for the NPRM and the MYs 2012–2016 rulemaking. However, NHTSA expects to revisit the market forecast development process during the future rulemaking to develop final standards for MYs 2022–2025 and the concurrent mid-term evaluation.

c. How is the development of baseline fleets for this final rule different from the baseline fleet that NHTSA used for proposed rule?

The development of the baseline fleets for this rulemaking utilizes the same procedures used in the development of the baseline fleet for the proposed rule and, previously, the MY 2012–2016 rulemaking. For this final rule, we are using two baseline fleets. The first, as in the NPRM, is 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 (and, relative to the NPRM, correcting some erroneous footprint values, as discussed in Chapter 1 of the joint TSD). The second baseline used to analyze today's final rule was developed using essentially the same process, but making use of MY 2010 CAFE certification data (rather than MY 2008), the AEO 2012 Early Release version of NEMS (rather than AEO 2011), and a manufacturer- and segment-level forecast provided to EPA in 2011 by LMC (rather than the forecast provided to EPA in 2009 by CSM). Of those, most differences (relative to the baseline supporting the MY 2012–2016 rulemaking) are in input assumptions rather than the basic approach and methodology. These include changes in various macroeconomic assumptions underlying the AEO, CSM, and LCM forecasts and the use of results obtained by using DOE's National Energy Modeling System (NEMS) to repeat the AEO 2011 and AEO 2012 analysis without forcing increased passenger car volumes, and without assuming post-MY 2016 increases in the stringency of CAFE standards.[952]

[951] 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.

[952] 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- and Early Release AEO 2012-projected shifts in passenger car market share as a result of required fuel economy improvements create a circularity. Therefore, for the current analysis, the agencies developed new projections of passenger car and light truck sales shares by running scenarios from the Interim AEO 2011 and Early Release AEO 2012 reference cases that first deactivate the above-mentioned sales-volume shifting methodology and then hold post-2017 CAFE standards constant at MY 2016 levels.

Continued

d. How are these baselines different quantitatively from the baseline that NHTSA used for the proposed rule?

As discussed above, the current baselines were developed from adjusted MY 2008 and MY 2010 compliance data, respectively, and cover MY 2017–2025. This section describes, for the reader's comparison, some of the differences between the current baselines and baseline supporting the NPRM. These comparisons provide a basis for understanding general characteristics and measures of the difference between the three baselines. The current MY 2008-based baseline, while largely identical to that supporting the NPRM, reflects corrections to the footprint of some vehicle models, and corrections to the regulatory classification of a few General Motors vehicle models. The MY 2010-based baseline reflects use of MY 2010 certification data, a newer commercially-available forecast purchased by EPA in 2011 from LMC (formerly J.D. Power), and total passenger car and light truck volumes based on use of EIA's National Energy Modeling System (NEMS) for AEO 2012. The differences are in input assumptions rather than the basic approach and methodology.

e. Estimated Vehicle Sales During MYs 2017–2025

The fleetwide sales forecasts, based on the Energy Information Administration's (EIA's) Early Annual Energy Outlooks for 2011 and 2012 (Interim AEO 2011 and Early Release AEO 2012), used in the current MY 2008-based and MY 2010-based baselines, respectively, indicate that the total number of light vehicles expected to be sold during MYs 2017–2025 is 143–146 million, or about 15.9–16.2 million vehicles annually. NHTSA's NPRM forecast, also based on AEO 2011, of the total number of light vehicles likely to be sold during MY 2012 through MY 2016 was 146 million, or about 16.2 million vehicles annually. Light trucks are expected to make up 34–35 percent of the MY 2017–2025 baseline market forecast in the current baselines, compared to 35 percent of the baseline market forecast in the proposed rule.

f. Estimated Manufacturer Market Shares in MY 2016

Table IV–1 shows the agency's sales forecasts for passenger cars and light trucks under the current baselines and NPRM baseline. The MY 2008-based baseline is nearly identical to the NPRM baseline. The MY 2010-based baseline exhibits several significant differences, including, but not limited to, the following: A significant increase in Chrysler's market share; declines in some other manufacturers' (*e.g.,* BMW's, Suzuki's, and Toyota's) market shares; relative declines in light trucks as a share of many manufacturers' total production; the exit of Saab from the light vehicle market; and a lack of MY 2010-based data for Tesla. Also, underlying the overall volumes reported below for some manufacturers are some significant brand-level differences between the MY 2008- and MY 2010-based fleets, reflecting significant changes in some manufacturers' offerings—changes that began in MY 2007/2008 and were complete or in progress by MY 2010. In particular, the MY 2010-based forecast for General Motors contains about 90% fewer Hummers and about 75% fewer Pontiacs than the MY 2008-based forecast, reflecting GM's discontinuation of those brands.

TABLE IV–1—NHTSA SALES FORECASTS

[Production for U.S. sale in MY 2016, thousand units]

Manufacturer	Fleet MY	NPRM baseline		Current Baselines	
		Passenger	Non-passenger	Passenger	Non-passenger
Aston Martin	2008	1		1–	0–
	2010	1			0
BMW	2008	383	184	383–	184–
	2010			317	107
Daimler	2008	245	136	245–	136–
	2010			250	97
Fiat/Chrysler	2008	392	498	394–	495–
	2010			725	794
Ford	2008	1,393	930	1,393–	930–
	2010			1,354	1,039
Geely/Volvo	2008	94	50	94–	50–
	2010			58	34
General Motors [953]	2008	1,391	1,444	1,444–	1,391–
	2010			1,672	1,222
Honda	2008	862	588	862–	588–
	2010			1,127	531
Hyundai	2008	489	99	489–	99–
	2010			847	136
Kia	2008	512	124	512–	124–
	2010			333	46
Lotus	2008	0.3	-	0.3–	0.0–
	2010			0.4	0.0
Mazda	2008	393	78	378–	93–
	2010			258	60
Mitsubishi	2008	80	60	98–	42–
	2010			57	13
Nissan	2008	869	410	869–	410–
	2010			907	310

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.''

TABLE IV–1—NHTSA SALES FORECASTS—Continued

[Production for U.S. sale in MY 2016, thousand units]

Manufacturer	Fleet MY	NPRM baseline		Current Baselines	
		Passenger	Non-passenger	Passenger	Non-passenger
Porsche	2008	30	18	30–	18–
	2010			19	20
Spkyer/Saab	2008	18	2	18–	2–
	2010			0	0
Subaru	2008	236	74	236–	74–
	2010			213	94
Suzuki	2008	94	21	94–	21–
	2010			43	3
Tata	2008	59	46	59–	46–
	2010			29	53
Tesla	2008	27	-	27–	0–
	2010				
Toyota	2008	2,043	1,159	2,043–	1,159–
	2010			1,532	970
Volkswagen	2008	528	134	528–	134–
	2010			486	104
Total[954]	2008	10,140	6,055	10,198–	5,997–
	2010			10,227	5,635

g. Estimated Unadjusted Baseline Achieved Fuel Economy Levels in MY 2016

Table IV–2, below, compares unadjusted average fuel economy levels (*i.e.,* levels reflecting vehicle model fuel economy levels the CAFE certification data and vehicle model sales volumes adjusted to produce estimated future baseline fleets) in the current market forecasts to those in the market forecast supporting the NPRM. Under the current baselines, average fuel economy for MY 2016 is 27.0–27.9 mpg, versus 27.0 mpg under the baseline in the NPRM. The upward extension of this range relative to the value from the NPRM reflects a combination of changes in technology and fuel economy between MY 2008 and MY 2010 (e.g., the introduction of Ford's ''Ecoboost'' engine). Manufacturer-specific CAFE levels are shown below in Table IV–2, which does not count FFV credits that some manufacturers expect to earn. Table IV–3 shows the combined averages of these planned CAFE levels in the respective baseline fleets. Because the agencies have, based today's market forecasts on vehicles in the MY 2008 and MY 2010 fleets, respectively, these CAFE levels the projected future vehicle mix, not changes in the fuel economy that might be achieved by individual vehicle models by MY 2016.

TABLE IV–2—CURRENT BASELINE CAFE LEVELS IN MY 2016 VERSUS MY 2012–2016 RULEMAKING CAFE LEVELS

Manufacturer	Fleet MY	NPRM Baseline		Current Baselines	
		Passenger	Non-passenger	Passenger	Non-passenger
Aston Martin	2008	18.8		18.8–	
	2010			19.0	
BMW	2008	27.2	23.0	27.2–	23.0–
	2010			27.4	24.1
Daimler	2008	25.5	21.1	25.5–	21.1–
	2010			24.7–	21.0–
Fiat/Chrysler	2008	27.7	22.2	27.7–	22.2–
	2010			28.2	21.7
Ford	2008	28.2	21.3	28.2–	21.3–
	2010			30.3	22.2
Geely/Volvo	2008	25.9	21.1	25.9–	21.1–
	2010			28.2	22.8
General Motors	2008	28.4	21.4	28.2–	21.4–
	2010			30.3	22.5
Honda	2008	33.8	25.0	33.8–	25.0–
	2010			34.5	25.1
Hyundai	2008	31.7	24.3	31.7–	24.3–
	2010			32.9	28.2
Kia	2008	32.7	23.8	32.7–	23.8–
	2010			35.2	25.0

[953] For this final rule, the MY 2008-based baseline was corrected to reassign the Chevrolet Blazer, GMC Envoy, and Pontiac Torrent to the General Motors passenger car fleet.

[954] For this final rule, the MY 2008-based baseline was corrected to reassign the Chevrolet Blazer, GMC Envoy, and Pontiac Torrent to the General Motors passenger car fleet.

TABLE IV–2—CURRENT BASELINE CAFE LEVELS IN MY 2016 VERSUS MY 2012–2016 RULEMAKING CAFE LEVELS—Continued

Manufacturer	Fleet MY	NPRM Baseline		Current Baselines	
		Passenger	Non-passenger	Passenger	Non-passenger
Lotus	2008	29.7		29.7–	
	2010			26.7	
Mazda	2008	30.8	26.4	31.3–	25.6–
	2010			32.0	25.2
Mitsubishi	2008	28.8	23.6	27.5–	23.9–
	2010			32.5	28.1
Nissan	2008	32.0	22.1	32.0–	22.1–
	2010			32.6	23.6
Porsche	2008	26.2	20.0	26.2–	20.0–
	2010			25.4	20.5
Spkyer/Saab	2008	26.6	19.8	26.6	19.8
	2010				
Subaru	2008	29.6	27.3	29.6–	27.3–
	2010			29.7	30.7
Suzuki	2008	30.8	23.3	30.8–	23.3–
	2010			33.1	26.1
Tata	2008	24.6	19.7	24.6–	19.7–
	2010			23.3	18.9
Tesla	2008	244.0		244.0	
	2010				
Toyota	2008	35.2	24.3	35.2–	24.3–
	2010			35.4	24.1
Volkswagen	2008	28.9	20.2	28.9–	20.2–
	2010			31.8	24.0
Total	2008	30.7	22.6	30.6–	22.6–
	2010			31.6	23.1

TABLE IV–3—CURRENT BASELINE CAFE LEVELS IN MY 2016 VERSUS MY 2012–2016 RULEMAKING CAFE LEVELS (COMBINED)

Manufacturer	Fleet MY	NPRM baseline	Current baselines
Aston Martin	2008	18.8	18.8–
	2010		19.0
BMW	2008	25.7	25.7–
	2010		26.5
Daimler	2008	23.7	23.7–
	2010		23.6
Fiat/Chrysler	2008	24.3	24.3–
	2010		24.4
Ford	2008	25.0	25.0–
	2010		26.1
Geely/Volvo	2008	24.0	24.0–
	2010		25.9
General Motors	2008	24.4	24.4–
	2010		26.4
Honda	2008	29.6	29.6–
	2010		30.8
Hyundai	2008	30.2	30.2–
	2010		32.2
Kia	2008	30.5	30.5–
	2010		33.5
Lotus	2008	29.7	29.7–
	2010		26.7
Mazda	2008	30.0	30.0–
	2010		30.5
Mitsubishi	2008	26.3	26.3–
	2010		31.6
Nissan	2008	28.0	28.0–
	2010		29.7
Porsche	2008	23.5	23.5–
	2010		22.6
Spkyer/Saab	2008	25.7	25.7
	2010		
Subaru	2008	29.0	29.0–

TABLE IV–3—CURRENT BASELINE CAFE LEVELS IN MY 2016 VERSUS MY 2012–2016 RULEMAKING CAFE LEVELS (COMBINED)—Continued

Manufacturer	Fleet MY	NPRM baseline	Current baselines
	2010	....	30.0
Suzuki	2008	29.1	29.1–
	2010	....	32.5
Tata	2008	22.2	22.2–
	2010	....	20.3
Tesla	2008	244.0	244.0
	2010	....	....
Toyota	2008	30.3	30.3–
	2010	....	30.0
Volkswagen	2008	26.6	26.6–
	2010	....	30.1
Total	2008	27.0	27.0–
	2010	....	27.9

h. 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 these sensitivity analyses, 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 these sensitivity analyses are summarized in Section IV.G and in NHTSA's FRIA accompanying today's notice.

i. How else is NHTSA considering looking at the baseline in the future?

Beyond the sensitivity analysis discussed above, NHTSA is also in the process of developing 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 in IV.C.4 of the NPRM, the agency is currently sponsoring research directed toward developing such a model. However, that effort is still underway, so the agency has not integrated such a model into the CAFE modeling system. The agency may do so in the future, and use 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.

For today's rulemaking, the agency has, for purposes of the probabilistic uncertainty analysis documented in the accompanying FRIA, considered uncertainty regarding the future relative shares of passenger cars and light trucks. As discussed in the FRIA, we applied an approach relating these shares to, among other things, the price of fuel, such that shares varied as we varied fuel price, leading to changes in estimated outcomes such as fuel consumption and CO_2 emissions.

2. How were the technology inputs developed?

As discussed above in Section II.D, for developing the technology inputs for the proposed MYs 2017–2025 CAFE and GHG standards, which have been carried over largely unchanged since the NPRM, the agencies primarily began with the technology inputs used in the MYs 2012–2016 CAFE final rule and in the 2010 TAR. For the NPRM, the agencies 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. The agencies also relied on a model developed by Argonne National Laboratory to estimate hybrid, plug-in hybrid and electric vehicle battery costs, which was updated between the NPRM and final rule. As another update for the final rule analysis, NHTSA used information from vehicle simulation work conducted by Argonne National Laboratory, which was contracted by the U.S. DOT Volpe Center to support CAFE rulemaking analyses. The Argonne work was used to inform several technology effectiveness estimates. More detail is available regarding how the agencies developed the technology inputs for the final rule above in Section II.D, in Chapter 3 of the Joint TSD, and in Chapter V of NHTSA's FRIA.

a. What technologies does NHTSA consider?

For purposes of this final rule and as discussed in greater detail in the Joint TSD, NHTSA and EPA built upon the list of technologies used by the agencies for the MYs 2012–2016 CAFE and GHG standards. Section II.D.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. These new technologies include higher BMEP turbocharged and downsized engines, advanced diesel engines, higher efficiency transmissions, additional mass reduction levels, PHEVs, EVs, etc. As discussed, the technologies considered fall into five broad categories: engine technologies, transmission technologies, vehicle technologies, electrification/accessory technologies, and hybrid technologies. We note that one technology has been added since the NPRM—Integrated Starter Generator (or Mild Hybrid)—based on the Argonne work. This addition is discussed in more detail in Chapter V of the FRIA.

Table IV–4 below lists all the technologies considered and provides the abbreviations used for them in the

CAFE model,[955] as well as their year of availability, which for purposes of NHTSA's analysis means the first model year in the rulemaking period that the CAFE model is allowed to apply a technology to a manufacturer's fleet.[956] ''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. Year of availability may vary in NHTSA's analysis depending on whether the modeling runs are for purposes of evaluating whether a given regulatory alternative is maximum feasible (''standard-setting runs''), or for evaluating the real-world impacts of a given regulatory alternative (''real-world runs'')—the difference occurs because EPCA/EISA restricts NHTSA's ability to consider the availability of certain technologies in certain model years. 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 Chapter V of NHTSA's FRIA.

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
Integrated Starter Generator (Mild Hybrid)	ISG	2012
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

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

[956] A date of 2007 or 2012 means the technology can be applied in all model years, while a date of 2020, for example, means the technology can only be applied in model years 2020 through 2025.

TABLE IV–4—LIST OF TECHNOLOGIES IN NHTSA'S ANALYSIS—Continued

Technology	Model abbreviation	Year available
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

* PHEV is applied in NHTSA's standard setting analysis starting from MY 2020 and in the real-world analysis starting from MY 2017.
** EV is not applied in NHTSA's standard setting analysis and applied in the real-world analysis starting from MY 2017.

b. How did NHTSA determine the costs and effectiveness of each of these technologies for use in its modeling analysis?

Building on the 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 Chapter V of NHTSA's FRIA.

For costs, the FEV tear-down work was expanded between the 2012–2016 final rule and the proposal 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; the estimates based on this work were carried forward into the final rule. Battery costs were revised between the 2012–2016 final rule and the NPRM using Argonne National Laboratory's battery cost model, which allows users to estimate unique battery pack cost using user customized input sets for different hybridization applications, such as strong hybrid, PHEV and EV. Argonne updated the model and EPA updated costs for battery packs between the NPRM and this final rule to account for air cooling (for HEVs) and parallel battery modules. EPA and NHTSA also modified how the indirect costs (using ICM factors) were derived and applied for the NPRM based on staff input and public feedback, and carried this change forward into the final rule. The updates are discussed at length in Chapter 3 of the Joint TSD and in Chapter V of NHTSA's FRIA.

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. For the final rule, NHTSA conducted a vehicle simulation project with Argonne National Laboratory (ANL), described in more detail in NHTSA's FRIA, that performed additional analyses on mild hybrid technologies and advanced transmissions to help NHTSA develop effectiveness values better tailored for the CAFE model's incremental structure. The effectiveness values that were developed by ANL for the mild hybrid vehicles were applied by both agencies for the final rule. Additionally, NHTSA updated the effectiveness values of advanced transmissions when coupled with naturally-aspirated engines based on ANL's simulation work for the final rule. 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 non-performance passenger cars. NHTSA sought comment on the extent to which commenters believed that the agencies have been successful in holding constant these elements of vehicle performance and utility in developing the technology cost and effectiveness estimates.

With respect to the cost estimates employed in the NPRM analysis, ICCT commented that technology costs continue to drop in the agencies' assessments over the past several rulemakings, which is evidence that technology will be even cheaper in the future.[957] ICCT expressed optimism that reductions in technology costs could lead the agencies to set higher standards for MYs 2022–2025 as part of NHTSA's future rulemaking and the mid-term evaluation.[958] With regard to the FEV tear-down studies in particular, ICCT stated that it was continuing to fund such work, and that it would share the cost estimates for P2 hybrids, advanced diesel engines, basic start-stop systems, manual transmissions, and cooled EGR systems with the agencies when they became available.[959] CBD concurred with ICCT's assessment.[960] NACAA suggested that costs could be brought down more quickly if more technology was introduced earlier.[961] NADA provided a number of comments related to cost, albeit focused on the broader issue of programmatic costs rather than on costs for specific technologies. NADA argued generally that attempting to estimate cost increases so far in advance was ''inherently suspect,'' given the uncertainty involved, and that

[957] ICCT, Docket No. NHTSA–2010–0131–0258, at 8.

[958] *Id.*

[959] *Id.*

[960] CBD, Docket No. NHTSA–2010–0131–0255, at 7.

[961] NACAA, Docket No. EPA–HQ–OAR–2010–0799–8084, at 3.

the agencies' cost estimates were very likely significantly undervalued.[962] NRDC commented that NADA's cost estimates appeared to be incorrect and overstated.[963] API commented that the agencies should review and use the technology cost estimates employed in AEO 2011.[964] BMW commented that the agencies' assessment of costs for BMW was understated, because BMW had already employed many of the technologies considered for BMW in the agencies' NPRM analysis, and thus further improvements will have to come from more advanced (and expensive) technologies than the agencies had estimated.[965] In response, while we recognize that our cost analyses only identify one feasible path for manufacturers to comply with the standards and that individual manufacturers may pursue other approaches, we continue to believe that tear-down analyses are the most accurate method to estimate costs for purposes of rulemaking analysis. We also recognize the inherent uncertainty in estimating costs in the 2017–2025 timeframe; to address some of this uncertainty, we are conducting sensitivity analyses to understand its magnitude with respect to costs and benefits. We will closely monitor the development of the technologies and their cost over the next several years, and will revisit these areas as needed during the future rulemaking to develop the MYs 2022–2025 standards and concurrent mid-term evaluation.

With respect to battery costs, ICCT commented that future versions of the BatPaC model should include the option to select either air or liquid cooling.[966] Tesla commented that that while it thought the BatPaC model was helpful, Tesla rather ''supports a more comprehensive approach to assessing battery cost,'' *i.e.,* by ''factor[ing] in all the costs of the battery and attendant systems including cell management, thermal management and the disconnect unit.'' [967] Tesla stated that the battery systems in its Model S would cost only $350/kWh at production levels of 25,000/year, and that it expected its costs to come down in the future.[968] Porsche, in contrast, argued that the battery costs used in the NPRM were significantly underestimated, which ''inflates the apparent cost-effectiveness'' of the standards.[969] As stated above, for the final rulemaking the agencies requested that ANL update the BatPaC model to allow for either air or liquid cooling. These updates were incorporated in the final rule analysis. Additionally, the agencies are accounting for the costs of cell management, thermal management, and battery disconnect. As mentioned above, recognizing that future battery costs are uncertain, we have run sensitivity analyses using upper and lower bounds of expected battery cost. The cost projections produced by BatPaC are sensitive to the inputs and assumptions the user provides. The battery pack cost projection from BatPaC model ranges from $160/kWh for EV150 for a large truck to $306/kWh for a PHEV40 for large passenger cars using NMC battery chemistry, and up to $376/kWh for a PHEV20 for large passenger cars using LMO battery chemistry.

With respect to the cost estimate for mass reduction, ICCT commented that it expected costs to drop in the future as computer modeling improves manufacturers' ability to reduce mass.[970] ICCT recommended that the agencies use the Lotus and FEV mass reduction studies for the final rule.[971] VW, on the other hand, agreed that mass reduction costs were likely best represented by an exponential function, but argued that based on its experience, the agencies' cost curve was too shallow and should increase faster in general and even faster for passenger cars as compared to light trucks, since passenger cars are already lighter and may have fewer opportunities for simple mass removal.[972] We agree, as VW implies, that the cost of mass reduction may vary between manufacturers, depending on what a manufacturer has already applied in its current fleet and the approach the OEMs take to address mass reduction, such as the material usage, manufacturing process, etc. As suggested by ICCT, the study sponsored by NHTSA took advantage of computer optimization, computer simulation, and advanced materials. The costs derived from NHTSA's study are based on a clean-sheet-of-paper approach and take advantage of secondary mass reduction. NHTSA's study is discussed in greater details in Chapter V of NHTSA's FRIA and Chapter 3 of the joint TSD.

As discussed in Section II.D above and Chapter 3 of the joint TSD, as well as in Chapter V of NHTSA's RIA, however, the agencies are continuing to employ the NPRM estimates for mass reduction costs in this final rule. The agencies considered updating cost estimates based on the studies that were underway when the NPRM was issued. Those studies included the EPA/ICCT funded Phase 2 Toyota Venza Low Development project and the NHTSA funded Honda Accord mass reduction project, which are described in the section titled ''*What additional studies are the agencies conducting to inform our estimates of mass reduction amounts, cost, and effectiveness?''* However, these studies were in the middle of the peer review process and had not yet been finalized at the time when the inputs for the main analysis for this final rule were required. We continue to believe the NPRM estimates are reasonable and appropriate for several reasons. First, given what we know about how differently individual manufacturers may undertake mass reduction, coming up with a single cost curve applicable to the entire industry is inherently uncertain. The mass reduction amounts and costs derived by design studies are typically directly applicable to a particular vehicle model and may not be completely applicable to other vehicle models and vehicle subclasses. The NPRM estimates were developed by reviewing nearly every available information source for mass reduction costs, which gives the agency some confidence that even if the estimates are not exactly correct for every vehicle model and subclass, they are reasonable to some extent by virtue of being fully informed. Second, while NHTSA's study was not completed in time to incorporate its results in the final rule analysis, we note that NHTSA's study developed mass reduction cost estimates both for the glider only, and for the glider plus the powertrain. At 20 percent mass reduction, the NPRM cost essentially falls in between the two cost estimates from the NHTSA study. On balance, NHTSA believes that continuing to employ the NPRM estimates for mass reduction cost is a reasonable surrogate for the result that the agency might have obtained if it had been able to incorporate results from NHTSA's mass reduction study in time for the final rule analysis. Third, the agencies conducted sensitivity studies varying the cost for mass reduction using a ±40% unit cost range, and found that even when using

[962] NADA, Docket No. NHTSA–2010–0131–0261, at 3.

[963] NRDC, Docket No. EPA–HQ–OAR–2010–0799–9472, at 20.

[964] API, Docket No. NHTSA–2010–0131–0238, at 10.

[965] BMW, Docket No. NHTSA–2010–0131–0250, at 9–10.

[966] ICCT, Docket No. NHTSA–2010–0131–0258, at 21–22.

[967] Tesla, Docket No. NHTSA–2010–0131–0259, at 5.

[968] *Id.*

[969] Porsche, Docket No. NHTSA–2010–0131–0224, at 6.

[970] ICCT, Docket No. NHTSA–2010–0131–0258, at 8.

[971] *Id.* at 9.

[972] VW, Docket No. NHTSA–2010–0131–0247, at 17.

costs at these limits, there was little change in the average vehicle technology cost. This supports that had the agencies used a different cost curve based on the completion of their studies, the use of the revised cost curve would have had very little effect on the results of agencies' analyses. Therefore, the agencies conclude that it is reasonable and appropriate to use the NPRM cost estimates for mass reduction in the final rule.

The agency notes that the technology costs included in this final rule for the central analysis 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, in the proposal the agencies did not explicitly incorporate maintenance costs (or potential savings) as a separate element. The agency sought comments on this topic and undertook a more detailed review of these potential costs for the final rule. NADA commented that the agencies should evaluate the potential impact on a vehicle's total cost of ownership, including maintenance costs, in the final rule. In response, NHTSA identified a list of technologies for which sufficient data on frequency and cost of maintenance events exists to support quantification of changes in vehicle maintenance costs. This list includes costs associated with low rolling resistance tires, diesel fuel filters, and benefits resulting from electric vehicle characteristics that eliminate the need for oil changes as well as engine air filter changes. These repair costs during the warranty period that are identifiably different for new technologies were included in the central analysis for the final rule. The full list of technologies shown is in Chapter 3 of the joint TSD, along with the maintenance interval comparisons, and costs per maintenance event. In the final rule as in the NPRM, repair costs during the warranty period that are common for all vehicles remain a component of the indirect cost multiplier. A sensitivity analysis was added to the FRIA to examine repair costs in the post-warranty period, discussed further in Chapter X of NHTSA's FRIA. For example, EVs may have reduced total life compared to a conventional vehicle due to battery degradation. For the NPRM analysis, the agencies assumed that the batteries would last the full useful life of the vehicle. In the final rule analysis, NHTSA has considered a cost to estimate the value of the possibility for an EV to have a different lifetime than a conventional vehicle. NHTSA only applied this cost to ''broad-market'' EVs (those sold above a 5 percent penetration threshold), as it assumed that early-adopters would not be concerned by the possibility of earlier end-of-life (this is consistent with our previous assumption that early adopters would not be concerned by EVs' shorter driving range). This out-of-warranty cost is only included in a sensitivity analysis, not the central run. For further detail on how this cost is implemented in our analysis, please refer to Chapter VII of NHTSA's FRIA.

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 invited comment on all of its technology estimates, and specifically requested 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. NHTSA did not receive any comment on this aspect. The agency also invited comment on whether its central analysis should be revised to include estimated market-driven application of technology. Some comments addressed this specific question; these will be summarized and discussed below.

The agencies received several comments on the approach used to estimate indirect costs in the proposal. NADA argued that the ICM approach was not valid and an RPE approach was the only appropriate approach, and that the RPE factor should be 2.0 x direct costs [973] rather than the 1.5 that is supported by filings to the Securities and Exchange Commission. ICCT agreed with the new ICM approach as presented in the proposal, but argued that sensitivity analyses examining the impact of using an RPE should be deleted from the final rule.[974] Both agencies have conducted thorough analysis of the comments received on the RPE versus ICM approach. Regarding NADA's concerns about the accuracy of ICMs, although the agencies recognize that there is uncertainty regarding the impact of indirect costs on vehicle prices, they have retained ICMs for use in the central analysis because it offers the advantage of a disaggregated approach that better differentiates among technologies. The impact of using an RPE is examined in sensitivity analyses, and we note that even under the higher cost estimates that result from using the RPE, the rulemaking is highly cost beneficial. The agencies disagree with NADA's contention that the correct factor to reflect the RPE should be 2.0, and we cite data demonstrating that the overall RPE should average about 1.5. Regarding ICCT's contention that NHTSA should delete sensitivity analyses examining the impact of using an RPE, NHTSA disagrees based on both compliance with OMB guidance and good analytical practice. Further analysis of NADA's comments is summarized in Chapter 3 of the joint TSD. NHTSA's full response to both NADA and ICCT is presented in Chapter VII of NHTSA's FRIA. For this final rule, each agency is using an ICM approach with ICM factors identical to those used in the proposal. The impact of using an RPE rather than ICMs to calculate indirect costs is examined in sensitivity and uncertainty analyses in Chapters VII, X, and XII of NHTSA's FRIA.

With respect to technology effectiveness, ICCT commented generally in support of simulation modeling, but argued that the Ricardo work resulted in conservative effectiveness estimates because it is restricted to currently-available data and engine maps, and cannot account for future improvements that might result from CAD used in technology design and on-board vehicle controls that will increase technology effectiveness.[975] ICCT stated that estimates for

[973] NADA, Docket No. NHTSA–2010–0131–0261, at 4.

[974] ICCT, Docket No. NHTSA–2010–0131–0258, at 19–20.

[975] ICCT, Docket No. NHTSA–2010–0131–0258, at 4–7.

technology effectiveness continue to improve, citing the example of turbocharging and downsizing, which ICCT said the agencies used to estimate at 5–7 percent and now estimate at closer to 12–20 percent effectiveness improvement.[976] Therefore, ICCT stated, the agencies' technology effectiveness estimates were likely to be understated.[977] Several commenters also discussed the agencies' effectiveness estimates for various technologies. For example, VW suggested that the effectiveness of high BMEP engines might be overstated, because the torque curve for future engines may be constrained over the rpm range by charging limits, exhaust temperature, peak cylinder pressures and mechanical forces that may limit the practicable increase in BMEP.[978] VW also commented that the maximum cost-effective amount of mass reduction is likely closer to 10 percent instead of 20 percent. In response, NHTSA recognizes that different manufacturers may obtain different amounts of ''bang for their buck,'' at different costs, when they apply different technologies. We maintain that we analyze a possible feasible path for compliance with the standards, although we recognize that actual manufacturer compliance paths may vary due to their judgment of cost-effectiveness. We will continue to monitor changes in cost and effectiveness of technologies and will revisit all estimates during the mid-term review and future rulemaking for the MYs 2022–2025.

The tables below provide examples of the incremental cost and effectiveness estimates employed by the agency in developing this final rule, according to the decision trees used in the 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.

TABLE IV–5—NHTSA 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	2.1	1.8	2.1	2.1
Integrated Starter-Generator (Mild Hybrid)	7.5	7.5	6.6	6.4	7.5	7.5	6.6	6.4	5.7	6.1	5.7	3.0
Strong Hybrid (level 2)	3.0	3.0	0.1	0.6	3.0	3.0	0.1	0.6	(0.3)	4.3	(0.3)	1.6
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

[976] ICCT, Docket No. NHTSA–2010–0131–0258,. at 7.

[977] *Id.*

[978] VW, Docket No. NHTSA–2010–0131–0247, at 19.

TABLE IV–5—NHTSA TECHNOLOGY EFFECTIVENESS ESTIMATES EMPLOYED IN THE CAFE MODEL FOR CERTAIN TECHNOLOGIES—Continued

	Subcomp. car	Compact car	Midsize car	Large car	Perform. subcomp. car	Perform. compact car	Perform. midsize car	Perform. large car	Minivan LT	Small LT	Midsize LT	Large LT
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 NHTSA TECHNOLOGY COST ESTIMATES EMPLOYED IN THE CAFE MODEL FOR CERTAIN TECHNOLOGIES, MY 2017

	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 (2010$)												
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)	4	4	4	4	4	4	4	4	4	4	4	4
Engine friction reduction (level 1)	60	60	60	91	60	91	91	121	91	60	91	121
VVT—Dual cam phasing (DCP)	44	44	44	89	44	89	89	89	89	44	89	89
Discrete variable valve lift (DVVL) on DOHC	163	163	163	245	163	245	245	326	245	163	245	326
Cylinder deactivation on OHV	208	208	208	208	208	208	208	208	208	208	208	208
Stoichiometric gasoline direct injection	268	268	268	403	268	403	403	537	403	268	403	537
Turbocharging and downsizing (level 1)	494	494	494	19	494	19	19	621	19	494	19	621
Turbocharging and downsizing (level 2)	26	26	26	262	26	262	262	442	262	26	262	442
Cooled exhaust gas recirculation (EGR)—(level 1)	302	302	302	302	302	302	302	302	302	302	302	302
Cooled exhaust gas recirculation (EGR)—(level 2)	525	525	525	525	525	525	525	(300)	525	525	525	(300)
Advanced Diesel	889	889	889	855	889	855	855	1,710	855	889	855	1,710
6-speed auto. trans. with improved internals	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)	(39)
6-speed DCT	(109)	(109)	(75)	(75)	(75)	(75)	(75)	(75)	0	(75)	0	0
High Efficiency Gearbox	251	251	251	251	251	251	251	251	251	251	251	251
Shift Optimizer	2	2	2	2	2	2	2	2	2	2	2	2
Electric power steering	109	109	109	109	109	109	109	109	109	109	109	109
12V micro-hybrid	325	351	385	414	325	351	385	414	414	366	424	480
Integrated Starter-Generator (Mild Hybrid)	976	976	976	976	976	976	976	976	976	976	976	976
Strong Hybrid (level 2)	1,921	1,921	2,334	3,054	1,921	1,921	2,334	3,054	2,723	2,205	2,723	3,111

TABLE IV–6 NHTSA TECHNOLOGY COST ESTIMATES EMPLOYED IN THE CAFE MODEL FOR CERTAIN TECHNOLOGIES, MY 2017—Continued

	Subcomp. car	Compact car	Midsize car	Large car	Perform. subcomp. car	Perform. compact car	Perform. midsize car	Perform. large car	Minivan LT	Small LT	Midsize LT	Large LT
Plug-in Hybrid ...	11,043	11,043	13,449	18,538	11,043	11,043	13,449	18,538	0	12,828	0	0
Electric Vehicle (Early Adopter)	2,416	2,416	3,711	4,614	2,416	2,416	3,711	4,614	0	2,208	0	0
Low Rolling Resistance Tires (level 1)	7	7	7	7	7	7	7	7	7	7	7	7
Low Rolling Resistance Tires (level 2)	73	73	73	73	73	73	73	73	73	73	73	73
Aero Drag Reduction (level 1)	49	49	49	49	49	49	49	49	49	49	49	49
Aero Drag Reduction (level 2)	164	164	164	164	164	164	164	164	164	164	164	164

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 V of the FRIA. 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) two sets of market forecast were developed jointly by NHTSA and EPA staff using MY 2008 and 2010 CAFE compliance data. The 2008 data was used in the NPRM analysis, while both the 2008 and 2010 data are used in the final rule analysis. 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.[979] 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.[980] The MY 2010 compliance data includes about 1,170 vehicle models, about 330 specific engines, and about 330 specific transmissions, while the MY 2008 compliance data includes about 1,300 vehicle models, about 440 specific engines and about 210 specific transmissions.

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.

i. 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 2012–2016 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

[979] The market file for the MY 2011 final rule, which included data for MYs 2011–2015, had 5500 vehicles, about 5 times what we are using in this analysis of the MY 2010 certification data.

[980] Because CAFE standards apply to the average performance of each manufacturer's fleet of cars and light trucks, the impact of potential standards on individual manufacturers cannot be credibly estimated without analysis of the fleets that manufacturers can be expected to produce in the future. Furthermore, because required CAFE levels under an attribute-based CAFE standard depend on manufacturers' fleet composition, the stringency of an attribute-based standard cannot be predicted without performing analysis at this level of detail.

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 sought 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. NHTSA did not receive any comments on this issue.

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 final rule, are based on analysis that assumes each of these factors is addressed prior to production implementation of the technologies. NHTSA sought 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. The Pennsylvania Department of Environmental Protection and Clean Fuel Development Coalition both commented that the agencies should evaluate the benefits of higher octane fuels and whether or not they are required for some of the advanced engine technologies like turbocharging and downsizing. While the agencies agree that higher octane ratings could provide additional benefits, the agencies relied in the rulemaking analyses on the Ricardo simulation study, which assumed certification gasoline which typically has a Research Octane Number (RON) of approximately 95 versus approximately 91 RON for regular grade 87 anti-knocking index gasoline, to determine the effectiveness of engine technologies. We note, however, that in the Ricardo simulation cooled EGR was included on higher BMEP engines and it as assumed that all of the 27-bar BMEP engine packages with cooled EGR would allow for the use of 91 RON (regular grade) fuels while reducing the need for enrichment and spark retard to prevent the onset of knocking combustion.

ii. Is a vehicle being redesigned or refreshed?

Manufacturers typically plan vehicle changes to coincide with certain stages of a vehicle's life cycle that are appropriate for the change, or in this case the technology being applied. In the automobile industry there are two terms that describe *when* technology changes to vehicles occur: Redesign and refresh (*i.e.,* freshening). Vehicle *redesign* usually refers to significant changes to a vehicle's appearance, shape, dimensions, contents, material usage 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 many of the technologies discussed today, manufacturers will only be able to apply them at a refresh or for a majority of the technologies at redesign, because their application would be significant enough to involve some level of engineering, testing, and calibration work.[981]

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, conversion to diesel or hybridization, or significant amounts of mass reduction. 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 CAFE 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 (*e.g.,* luxury and performance vehicles) and large trucks are assumed to have 6- to

[981] 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.

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 V of the FRIA 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.[982] 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. No comments were received on this specific issue.

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 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.

iii. 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).[983] 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 sought comment on the appropriateness of these 12 subclasses for the MYs 2017–2025 timeframe. The agency also sought 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. NHTSA did not receive any comments on this issue.

For this final rule, as in the NPRM, NHTSA divides the vehicle fleet into subclasses based on model inputs, and applies subclass-specific estimates, also from model inputs, of the applicability, cost, and effectiveness of each fuel-saving technology. 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

[982] 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 Jul. 8, 2012).

[983] 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-on-frame large trucks.

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 final rule for MYs 2017–2025. Vehicle subclasses are discussed in more detail in Chapter V of the FRIA and in Chapter 3 of the TSD.

For the reader's reference, the subclasses and example vehicles from the market forecast file are provided in Table IV–7 and Table IV–8.

TABLE IV–7—NHTSA PASSENGER CAR SUBCLASSES EXAMPLE (MY 2008) VEHICLES

Class	Example vehicles
Subcompact	Chevrolet Aveo, Hyundai Accent
Subcompact performance	Mazda MX–5, BMW Z4
Compact	Chevrolet Cobalt, Nissan Sentra and Altima
Compact performance	Audi S4, Mazda RX–8
Mid-size	Chevrolet Impala, Toyota Camry, Honda Accord, Hyundai Azera
Mid-size performance	Chevrolet Corvette, Ford Mustang (V8), Nissan 350Z
Large	Audi A8, Cadillac CTS and DTS
Large performance	Bentley Arnage, Mercedes-Benz CL600

TABLE IV–8—NHTSA LIGHT TRUCK SUBCLASSES EXAMPLE (MY 2008) VEHICLES

Class	Example vehicles
Minivans	Dodge Grand Caravan, Toyota Sienna
Small SUV/Pickup/Van	Ford Escape and Ranger, Nissan Rogue
Mid-size SUV/Pickup/Van	Chevrolet Colorado, Jeep Wrangler, Toyota Tacoma
Large SUV/Pickup/Van	Chevrolet Silverado, Ford E-Series, Toyota Sequoia

iv. What technologies have already been applied to the vehicle (i.e., where in the ''decision trees'' is it)?

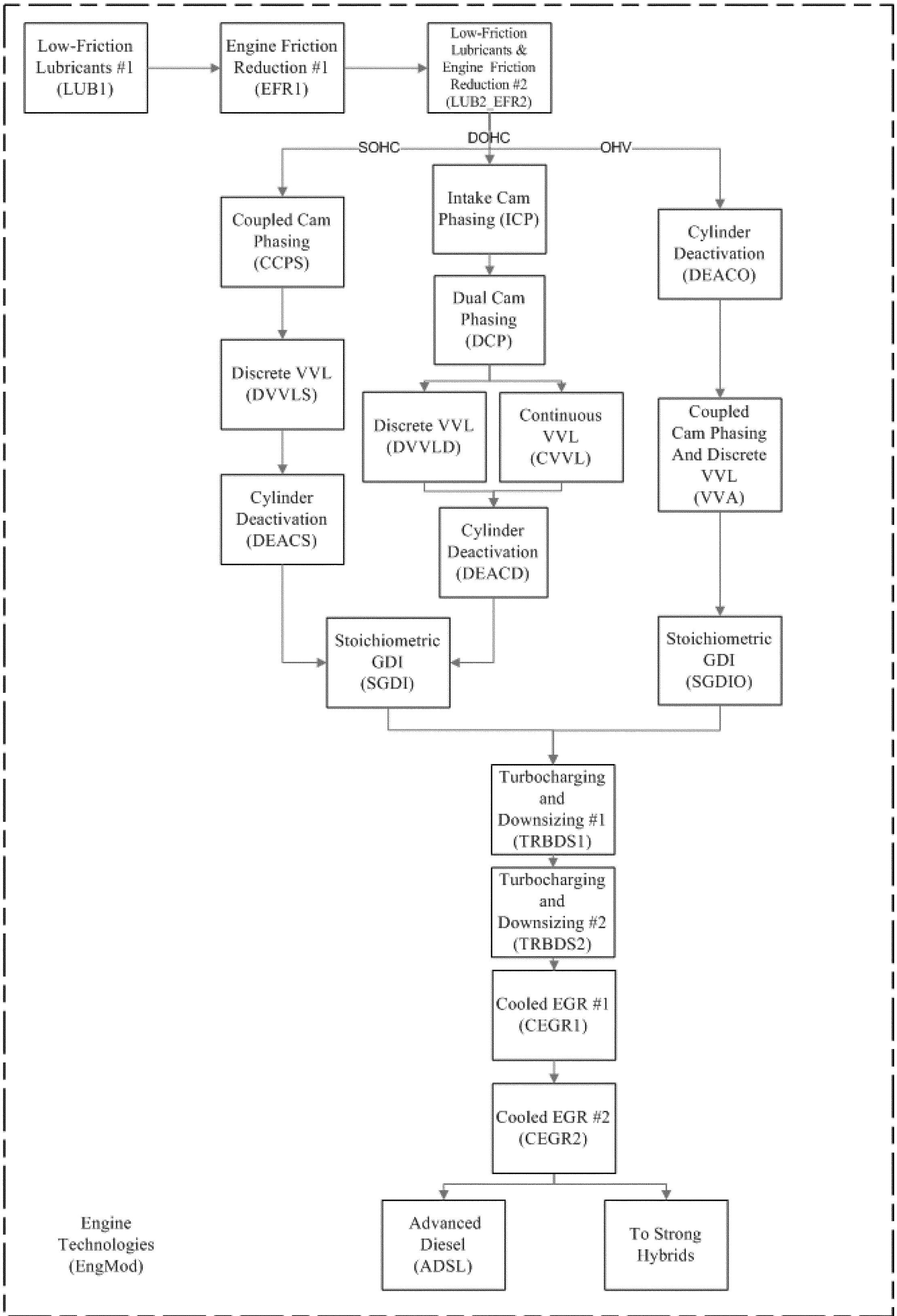
NHTSA's methodology for technology analysis evaluates the application of individual technologies and their incremental costs and effectiveness. Individual technologies are assessed relative to the prior technology state, which means that it is crucial to understand what technologies are already present 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 account 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 V of the current FRIA,[984] each technology is assigned to one of the five following categories based on the system it affects or impacts: engine, transmission, electrification/accessory, hybrid or vehicle. Each of these categories has its own decision tree that the 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 V of the FRIA. Expanded decision trees are available in the docket for this final rule.

[984] Additional details about technologies are categorized can be found in the MY 2011 final rule.

Figure IV-1 NHTSA 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 V of the FRIA). Each technology's incremental estimate takes into account its position in the decision tree path. If a technology is located further down the decision tree, the estimates for the costs and effectiveness values attributed to that technology are influenced by the incremental estimates of costs and effectiveness values for prior technology applications. In essence, this approach accounts for ''in-path'' effectiveness synergies, as well as cost effects that occur between the technologies in the same path. When comparing cost and effectiveness estimates from various sources and those provided by commenters in this and the previous CAFE rulemakings, it is important that the estimates evaluated are analyzed in the proper context, especially as concerns their likely position in the decision trees and other technologies that may be present or missing. Not all estimates available in the public domain or that have been (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.[985] To the extent that the decision trees have changed for purposes of the MYs 2012–2016 final rule and this final rule, it was due not to revisions in the order of technology application, but rather to redefinitions of technologies or addition or subtraction of technologies.

v. 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 are not applied to some vehicles due to technological constraints—for example, cylinder deactivation has not been applied to vehicles with current 4-cylinder engines (because operating on three or fewer cylinders can cause unacceptable noise, vibration and harshness) 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 sought comment on the appropriateness of the assumed years of availability. As discussed above, VW raised concerns with the viability of high BMEP engines.

vi. 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.[986] 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, OEMs 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,[987] in the MY 2012–2016 final rule and in Chapter V of the FRIA 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 final rule, 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 application of either or

[985] *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.

[986] 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.

[987] 74 FR 14195–14456 (Mar. 30, 2009).

both to any manufacturer's fleet is limited to the value of the cap.[988]

In developing phase-in cap values for purposes of this final rule, 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 sought comment on the appropriateness of both the carryover phase-in caps and the newly defined ones proposed in this NPRM. The only comment received on phase-in caps was from AFPM, who stated that the agencies should use lower phase-in caps for electrification technologies, and consider the 2011 NAS report in developing them. In our analyses for the final rule, the penetration of electrification technologies (from strong hybrid to EV) was significantly below the phase-in caps; thus, changing the phase-in caps would not affect the analysis. The agencies will continue to monitor the application of electrification technologies and will revisit the levels of the phase-in caps for the future rulemaking to develop final standards for MYs 2022–2025 and the concurrent mid-term evaluation.

vii. 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.[989]

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).[990]

In the MYs 2012–2016 final 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. The agencies employ a number of different learning curves, depending on the nature of the technology. As an example, 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-

[988] *See* 74 FR 14270 (Mar. 30, 2009) for further discussion and examples.

[989] 76 FR 57106, 57320 (Sept. 15, 2011).

[990] 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.

defined Bills of Materials (EFR, LDB), as was the case in the MY 2012–2016 final rule. Chapter 3 of the Joint TSD and the Chapter 7 of the FRIA show the specific learning factors that NHTSA has applied in this analysis for each technology, and discuss learning factors, each agency's use of them and how much learning reduces the cost of each technology. EPA and NHTSA included discussion of learning cost assumptions in the FRIAs and TSD Chapter 3. Since the agencies had to project how learning will occur with new technologies over a long period of time, we requested comments on the assumptions of learning costs and methodology. In particular, we were 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 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 sought comment on the appropriateness of these pre-production applications of learning. There were no significant comments on the issue of learning curves.

viii. 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.[991] 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 joint 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).[992] 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 FRIA) 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.

As discussed in the proposal, 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 modeling was not complete in time for use in the NPRM, the ANL results were available for the final rule and were used to define the effectiveness of mild hybrids for both agencies, and NHTSA used the results to update the effectiveness of advanced transmission technologies coupled with naturally-aspirated engines for the CAFE analysis.

[991] 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.

[992] 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).

This simulation modeling was 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 which includes sophisticated models for advanced vehicle technologies. The ANL simulation modeling process and results are discussed in greater detail in Chapter V of NHTSA's FRIA and fully documented in multiple reports that can be found in NHTSA's docket.[993]

d. Where can readers find more detailed information about NHTSA's technology analysis?

Much more detailed information is provided in Chapter 5 of the FRIA, and a discussion of how NHTSA and EPA jointly reviewed and updated technology assumptions for purposes of this final rule is available in Chapter 3 of the TSD. Additionally, all of NHTSA's model input and output files are now public and available for the reader's review and consideration. The technology input files can be found in the docket for this final rule, Docket No. NHTSA–2010–0131, and on NHTSA's Web site. And finally, because much of NHTSA's technology analysis for purposes of this final rule builds on the work that was done for the MY 2011 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.[994]

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 final rule, NHTSA considered comments received on the NPRM and also reviewed newly available literature. Many of the estimates have been carried forward from the NPRM without substantive change, and were based then on the agency's reconsideration of comments it had previously received on the NPRM for MYs 2012–16 CAFE standards and to the NOI/Interim Joint TAR, and newly available literature at that time. The agency elected to revise some of its economic assumptions and parameter estimates for this rulemaking, while retaining others.

Between the final rule establishing CAFE standards for MY 2012–16 passenger cars and light trucks and the proposed rule for MY 2017–25, the agency extensively revised its method for estimating benefits from less frequent refueling of vehicles with higher fuel economy, and also revised its forecasts of fuel prices and future growth in total vehicle use to be consistent with those reported in Annual Energy Outlook 2011. For this final rule, NHTSA made several changes to the economic assumptions it used to analyze the impacts of its proposed rule, including revising its technology cost estimates to reflect more recently available data; updating the estimated cost of owning a vehicle based to include additional categories of ownership costs and utilize newer data; updating its fuel price and transportation demand forecasts to be consistent with those presented in the Annual Energy Outlook (AEO) 2012 Early Release; and updating and revising its estimates of vehicle use (VMT) schedules, survival rates, and methods for projecting total VMT in future years. For the reader's reference, Table IV–9 below summarizes the values used to calculate the economic benefits from each alternative.

TABLE IV–9—NHTSA ECONOMIC VALUES FOR ESTIMATING BENEFITS

[2010$]

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)	$21.45 cars $21.81 trucks
Average tank volume refilled during refueling stop	65%
Annual growth in average vehicle use	0.6%
Fuel Prices (2017–50 average, $/gallon):	
Retail gasoline price	$4.13
Pre-tax gasoline price	$3.78
Economic Benefits from Reducing Oil Imports ($/gallon):	
''Monopsony'' Component	$ 0.00
Macroeconomic Disruption (''Price Shock'') Component	$ 0.197 in 2025
Military Security/SPR Component	$ 0.00
Total Economic Costs ($/gallon)	$ 0.197 in 2025
Emission Damage Costs (2020, $/short ton):	
Carbon monoxide	$ 0
Volatile organic compounds (VOC)	$ 1,700
Nitrogen oxides (NO_X)—vehicle use	$ 5,600
Nitrogen oxides (NO_X)—fuel production and distribution	$ 5,400
Particulate matter ($PM_{2.5}$)—vehicle use	$ 310,000

[993] Moawad, A. and Rousseau, A., ''Impact of Transmission Technologies on Fuel Efficiency,'' Energy Systems Division, Argonne National Laboratory, ANL/ESD/12–6, August 2012, and Moawad, A. and Rousseau, A., ''Impact of Electric Drive Vehicle Technologies on Fuel Efficiency,'' Energy Systems Division, Argonne National Laboratory, ANL/ESD/12–7, August 2012, are available in Docket No. NHTSA–2010–0131.

[994] 74 FR 14233–308 (Mar. 30, 2009).

TABLE IV–9—NHTSA ECONOMIC VALUES FOR ESTIMATING BENEFITS—Continued

[2010$]

Particulate matter ($PM_{2.5}$)—fuel production and distribution	$ 250,000
Sulfur dioxide (SO_2)	$ 33,000
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	$ 0.081
External Costs from Additional Light Truck Use ($/vehicle-mile):	
Congestion	$0.050
Accidents	$0.027
Noise	$0.001
Total External Costs	$0.078
Discount Rates Applied to Future Benefits	3%, 7%

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 in the NPRM for the new technologies considered for the proposal and for some of the technologies carried over from the MYs 2012–2016 final rule and 2010 TAR. This joint work is described 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 FRIA.

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 joint TSD and Chapters V and VII of NHTSA's FRIA. 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 conventional passenger cars, and its cost estimates for improving the fuel economy of performance cars are higher than those for other models because of the additional costs necessary to maintain the performance levels their buyers expect. NHTSA sought comment in the NPRM 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. Few commenters addressed this issue, but comments regarding the agencies' cost estimates and the agency's response are presented in Section IV.C.2 above. 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 also sought comments on this topic in the NPRM and stated that it would undertake a more detailed review of these potential costs for the final rule. NHTSA did, in fact, receive comments regarding costs of ownership, and incorporated certain additional maintenance costs in the final rule analysis. More discussion of this topic is available in Section IV.C.2 above and in Chapter V of NHTSA's FRIA.

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 joint TSD, and in Chapters V and VII of NHTSA's FRIA. NHTSA also sought and received comments to the NPRM on the use of ICMs; those comments and the agency's response are presented above in Section IV.C.2 and in Chapter V of NHTSA's FRIA.

b. Potential Opportunity Costs of Improved Fuel Economy

An important concern is whether achieving the fuel economy improvements required by the final CAFE standards will require manufacturers to modify the performance, carrying capacity, safety, or comfort of some vehicle models. To the extent that compliance with the standards requires such modifications, 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.[995]

NHTSA and EPA approached this potential problem by developing cost estimates for fuel economy-improving technologies that are intended to 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.

As NHTSA stated in the NPRM, 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 in vehicles' performance, carrying capacity, and utility, and omitting these will cause the agency's estimated technology costs to underestimate the true economic costs of improving fuel economy.

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 an empirical model of potential vehicle buyers' decisions about whether to purchase a new car or light truck and their choices among available vehicle models, which will eventually allow it to conduct such an analysis. This process was not completed on a schedule that allowed it to be used in analyzing final CAFE standards for this rulemaking, as discussed in Section IV.C.4 below, but 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 final standards.

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.[996]

In that final rule, however, EPA acknowledged that actual on-road fuel 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 combined 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. It used these data to develop estimates of the average fuel economy that the U.S. light-duty 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–10 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.[997] 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, NHTSA concluded in the NPRM that 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.

[995] *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. ''Market Price and Income Elasticities of New Vehicle Demands'', *Review of Economics and Statistics* 78: 543–547.

[996] 71 FR 77871 (Dec. 27, 2006).

[997] 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–10—NHTSA ESTIMATED FLEET-WIDE FUEL ECONOMY OF PASSENGER CARS AND LIGHT TRUCKS COMPARED TO REPORTED FUEL ECONOMY

Year	Passenger cars			Light 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 stated in the NPRM that we do 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 employed this value for vehicles operating on liquid fuels (gasoline, diesel, and gasoline/alcohol blends), and used it to analyze the impacts of proposed CAFE standards for model years 2017–25 on the use of these fuels.

In the 2010 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.[998] 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.[999] 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.[1000] 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.[1001] Because these two effects are expected approximately to counterbalance each other, NHTSA elected not to adjust its estimate of the on-road gap for use in the analysis for the proposal.

NHTSA received only two comments to the NPRM regarding the on-road fuel economy gap. The Sierra Club commented that the agencies had pledged in the final rule establishing the MYs 2012–2016 standards to address the disparity between the standards and on-road mileage, but that given the timing of this rulemaking for MYs 2017–

[998] 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.*

[999] 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.*

[1000] 4% of the on-road gap x 40% reduction in air conditioning fuel consumption x 85% of the fleet = ~2%.

[1001] As an example, the air conditioning load of 14.3 g/mile of CO2 is a smaller percentage (4.3%) of 330 g/mile than 260 (5.4%).

2205, had not done so.[1002] The Sierra Club stated that the disparity is further impacted by the inclusion of fuel economy improvements for A/C efficiency and off-cycle technologies in CAFE compliance.[1003] The Sierra Club suggested that CAFE testing be reformed to reduce this disparity, but did not suggest revisions to the on-road fuel economy gap.[1004] The U.S. Coalition for Advanced Diesel Cars suggested that the on-road gap used in the proposal was overly conservative, and that advanced technology vehicles may have on-road gaps larger than 20 percent.[1005] The agencies recognize this potential issue—future changes in driver behavior or vehicle technology may change the on-road gap. As an example, while some technologies such as electrification may increase the on-road gap, other off-cycle technologies such as tire pressure management systems, air conditioning improvements and aerodynamic improvements may decrease it. The agencies will continue to compare monitor the EPA fuel economy ratings for new vehicle models to other sources of data on their actual on-road fuel economy as these vehicles are incorporated into the fleet, in an effort to improve and update their estimate of the on-road gap. For purposes of evaluating this final rule, however, both NHTSA and EPA will continue to use the estimate of the on-road gap they employed in evaluating the proposed standards.

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 percent of the 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) to estimate the economic value of fuel savings projected to result from alternative CAFE standards: in the NPRM, the most recent edition of this publication was the AEO 2011 Reference Case, while for the final rule, this is the AEO 2012 Early Release Reference Case. Although EIA released the final version of AEO 2012 prior to the publication of this final rule, as of the time by which the analysis had to be completed, the AEO 2012 Early Release Reference Case projections of gasoline and diesel fuel prices represented 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 the NPRM, the AEO 2012 Early Release Reference Case fuel prices are slightly higher through the year 2020, but slightly lower for most years thereafter. Expressed in constant 2010 dollars, the AEO 2012 Early Release Reference Case forecast of retail gasoline prices (which include federal, state, and local taxes) during 2017 is $3.62 per gallon, rising gradually to $4.08 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.[1006] 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 (0.8%) projected for 2017–2035 in the AEO 2012 Early Release Reference Case. This assumption results in a projected retail price of gasoline that reaches $4.94 in 2050. Over the entire period from 2017–2050, retail gasoline prices are projected to average $4.13, as Table IV–9 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 real economic value of fuel savings resulting from more stringent CAFE standards to the U.S. economy.

NHTSA follows the assumptions used by EIA in AEO 2012 Early Release that State and local gasoline taxes will keep pace with inflation in nominal terms, and thus remain constant when expressed in constant dollars. In contrast, EIA assumes that Federal gasoline taxes will remain unchanged in *nominal* terms, and thus decline throughout the forecast period when expressed in constant dollars. These differing assumptions about the likely future behavior of Federal and State/local fuel taxes are consistent with recent historical experience, which reflects the fact that Federal as well as most State motor fuel taxes are specified on a cents-per-gallon rather than an *ad valorem* basis, and typically require legislation to change. Subtracting fuel taxes from the retail prices forecast in AEO 2012 results in projected values for saving gasoline of $3.22 per gallon during 2017, rising to $3.73 per gallon by the year 2035, and to $4.61 by the year 2050. Over this entire period, pre-tax gasoline prices are projected to average $3.77 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. However, the Early Release versions of AEO, including the AEO 2012 Early Release relied upon by NHTSA for this analysis, does not include alternative forecasts reflecting high and low global oil price scenarios. In their absence, NHTSA constructed high and low fuel price forecasts that were consistent with the Reference Case forecast of fuel prices from the AEO 2012 Early Release, as well as with the relationship of the high and low fuel price forecasts to the Reference Case forecast in AEO 2011. These alternative scenarios project retail gasoline prices that range from a low of $2.46 to a high of $4.90 per gallon during 2020, and from $2.53 to $5.12 per gallon during 2035 (all figures in 2010 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 $2.07 to $4.51 per gallon during 2020, and from $2.18 to $4.77 per gallon in 2035 (again, all figures are in constant 2010 dollars). In conducting the analysis of uncertainty in benefits and costs from

[1002] Sierra Club *et al.,* Docket No. NHTSA–2010–0131–0053, at 9.

[1003] *Id.*

[1004] *Id.* at 9–10.

[1005] U.S. Coalition for Advanced Diesel Cars, Docket No. NHTSA–2010–0131–0246, at 11–13.

[1006] 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.

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 Chapter X of NHTSA's FRIA. 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.

Many environmental and consumer group commenters argued that the fuel price estimates employed in the NPRM were too low. Consumers Union [1007] and UCS [1008] stated that EIA consistently underestimates future gasoline prices. NRDC,[1009] CFA,[1010] and Sierra Club [1011] also commented that AEO 2011 fuel price estimates were too low; UCS suggested that the agencies use the AEO 2012 Early Release estimates for the final rule because they were higher, and requested that the agencies try to account for gasoline price spikes in the fuel cost estimates.[1012] UCS [1013] and EDF[1014] commented that the agencies should conduct sensitivity analysis using AEO's High Price Case. Pennsylvania's Department of Environmental Protection suggested that the agencies' analysis should include the additional cost of the higher octane gasoline that would be required as a result of the standards.[1015]

In keeping with its usual practice of employing fuel price forecasts from the most recently published version of AEO, NHTSA has elected to use the Reference Case fuel price forecast from the AEO 2012 Early Release in its analysis of benefits form this final rule. As suggested by some commenters, NHTSA has also conducted sensitivity analyses using the high and low fuel price forecasts it constructed to be consistent with the AEO 2012 Early Release Reference Case forecast, although the agency notes that this is also its usual practice. The agency accounts separately for the economic costs associated with the potential for rapid increases in fuel prices (''price spikes'') or interruptions in the supply of petroleum products as part of the macroeconomic disruption costs of U.S. petroleum imports; these costs are discussed in Section IV.C.3.k.ii.

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 amount by which its manufacturer could expect to change that model's selling price, this difference 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 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, the effective cost of improving its fuel economy 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. This assumption produces an extremely conservative estimate of the extent to which manufacturers are likely to over-comply with the prevailing CAFE standard.

Several commenters addressed the issue of payback periods. EDF commented that the payback period should be 5 years or greater, in order to ''accurately reflect the current and forecasted buying trends of consumers,'' including increases in the average length of ownership of new vehicles since the 2008 recession.[1016] EDF argued that as a result, ''the period of time that potential vehicle buyers can be assumed to value fuel economy improvements in making their purchasing decisions may also be increasing.'' [1017] The Sierra Club also supported the use of a 5 year payback period, noting increasing consumer interest in fuel economy.[1018] NADA and VW commented that the real-life payback period for consumer decisions was likely shorter. NADA commented that the payback period should be ''at most'' 5 years, suggesting that even if consumers value fuel economy, they will still be in a hurry to recoup their costs.[1019] VW commented that while the agencies had estimated that the average consumer would recoup his higher purchase price in ''just less than 4 years,'' the payback period ''for a consumer purchasing a passenger car will be longer than a consumer purchasing a light truck,'' and suggested that consumers would likely choose vehicles with shorter payback periods.[1020] NADA also suggested that the agencies' approach in the NPRM to estimating the payback period was too simplistic, and requested that the agencies account for ''real-world finance, opportunity, and additional maintenance costs'' in that estimate for the final rule.[1021] ICCT commented that David Greene had found in 2010 that using reasonable estimates of the uncertainty in in-use fuel economy, future fuel prices, annual vehicle use, vehicle lifetime, and incremental vehicle price yielded an average customer payback period of roughly 3 years.[1022] In the context of the

[1007] Consumers Union attachment, Docket No. EPA–HQ–OAR–2010–0799–9454, at 1–2.

[1008] UCS, Docket No. EPA–HQ–OAR–2010–0799–9567, at 7.

[1009] NRDC, Docket No. EPA–HQ–OAR–2010–0799–9472, at 3.

[1010] CFA, Docket No. EPA–HQ–OAR–2010–0799–9419., at 15.

[1011] Sierra Club *et al.,* Docket No. NHTSA–2010–0131–0068, at 10.

[1012] UCS, Docket No. EPA–HQ–OAR–2010–0799–9567, at 7, 14.

[1013] *Id.* at 7.

[1014] EDF, Docket No. NHTSA–2010–0131–0302, at 9.

[1015] PA DEP, Docket No. EPA–HQ–OAR–2010–0799–7821, at 3.

[1016] EDF, Docket No. NHTSA–2010–0131–0302, at 9.

[1017] *Id.*

[1018] Sierra Club *et al.,* Docket No. NHTSA–2010–0131–0068, at 3.

[1019] NADA, Docket No. NHTSA–2010–0131–0261, at 10.

[1020] VW, Docket No. NHTSA–2010–0131–0247, at 12.

[1021] NADA, Docket No. NHTSA–2010–0131–0261, at 10.

[1022] ICCT, Docket No. NHTSA–2010–0131–0258, at 16.

sensitivity analysis looking at market-driven overcompliance, however, a number of environmental and consumer groups argued that the agency should *not* assume any such overcompliance. These comments will be summarized and addressed in Section IV.G below.

After considering these comments, the agency has elected to retain the five-year payback period for use in most aspects of its analysis. In addition, NHTSA has elected to include increases in financing, insurance, and other components of the cost of vehicle ownership that would be expected to increase in proportion to increases in vehicle purchase prices in its analysis of the rule's impacts on individual buyers, as well as in its analysis of potential changes in total sales of new vehicles.

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 are assumed to employ when assessing changes in the net price of purchasing and owning 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 procedure the agency uses for calculating lifetime fuel savings is discussed in detail in the following section, while a more detailed analysis of the time horizon over which potential buyers may consider fuel savings in their vehicle purchasing decisions is provided 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 MY 2016 levels. The first step in estimating lifetime fuel consumption by vehicles of each model year is to calculate the number of vehicles originally produced during that model year that are expected to remain in service during each subsequent year.[1023] 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 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.[1024] However, Annual Energy Outlook forecasts only total car and light truck sales, rather than sales at the manufacturer and model-specific level, which the agencies require in order to estimate the effects new standards will have on individual manufacturers.[1025]

To estimate sales of individual car and light truck models produced by each manufacturer, EPA purchased data from CSM Worldwide (for the MY 2008-based market forecast) and LMC (for the MY 2010-based fleet) and used these firms' 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 2025.[1026] 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 and LMC's forecasts for the 2025 calendar year.) Normalizing these percentages to the total car and light truck sales volumes projected for 2017 through 2025 in AEO 2011 (for the MY 2008-based market forecast) and AEO 2012 (for the MY 2010-based market forecast) provided manufacturer-specific market share and model-specific sales estimates for those model years.

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. For use in this final rule, NHTSA updated its previous estimates of car and light truck survival rates using registration data for vehicles produced for model years through 2010 from R.L. Polk, Inc, in order to ensure that they reflected recent increases in the durability and expected life spans of cars and light trucks. 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 will be driven each year they remain in use. To estimate the total number of miles vehicles produced in a model year are

[1023] 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 Jul. 9, 2012).

[1024] *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.

[1025] 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.

[1026] EPA also considered other sources of similar information, such as J.D. Powers, and concluded that CSM and LMC were better able to provide forecasts at the requisite level of detail for most of the model years of interest.

driven during each year of their lifetimes, the number projected to remain in use during that year is multiplied by the average number of miles vehicles are projected to be driven at the age they will have reached in that year. The agency estimated annual usage of household vehicles during 2008 using data from the Federal Highway Administration's 2009 National Household Travel Survey (NHTS), together with data on the use of fleet cars and light trucks from the Annual Energy Outlook for that same year.[1027] Because these estimates reflect the gasoline prices that prevailed at the time, 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 FRIA and Chapter 4 of the Joint TSD.

The estimates of annual miles driven by vehicles of different vehicle ages during 2008 were also adjusted to reflect projected future growth in average use of vehicles over their entire 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 for 2008 that would be necessary for *total* car and light truck travel to increase at the rate forecast in the AEO 2012 Early release Reference Case.[1028] 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 with the updated survival rates described above. The resulting growth rate in average annual car and light truck use is approximately 0.6 percent from 2017 through 2060. While the adjustment for forecast fuel prices reduces average annual mileage in most future years from the values derived for 2008, 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 13 percent from the estimates originally derived for 2008.

Finally, the agency estimates 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 their 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.[1029]

g. Accounting for the Fuel Economy Rebound Effect

The fuel economy rebound effect refers to the fact that some of the fuel savings expected to result from higher fuel economy, including increases 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 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.[1030]

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.[1031] The most common approach to estimating its magnitude has been to analyze survey data on household vehicle use, fuel consumption, fuel prices, household characteristics, and vehicle attributes to isolate 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 changes in fuel economy, the agency regards such 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 influencing aggregate travel demand to estimate the response of total or average vehicle use to changes in fleet-wide average fuel economy or 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.[1032] A recurring problem with studies that use national or state-level aggregate data on vehicle use is that their measures of fuel efficiency are constructed from data on national or

[1027] For a description of the Survey, see *http://nhts.ornl.gov/introduction.shtml* (last accessed Aug. 5, 2012). Because much of the survey was conducted during 2008, it was used to develop estimates of vehicle use for that year.

[1028] 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.

[1029] 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 cars 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).

[1030] 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).

[1031] 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.

[1032] 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.

state total fuel consumption and the same national or state measure of vehicle use that is used as their dependent variable. This means that their measures of fuel efficiency and fuel cost per mile are ''definitionally'' related to their dependent variables, and that the usual statistical techniques for minimizing the effect of such joint causality cannot be fully effective. At the same time, their measures of aggregate VMT and average fuel economy obscure the shifting of travel among vehicles with different fuel economy levels during the time period (usually a year) they span, which means that both variables *already* incorporate the effect the model is attempting to measure. For these reasons, estimates of the rebound effect based on aggregate VMT data need to be interpreted cautiously.

It is also important to note that many studies attempting to measure the rebound effect using aggregate data on vehicle use actually quantify the price elasticity of gasoline demand, or the elasticity of VMT with respect to the per-gallon price of gasoline, rather than the elasticity of VMT with respect to fuel efficiency or the fuel cost per mile of driving. Because neither of these measures actually corresponds to the definition of the fuel economy rebound effect, these studies provide limited evidence of its actual magnitude. Another important distinction among studies of the rebound effect is whether they assume that the effect is constant, or instead 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. Many studies conclude that the long-run rebound effect is significantly larger than the short-term 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 2011. 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–11 below.[1033] As the table indicates, these estimates range from as low as 7 percent to as high as 75 percent, with a mean value of 22 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 28 estimates based on household survey data is considerably larger (25 percent), and the mean of 15 estimates based on pooled state data (23 percent) is close to that for the entire sample. The 48 estimates assuming a constant rebound effect produce a mean of 22 percent, identical to the mean of the 37 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–11 reports.

TABLE IV–11—NHTSA SUMMARY OF PUBLISHED ESTIMATES OF THE REBOUND EFFECT

Category of estimates	Number of studies	Number of estimates	Range		Distribution		
			Low percent	High percent	Median percent	Mean percent	Std. dev. percent
All Estimates	27	87	6	75	19	22	13
Published Estimates	20	68	7	75	19	23	13
Authors' Preferred Estimates	20	20	9	75	22	22	15
U.S. Time-Series Estimates	7	34	7	45	14	18	9
Household Survey Estimates	17	38	6	75	22	25	15
Pooled U.S. State Estimates	3	15	8	58	22	23	12
Constant Rebound Effect (1)	18	48	6	75	16	22	15
Variable Rebound Effect (1) Reported Estimates	12	37	10	45	20	22	9
Updated to Current Conditions	12	37	7	56	16	19	12

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 recent years. Second, rising personal incomes would be expected to reduce the sensitivity of vehicle use to fuel costs as the hourly value of time spent driving—which is likely to be related to income levels—accounts for a larger fraction of 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 those vehicles in response to varying fuel prices and differences in their fuel economy levels. This effect is likely to increase the sensitivity of households' overall vehicle use to differences in the fuel economy levels of

[1033] In some cases, NHTSA derived summary estimates of the 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.

individual vehicles. Thus on balance, it is not clear how rising income levels are likely to affect the magnitude of the rebound effect.

Small and Van Dender combined annual time series data on aggregate vehicle use, fuel prices, average fuel economy, and other variables for individual 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.[1034] The authors employ a model specification that allows the effect of fuel cost per mile on statewide average vehicle use to vary in response to changes in personal income levels and increasing urbanization of each state's population. For the time period 1966–2001, their analysis implied a long-run rebound effect of 22 percent, which is consistent with many 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, while 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.[1035]

More recently, Hymel, Small and Van Dender extended the previous analysis to incorporate the effect on vehicle use of traffic congestion levels in urbanized areas.[1036] 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 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.[1037] Greene found that fuel prices generally had a statistically significant impact on VMT, yet fuel efficiency sometimes 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 by 2007.

More recent research provides contrasting evidence on the magnitude of the rebound effect. Bento *et al.* analyzed data on household vehicle ownership and use from the 2001 National Household Travel Survey using a complex model of household purchases, ownership, retirement, and use of both new and used vehicles.[1038] These authors estimated that the rebound effect averaged 34 percent for all households, but varied widely among those owning different types and ages of automobiles, and among households with varying demographic characteristics. Gillingham used a large sample of vehicles registered in California and detailed estimates of local fuel prices to estimate elasticities of vehicle use with respect to gasoline prices and fuel economy. His estimate of the former elasticity was −0.17, while his corresponding estimate of the elasticity of vehicle use with respect to fuel economy was 0.06, corresponding to a rebound effect of 6 percent.[1039]

West and Pickrell used a sample of nearly 300,000 vehicles from the 2009 National Household Travel Survey to analyze vehicle use decisions among households owning different numbers of vehicles.[1040] Controlling for vehicle type and age, as well as for household characteristics and location, they estimated that the fuel economy rebound effect ranged from 0–9 percent among single-vehicle households, 10–26 percent among households owning two vehicles, and 26–34 percent among three-vehicle households. Most recently, Su[1041] used quantile regression analysis to analyze variation in the rebound effect among households included in the 2009 National Household Travel Survey. Su's estimates of the rebound effect varied from 11 to 19 percent depending on the total number of miles driven annually by members of the household, with the smallest values applying to households at the extremes of the distribution of annual vehicle use, and the largest values to households in the middle of that distribution.

In light of findings from recent research, the agencies judged that the apparent decline over time in the magnitude of the rebound effect justified using a value that is lower than previous estimates, which are concentrated within the 15–30 percent range. Thus, as we elected to do in our previous analysis of the effects of raising CAFE standards for MY 2012–16 cars and light trucks, NHTSA used a 10 percent rebound effect in its analysis of fuel savings and other benefits from the proposed CAFE standards that would apply to MY 2017–25 cars and light trucks. The 10 percent estimate lies between the 10–30 percent range of estimates for the 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. Thus the 10 percent value was not derived from a single estimate or particular study, but instead represented a compromise between historical estimates and projected future estimates. Recognizing the wide range of uncertainty surrounding its correct value, however, the agency also employed estimates of the rebound effect ranging from 5 to 20 percent in its sensitivity testing.

In their comments on the analysis of the proposed standards for MY 2017–25,

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1034 Small, K. and K. Van Dender, 2007a. ''Fuel Efficiency and Motor Vehicle Travel: The Declining Rebound Effect'', The Energy Journal, vol. 28, no. 1, pp. 25–51. Docket No. NHTSA–2010–0131–0130.

1035 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. *Available at http://internationaltransportforum.org/jtrc/DiscussionPapers/DiscussionPaper16.pdf* (last accessed Jul. 12, 2012).

1036 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 No. NHTSA–2010–0131.

1037 Greene, David, 2012. ''Rebound 2007: Analysis of National Light-Duty Vehicle Travel Statistics,'' Energy Policy 41: 14–28.

1038 Bento, Antonio M., Lawrence H. Goulder, Mark R. Jacobsen, and Roger H. von Haefen, ''Distributional and Efficiency Impacts of Increased US Gasoline Taxes,'' *American Economic Review* 99 (2009), pp. 1–37. For information on the 2001 National Household Travel Survey, see *http://nhts.ornl.gov/introduction.shtml#2001* (last accessed July 17, 2012).

1039 Gillingham, Kenneth. ''The Consumer Response to Gasoline Price Changes: Empirical Evidence and Policy Implications.'' Ph.D. diss., Stanford University, 2011. See *https://stacks.stanford.edu/file/druid:wz808zn3318/Gillingham_Dissertation-augmented.pdf* (last accessed Aug 14, 2012). Docket NHTSA–2010–0131.

1040 West, Rachel, and Don Pickrell, ''Factors Affecting Vehicle Use in Multiple-Vehicle Households,'' *http://onlinepubs.trb.org/onlinepubs/conferences/2011/NHTS1/West.pdf* (last accessed July 17, 2012). For information on the 2009 National Household Travel Survey, see *http://nhts.ornl.gov/introduction.shtml* (last accessed July 17, 2012).

1041 Su, Qing, ''A Quantile Regresssion Analysis of the Rebound Effect: Evidence from the 2009 National Household Transportation Survey in the United States,'' *Energy Policy* 45 (2012), pp. 368–377. *See http://www.sciencedirect.com/science/article/pii/S0301421512001620* (last accessed on Aug 14, 2012). Docket NHTSA–2010–0131.

CFA[1042] and ICCT suggested that the agencies' estimate of the rebound effect should be smaller. ICCT argued that the 10 percent rebound effect estimate was based simply on compromise, and that only future projections of the rebound effect that include the impacts of personal income, vehicle efficiency, and fuel price should be used to calculate the future rebound effect.[1043] ICCT suggested that only the recent Greene paper and the Small and Van Dender work from 2007 should be used for estimating the value for the final rule.[1044] CFA suggested that ''from the point of view of the individual consumer, the analysis must assume that all of the savings increase consumer welfare and that consumers choose to use those savings in a manner that maximizes their individual welfare.'' [1045] Thus, CFA argued, ''the rebound effect should be subtracted in the national cost benefits analysis but not the consumer pocketbook analysis.'' [1046]

In response to the comments offered by CFA and ICCT, the agency notes that the effect of future growth in income levels on the magnitude of the rebound effect is uncertain, because rising incomes are associated with higher vehicle ownership levels, and there is evidence that the rebound effect is larger among households owning multiple vehicles. In addition, AEO 2012 and the agencies' extrapolation of its forecasts anticipate rising fuel prices throughout the lifetimes of cars and light trucks subject to this final rule, which by themselves would be expected to increase the magnitude of the rebound effect. Further, as the previous summary of published estimates of the rebound effect indicates, the Small-Van Dender and Greene studies must be considered in the context of many other studies of the fuel economy rebound effect that have published over the past three decades. In that context, these studies represent lower outliers in the distribution of reported estimates of the rebound effect, and for that reason should not be relied upon *by themselves* for estimates of its likely current or future magnitude. Thus the agency's estimate takes adequate account of the findings from the Small-Van Dender and Greene studies, while also giving due consideration to the large body of previous and subsequent research on the fuel economy rebound effect. NHTSA believes that it accords appropriate weight to estimates derived using different measurement approaches, estimation methods, data sources, and time periods, and is thus likely to represent a reliable estimate of increases in vehicle use resulting from the increases in fuel economy that this final rule requires manufacturers to achieve.

In response to the observation by CFA, the agency notes that its analysis of the consumer impacts of the rule accounts for fuel consumption and fuel costs associated with increased driving due to the fuel economy rebound effect. At the same time, this analysis also accounts for the benefits that vehicle buyers derive from that additional travel, which clearly exceed the increased fuel costs they pay because they voluntarily elect to drive more. The nature of these benefits and the procedure the agency uses to estimate their value are described in the following section. Thus on balance, the additional vehicle use stemming from the rebound effect increases the welfare of individual vehicle buyers, and is properly included in the agency's analysis. NHTSA continues to include both the consumer benefits and higher fuel costs associated with additional vehicle use in its analyses of the individual (or private) and economy-wide (or social) impacts of this final rule.

h. Benefits From Increased Vehicle Use

The increase in vehicle use resulting from the fuel economy 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 fuel and other 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.[1047] 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. Benefits Due to Reduced Refueling Time

Direct estimates of the value of extended vehicle range are not available in the literature, so the agencies instead calculate the reduction in the required annual number of refueling cycles due to improved fuel economy, and assess the economic value of the resulting benefits. Chief among these benefits is the time that owners save by spending less time both in search of fueling stations and in the act of pumping and paying for fuel.

The economic value of refueling time savings was calculated by applying DOT-recommended valuations for travel time savings to estimates of how much time is saved.[1048] The value of travel time depends on average hourly valuations of personal and business time, which are functions of total hourly compensation costs to employers. The total hourly compensation cost to employers, inclusive of benefits, in 2010$ is $29.68.[1049] Table IV–12 below demonstrates the agencies' approach to estimating the value of travel time ($/hour) for both urban and rural (intercity) driving. This approach relies on the use of DOT-recommended weights that assign a lesser valuation to personal travel time than to business travel time, as well as weights that adjust for the distribution between personal and business travel.

1042 CFA, Docket No. EPA–HQ–OAR–2010–0799–9419, at 16.

1043 ICCT, Docket No. NHTSA–2010–0131–0258, at 25–26.

1044 *Id.*

1045 CFA, Docket No. EPA–HQ–OAR–2010–0799–9419, at 16, 54.

1046 *Id.*

1047 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.

1048 See *http://ostpxweb.dot.gov/policy/Data/VOT97guid.pdf* and *http://ostpxweb.dot.gov/policy/Data/VOTrevision1_2–11–03.pdf* (last accessed Aug. 5, 2012).

1049 Total hourly employer compensation costs for 2010 (average of quarterly observations across all occupations for all civilians). See *http://www.bls.gov/ect/* (last accessed Aug. 5, 2012).

TABLE IV–12—NHTSA ESTIMATES OF THE VALUE OF TRAVEL TIME FOR URBAN AND RURAL (INTERCITY) TRAVEL [1050]

[$/hour]

	Personal travel	Business travel	Total
Urban Travel			
Wage Rate ($/hour)	$29.68	$29.68	
DOT-Recommended Value of Travel Time Savings, as % of Wage Rate	50%	100%	
Hourly Valuation (=Wage Rate * DOT-Recommended Value)	$14.84	$29.68	
% of Total Urban Travel	94.4%	5.6%	100%
Hourly Valuation (Adjusted for % of Total Urban Travel)	$14.01	$1.66	$15.67
Rural (Intercity) Travel			
Wage Rate ($/hour)	$29.68	$29.68	
DOT-Recommended Value of Travel Time Savings, as % of Wage Rate	70%	100%	
Hourly Valuation (=Wage Rate * DOT-Recommended Value)	$20.77	$3.86	
% of Total Rural Travel	87.0%	13.0%	100%
Hourly Valuation (Adjusted for % of Total Rural Travel)	$18.07	$3.86	$21.93

The estimates of the hourly value of urban and rural travel time ($15.67 and $21.93, respectively) shown in Table IV–12 above must be adjusted to account for the nationwide ratio of urban to rural driving. By applying this adjustment (as shown in Table IV–13 below), an overall estimate of the hourly value of travel time—independent of urban or rural status—may be produced. Note that the calculations above assume only one adult occupant per vehicle. To fully estimate the average value of vehicle travel time, the presence of additional adult passengers during refueling trips must be accounted for. The agencies apply such an adjustment as shown in Table IV–13; this adjustment is performed separately for passenger cars and for light trucks, yielding occupancy-adjusted valuations of vehicle travel time during refueling trips for each fleet. Note that children (persons under age 16) are excluded from average vehicle occupancy counts, as it is assumed that the opportunity cost of children's time is zero.

TABLE IV–13—NHTSA ESTIMATES OF THE VALUE OF TRAVEL TIME FOR LIGHT-DUTY VEHICLES

[$/hour]

	Unweighted value of travel time ($/hour)	Weight (% of total miles driven) [1051]	Weighted value of travel time ($/hour)
Urban Travel	$15.67	67.1%	$10.51
Rural Travel	$21.93	32.9%	$7.22
Total	—	100.0%	$17.73
		Passenger cars	Light trucks
Average Vehicle Occupancy During Refueling Trips (persons)[1052]		1.21	1.23
Weighted Value of Travel Time ($/hour)		$17.73	$17.73
Occupancy-Adjusted Value of Vehicle Travel Time During Refueling Trips ($/hour)		$21.45	$21.81

The agencies estimated the amount of refueling time saved using (preliminary) survey data gathered as part of our 2010–2011 National Automotive Sampling System's Tire Pressure Monitoring System (TPMS) study. [1053] The study was conducted at fueling stations nationwide, and researchers made observations regarding a variety of characteristics of thousands of individual fueling station visits from August, 2010 through April, 2011.[1054] Among these characteristics of fueling station visits is the total amount of time spent pumping and paying for fuel. From a separate sample (also part of the TPMS study), researchers conducted interviews at the pump to gauge the distances that drivers travel in transit to and from fueling stations, how long that transit takes, and how many gallons of fuel are being purchased.

This analysis of refueling benefits considers only those refueling trips which interview respondents indicated the primary reason was due to a low

[1050] Time spent on personal travel during rural (intercity) travel is valued at a greater rate than that of urban travel. There are several reasons behind the divergence in these values: 1) time is scarcer on a long trip; 2) a long trip involves complementary expenditures on travel, lodging, food, and entertainment, since time at the destination is worth such high costs.

[1051] Weights used for urban vs. rural travel are computed using cumulative 2011 estimates of urban vs. rural miles driven provided by the Federal Highway Administration. Available at *http://www.fhwa.dot.gov/policyinformation/travel_monitoring/tvt.cfm* (last accessed Aug. 5, 2012).

[1052] Source: National Automotive Sampling System 2010–2011 Tire Pressure Monitoring System (TPMS) study. See next page for further background on the TPMS study. TPMS data are preliminary at this time and rates are subject to change pending availability of finalized TPMS data. Average occupancy rates shown here are specific to refueling trips, and do not include children under 16 years of age.

[1053] TPMS data are preliminary and not yet published. Estimates derived from TPMS data are therefore preliminary and subject to change. Observational and interview data are from distinct subsamples, each consisting of approximately 7,000 vehicles. For more information on the National Automotive Sampling System and to access TPMS data when they are made available, see *http://www.nhtsa.gov/NASS.*

[1054] The data collection period for the TPMS study ranged from 08/10/2010 to 04/15/2011.

reading on the gas gauge.[1055] This restriction was imposed so as to exclude drivers who refuel on a fixed (*e.g.,* weekly) schedule and may be unlikely to alter refueling patterns as a result of increased driving range. The relevant TPMS survey data on average refueling trip characteristics are presented below in Table IV–14.

TABLE IV–14—NHTSA AVERAGE REFUELING TRIP CHARACTERISTICS FOR PASSENGER CARS AND LIGHT TRUCKS

	Gallons of fuel purchased	Round-trip distance to/from fueling station (miles)	Round-trip time to/from fueling station (minutes)	Time to fill and pay (minutes)	Total time (minutes)
Passenger Cars	9.8	0.97	2.28	4.10	6.38
Light Trucks	13.0	1.08	2.53	4.30	6.83

As an illustration of how we estimate the value of extended refueling range, assume a small light truck model has an average fuel tank size of approximately 20 gallons, and a baseline actual on-road fuel economy of 24 mpg (its assumed level in the absence of a higher CAFE standard for the given model year). TPMS survey data indicate that drivers who indicated the primary reason for their refueling trips was a low reading on the gas gauge typically refuel when their tanks are 35 percent full (*i.e.* as shown in Table IV–14, with 7.0 gallons in reserve, and the consumer purchases 13 gallons). By this measure, a typical driver would have an effective driving range of 312 miles (= 13.0 gallons × 24 mpg) before he or she is likely to refuel. Increasing this model's actual on-road fuel economy from 24 to 25 mpg would therefore extend its effective driving range to 325 miles (= 13.0 gallons × 25 mpg). Assuming that the truck is driven 12,000 miles/year,[1056] this 1 mpg improvement in actual on-road fuel economy reduces the expected number of refueling trips per year from 38.5 (= 12,000 miles per year/312 miles per refueling) to 36.9 (= 12,000 miles per year/325 miles per refueling), or by 1.6 refuelings per year. If a typical fueling cycle for a light truck requires a total of 6.83 minutes, then the annual value of time saved due to that 1 mpg improvement would amount to $3.97 (= (6.83/60) × $21.81 × 1.6).

In the central analysis, this calculation was repeated for each future calendar year that light-duty vehicles of each model year affected by the standards considered in this rule would remain in service. The resulting cumulative lifetime valuations of time savings account for both the reduction over time in the number of vehicles of a given model year that remain in service and the reduction in the number of miles (VMT) driven by those that stay in service. We also adjust the value of time savings that will occur in future years both to account for expected annual growth in real wages[1057] and to apply a discount rate to determine the net present value of time saved.[1058] A further adjustment is made to account for evidence from the interview-based portion of the TPMS study which suggests that 40 percent of refueling trips are for reasons other than a low reading on the gas gauge. It is therefore assumed that only 60 percent of the theoretical refueling time savings will be realized, as it was assumed that owners who refuel on a fixed schedule will continue to do. NHTSA sought feedback from peer reviewers (one from DOT's Office of the Secretary, one from DOT's Research and Innovative Technology Adminstration, and one from West Virginia University's Department of Economics) regarding the NPRM analysis of refueling time savings and has updated its analysis and discussion to address peer reviewers' comments.[1059] NHTSA's and EPA's approaches to assessing future fuel tank sizes and the associated benefit to refueling are explained in the agencies' respective RIAs (EPA RIA Chapter 7 and NHTSA RIA Chapter VIII).

Since a reduction in the expected number of annual refueling trips leads to a decrease in miles driven to and from fueling stations, we can also calculate the value of consumers' fuel savings associated with this decrease. As shown in Table IV–14, the typical incremental round-trip mileage per refueling cycle is 1.08 miles for light trucks and 0.97 miles for passenger cars. Going back to the earlier example of a light truck model, a decrease of 1.6 in the number of refuelings per year leads to a reduction of 1.73 miles driven per year (= 1.6 refuelings × 1.08 miles driven per refueling). Again, if this model's actual on-road fuel economy was 24 mpg, the reduction in miles driven yields an annual savings of approximately 0.07 gallons of fuel (= 1.73 miles/24 mpg), which at $3.77/gallon[1060] results in a savings of $0.27 per year to the owner. Note that this example is illustrative only of the approach the agencies use to quantify this benefit. In practice, the societal value of this benefit excludes fuel taxes (as they are transfer payments) from the calculation, and is modeled using fuel price forecasts specific to each year the given fleet will remain in service.

The annual savings to each consumer shown in the above example may seem like a small amount, but the reader should recognize that the valuation of the cumulative lifetime benefit of this

[1055] Approximately 60 percent of respondents indicated ''gas tank low'' as the primary reason for the refueling trip in question.

[1056] Source of annual vehicle mileage: U.S. Department of Transportation, Federal Highway Administration, 2009 National Household Travel Survey (NHTS). See *http://nhts.ornl.gov/2009/pub/stt.pdf* (table 22, p.48). 12,000 miles/year is an approximation of a light duty vehicle's annual mileage during its initial decade of use (the period in which the bulk of benefits are realized). The Volpe model estimates VMT by model year and vehicle age, taking into account the rebound effect, secular growth rates in VMT, and fleet survivability; these complexities are omitted in the above example for simplicity.

[1057] A 1.1 percent annual rate of growth in real wages is used to adjust the value of travel time per vehicle ($/hour) for future years for which a given model is expected to remain in service. This rate is supported by a BLS analysis of growth in real wages from 2000–2009. See *http://www.bls.gov/opub/ted/2011/ted_20110224.htm.*

[1058] Note that here, as elsewhere in the analysis, discounting is applied on a mid-year basis. For example, at a 3% discount rate, the sequence of discount factors is calculated as: {1/((1+0.03) − (0.5)), 1/((1+0.03) − (1.5)), * * *, 1/((1+0.03) − (T−0.5))}. NHTSA utilized mid-year discounting to reflect the fact that a given model year's vehicles are sold over the course of one or more years, therefore costs and benefits do not begin to fully accrue on January 1st of the model year.

[1059] Peer review materials, peer reviewer backgrounds, comments, and NHTSA responses are available at Docket NHTSA–2012–0001.

[1060] Estimate of $3.77/gallon is in 2010$. This figure is an average of forecasted cost per gallon (including taxes, as individual consumers consider reduced tax expenditures to be savings) for motor gasoline for years 2017 to 2027. Source of price forecasts: U.S. Energy Information Administration, Annual Energy Outlook Early Release 2012 (see table VIII–9a).

savings to owners is determined separately for passenger car and light truck fleets and then aggregated to show the net benefit across all light-duty vehicles—which is much more significant at the macro level. Calculations of benefits realized in future years are adjusted for expected real growth in the price of gasoline, for the decline in the number of vehicles of a given model year that remain in service as they age, for the decrease in the number of miles (VMT) driven by those that stay in service, and for the percentage of refueling trips that occur for reasons other than a low reading on the gas gauge; a discount rate is also applied in the valuation of future benefits. The agencies considered using this direct estimation approach to quantify the value of this benefit by model year, however concluded that the value of this benefit is implicitly captured in the separate measure of overall valuation of fuel savings. Therefore direct estimates of this benefit are not added to net benefits calculations.[1061] We note that there are other benefits resulting from the reduction in miles driven to and from fueling stations, such as a reduction in greenhouse gas emissions—CO_2 in particular—which, as per the case of fuel savings discussed in the preceding paragraph, are implicitly accounted for elsewhere.

Special mention must be made with regard to the value of refueling time savings benefits to owners of electric and plug-in electric (both referred to here as EV) vehicles. EV owners who routinely drive daily distances that do not require recharging on-the-go may eliminate the need for trips to fueling or charging stations. It is likely that early adopters of EVs will factor this benefit into their purchasing decisions and maintain driving patterns that require once-daily at-home recharging (a process which takes two to six hours for a full charge). However, EV owners who regularly or periodically need to drive distances further than the fully-charged EV range may need to recharge at fixed locations. A distributed network of charging stations (*e.g.,* in parking lots, at parking meters) may allow some EV owners to recharge their vehicles while at work or while shopping, yet the lengthy charging cycles of current charging technology may pose a cost to owners due to the value of time spent waiting for EVs to charge. Moreover, EV owners who primarily recharge their vehicles at home will still experience some level of inconvenience due to their vehicle being either unavailable for unplanned use, or to its range being limited during this time should they interrupt the charging process. Therefore, at present EVs hold potential in offering significant time savings to owners with driving patterns optimally suited for EV characteristics. If fast-charging technologies emerge and a widespread network of fast-charging stations is established, it is expected that a larger segment of EV vehicle owners will fully realize the potential refueling time savings benefits that EVs offer. This is an area of significant uncertainty.

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 increased use of automobiles and light trucks developed previously by the Federal Highway Administration.[1062] 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 resulting from 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, and recognizing that no commenters addressed these costs directly, the agency continues to find them appropriate for use in this final rule. The agency multiplies FHWA's estimates of per-mile costs by the annual increases in automobile and light truck use from the rebound effect to yield the estimated increases in total congestion, accident, and noise externality costs during each year over the lifetimes of MY 2017–25 cars and light trucks.

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,[1063] 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.[1064] 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.[1065] 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.[1066]

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 refined 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) increased 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

[1061] Estimates of the net present value of fuel savings are presented in the agencies' respective RIAs (EPA RIA Chapter 7 and NHTSA RIA Chapter VIII).

[1062] 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 Jul. 9, 2012).

[1063] The AEO 2012 Early Release did not contain the ''side cases'' that NHTSA used to conduct this analysis, so the agency relied on AEO 2011 for the work discussed in this section.

[1064] 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.

[1065] 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.

[1066] This figure is calculated as 50 gallons + 50 gallons*90% = 50 gallons + 45 gallons = 95 gallons.

resulting price increases.[1067] 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.[1068] However, this monopsony cost or premium represents a financial transfer from consumers of petroleum products to oil producers, and does not consume real economic resources. Thus, the decline in its value that occurs when reduced U.S. demand for petroleum products causes a reduction 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 excluded the reduced value of monopsony payments by U.S. oil consumers that would result from lower fuel consumption.

ACEEE stated that not including an estimate for monopsony value was a ''departure from previous rules,'' and argued that monopsony effects should be counted among the final rule's economic benefits, because (1) reduction in the price of petroleum would bring a net benefit in terms of job creation due to the low labor intensity of the energy sector, and (2) reduced demand means that the most expensive sources of petroleum are not used, which also reduces the price of all petroleum.[1069] CFA commented simply that the monopsony effect is a true consumption externality, and should be included for the final rule at a value of $0.30/gallon.[1070] SAFE suggested that even if reducing domestic demand for oil does not necessarily lead to lower fuel prices, it might lead to production levels that are adjusted downward based on expectations that increased fuel economy will reduce aggregate demand.[1071] UCS argued that if the purpose of the CAFE program is conserve energy and improve energy security by raising fuel economy standards, NHTSA must include a value for the monopsony effect in the final rule or risk ''abdication of [its] statutory responsibility.'' [1072] NHTSA also received comments from the Department of Energy during interagency review of the final rule suggesting that we consider including the monopsony effect not in the current analysis, but in future analyses, stating that doing so would be appropriate because (1) U.S. efforts to reduce CO_2 emissions will be accompanied by similar efforts in other nations, (2) climate change could promote political instability in other parts of the world that could be harmful to the U.S., and (3) the U.S. should value preservation of biodiversity and reduction of environmental impacts around the world and not just in the U.S.

In response to ACEEE, NHTSA previously excluded any reduction in these monopsony costs resulting from lower U.S. fuel consumption in its analyses of CAFE standards for MY 2008–11 light trucks, MY 2011 passenger cars and light trucks, and MY 2012–16 cars and light trucks. The rationale for doing so—namely that these costs represent a financial transfer rather than a use of real economic resources, and that reducing them does not provide a savings in the use of economic resources—is thus well-established, remains sound, and is consistent with the global perspective of NHTSA's analysis of this final rule. The agency also notes that job ''creation'' is not among the economic benefits attributable to higher CAFE standards (and in any case increased employment represents the consumption of additional economic resources, which is an economic *cost* rather than a benefit), and that any reduction in the price of petroleum that continues to be purchased after a decline in total demand also represents a financial transfer rather than a true economic benefit.

In response to the assertion by CFA, the monopsony effect does not meet the definition of a consumption externality, because it is transmitted completely through the price mechanism and does not directly affect the welfare of individuals or the production functions of firms. Further, the economic benefit resulting from any decline in production levels of crude petroleum is already accounted for in the agency's estimates of the (pre-tax) value of fuel savings. Finally, by excluding any reduction in monopsony payments from its analysis of benefits from higher fuel economy, the agency is simply being consistent with the usual principles of economic analysis and with OMB guidelines for conducting regulatory analysis, and is thus in no way failing to meet its statutory responsibilities. With respect to the comment by UCS, NHTSA agrees that the overarching purpose of EPCA/EISA is energy conservation, but disagrees that the statute requires us to include the monopsony effect in our calculation of benefits associated with higher fuel economy standards, particularly when the level of the standards is not driven by benefit-cost considerations. As explained above, NHTSA has consistently excluded the monopsony value in its rulemakings since it has used a global SCC value, and continues to believe that doing so is appropriate for this final rule. With respect to the comments by DOE about including a monopsony effect in future analyses, we reiterate that any future analyses will represent a totally fresh look at all relevant factors. If the situation in future rulemaking changes such that including a value for the monopsony effect is appropriate, NHTSA would certainly consider one at that time.

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 reduce U.S. economic output while (and potentially after) they occur, as well as because firms incur real economic costs in attempting to adjust prices, output levels, and their use of

[1067] 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.

[1068] 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.

[1069] ACEEE, Docket No. EPA–HQ–OAR–2010–0799–9528, at 1–2.

[1070] CFA, Docket No EPA–HQ–OAR–2010–0799–9419, at 16, 54–55.

[1071] SAFE, Docket No. NHTSA–2010–0131–0259, at 4.

[1072] UCS, Docket No. NHTSA–2010–0131, at 6–7.

energy, labor and other inputs rapidly in response to sudden changes in prices for petroleum products caused by interruptions in their supply. Reducing U.S. petroleum consumption and imports lowers these potential costs and may also reduce the probability that U.S. petroleum imports will be disrupted, and both of these effects reduce the probabilistic ''expected value'' of the costs of oil supply disruptions to the U.S. economy. The amount by which it does so represents an economic benefit *in addition* to the savings in resources from producing and distributing fuel that results from higher fuel economy. NHTSA estimated and included this value in its NPRM analysis of the economic benefits from adopting higher CAFE standards for MY 2017–2025 cars and light trucks.

Several environmental group and other NGO commenters suggested that the standards would have significant energy security benefits in terms of avoiding macroeconomic disruption. UCS stated that ''No other federal policy has delivered greater oil savings, energy security benefits, or greenhouse gas emissions reductions to the country,'' and requested that we monetize improved energy security through reduced oil consumption and lower carbon emissions for the final rule analysis.[1073] EDF described a study by Jamie Fine that found ''that cost savings from avoided gasoline and diesel use in the event of an energy price shock in 2020 could be in the range of $2.4 to $5.2 billion for the state of California alone'' under California's plan to reduce GHGs to 1990 levels by 2020, and requested that the agencies at least report a range of estimates for benefits associated with energy security.[1074] EDF suggested that the agencies ''consider cost estimation proposals such as that included in Sen. Richard Lugar's (R–Ind.) Practical Energy and Climate Plan, S. 3464,'' which ''included both an extensive list of potential impacts of energy security to be considered and an alternative approximation valuation methodology for the ''external cost of petroleum use'' (i.e. this does not include the actual fuel savings).'' [1075] EDF stated that ''For inputs that the agencies cannot quantify, the final rule should include a list and explain that the benefits of the rule are likely undervalued due to such factors.'' [1076] SAFE commented simply that electrification of the fleet is good for energy security because it reduces the risk of macroeconomic disruptions, as a domestic fuel source.[1077]

In response to these comments, the agency notes that its estimate of benefits from reducing U.S. petroleum consumption and imports incorporates both the potential economic cost of oil supply disruptions and the reduced probability that such disruptions will occur, exactly as advocated by UCS and other commenters. In addition, the agency analyzes the sensitivity of its benefit estimates to plausible variation in the per-gallon value of reduced macroeconomic disruption costs that result from lowering U.S. petroleum consumption and imports. The agency relies on estimates of this value and the range of uncertainty surrounding it prepared by Oak Ridge National Laboratories, which are described in detail in Chapter 4 of the joint TSD accompanying this rulemaking.

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, 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.

As discussed in the NPRM, although NHTSA recognizes that there would clearly be significant economic benefits from eliminating the nation's dependence on foreign oil, no serious analysis has been able to estimate the potential reduction in U.S. military activity and spending that is likely to result exclusively from the fuel savings and reductions in U.S. petroleum imports this final rule is expected to produce by itself. Two principal difficulties that have prevented researchers from developing credible estimates of the potential reduction in military activity that might accompany a significant reduction in U.S. oil imports are isolating the specific missions that are intended to secure foreign oil supplies and transportation routes, and anticipating how extensively they would be scaled back in response to a decline in U.S. petroleum imports. Analysts have been unable to answer either of these questions with sufficient confidence to produce reliable estimates of potential savings in U.S. military outlays. As a consequence, the agency has included *only* the macroeconomic disruption portion of the energy security benefits to estimate the economic value of the total energy security benefits of this program. We have calculated energy security benefits 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 estimated 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.

Comments addressing the potential benefits from a reduced military presence as a result of higher CAFE standards were mixed. While API agreed with NHTSA's discussion in the NPRM and supported a reiteration of such discussion for the final rule (and sensitivity analysis in the FRIA),[1078] other commenters strongly supported developing a specific estimate of potential savings in U.S. military spending that would accompany reduced petroleum imports. AGA/

[1073] UCS, Docket No. EPA–HQ–OAR–2010–0799–9567, at 5–6.

[1074] EDF, Docket No. NHTSA–2010–0131–0302, at 3–4, 15.

[1075] *Id.* at 15.

[1076] *Id.*

[1077] SAFE, Docket No. NHTSA–2010–0131–0259, at 6–7.

[1078] API attachment, Docket No. NHTSA–2010–0131–0238, at 11–12.

ANGA,[1079] CBD,[1080] CFA,[1081] and UCS [1082] commented that the difficulty of quantifying the costs of maintaining a military presence abroad to protect oil resources did not obviate the need to attempt to do so. SAFE also provided a number of citations regarding how much the U.S. spends to import oil and maintain an overseas military presence.[1083]

The agency believes that eliminating or significantly reducing U.S. consumption and imports of petroleum would provide an opportunity to reduce military activities that are dedicated to the purposes of securing oil supplies in unstable regions of the globe, and protecting international transportation routes. However, NHTSA has been unable to identify research that reports credible estimates of the extent to which these opportunities would arise and be acted upon as a consequence of reductions in U.S. petroleum consumption of the magnitude projected to result from this final rule, either alone or in conjunction with its previous actions to establish higher CAFE standards. This conclusion was echoed in a recent study conducted for EPA by Oak Ridge National Laboratory, the results of which are described in detail in Chapter 4 of the Final TSD accompanying this rulemaking. Thus as indicated previously, NHTSA's analysis of benefits from adopting this final rule 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.

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.[1084] 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.[1085] 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 the comments and recommendations provided by peer reviewers.[1086] 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. 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 $0.197 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 $0.096 per gallon to a high of $0.284 per gallon should be used to reflect this uncertainty. We note that the calculation of energy security benefits does not include any consideration of potential energy security *costs* associated with increased reliance on foreign sources of lithium and rare earth metals for HEVs and EVs. Any such costs would partially offset the energy security benefits from reducing U.S. petroleum imports. The agencies sought public input that would enable us to develop such an estimate, but received no useful information to support the necessary analysis.

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 magnitudes 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).[1087] Emission rates for SO_2 were calculated by NHTSA using estimates of average fuel sulfur content supplied by EPA, together with the assumption that the entire sulfur content of fuel is emitted in the form of SO_2.[1088] 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 2017–2025 cars

[1079] AGA/ANGA provided the example of the Navy's Fifth Fleet, ''reestablished in 1995 and based in Bahrain,'' which it said exists ''to secure the Persian Gulf sea-lanes,'' at an ''annual cost * * * in the billions of dollars.'' AGA/ANGA, Docket No. NHTSA–2010–0131–0237, at 5–6.

[1080] CBD, Docket No. NHTSA–2010–0131–0255, at 7.

[1081] CFA, Docket No. EPA–HQ–OAR–2010–0799–9419, at 16.

[1082] UCS provided the example of ''a recent peer-reviewed study [that] found that the U.S. military spent $7.3 trillion maintaining aircraft carriers in the Persian Gulf from 1976–2007,'' stating that ''Since this presence is largely purposed to protect key oil shipping lanes, it provides an indication of the significant cost to the U.S. economy as a result of our reliance on oil.'' UCS, Docket No.EPA–HQ–OAR–2010–0799–9567, at 7.

[1083] SAFE, Docket No. NHTSA–2010–0131–0259, at 2–6.

[1084] 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).

[1085] 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).

[1086] *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.

[1087] 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.

[1088] 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.

and light trucks are calculated as the difference 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 using Argonne National Laboratories' Greenhouse Gases and Regulated Emissions in Transportation (GREET) model, which provides estimates of air pollutant emissions that occur during different phases of fuel production and distribution [1089,1090] EPA modified the GREET model to change certain assumptions about emissions during crude petroleum extraction and transportation, as well as to update its emission rates to reflect adopted and pending EPA emission standards.

NHTSA used the resulting emission rates, together with its previous estimates of how reductions in total fuel use would be reflected in reductions in domestic fuel refining and crude petroleum production, to calculate emissions of each criteria pollutant that would occur during domestic fuel production, as well as in the distribution of domestic and imported fuel within the U.S. The agency's analysis assumes that reductions in imports of refined fuel would reduce domestic emissions of criteria pollutants during the fuel storage and distribution stages only. Reductions in domestic fuel refining using imported crude oil are assumed to reduce emissions during fuel refining, as well as during fuel storage and distribution. Finally, reduced domestic fuel refining using domestically-produced crude oil is assumed to reduce emissions during all phases of fuel production and distribution.[1091] As with emissions from vehicle use, the impact of alternative CAFE standards on total emissions from fuel production and distribution is estimated as the difference between emissions under the baseline alternative, and emissions with a higher CAFE standard in effect.

Finally, NHTSA calculated the net changes in domestic emissions of each criteria pollutant by combining the increases in emissions projected to result from increased vehicle use with the reductions anticipated to result from lower domestic fuel refining and distribution.[1092] As indicated previously, the effect of adopting higher CAFE standards on total emissions of each criteria pollutant depends on the relative magnitudes of the resulting reduction in emissions from fuel refining and distribution, and the increase in emissions from additional vehicle use. Although these net changes vary significantly among individual criteria pollutants, the agency projects that on balance, adopting higher CAFE standards 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 would be avoided, which were developed by EPA. These savings represent reductions in the value of damages to human health resulting from lower atmospheric concentrations and population exposure to air pollution that result from lower when emissions of each pollutant that contributes to atmospheric $PM_{2.5}$ concentrations. The value of reductions in the risk of premature death due to exposure to fine particulate pollution ($PM_{2.5}$) account for the 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 reductions in the impacts of $PM_{2.5}$ pollution on the natural environment, 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 $PM_{2.5}$ and other criteria pollutants from vehicle use than for reductions in emissions of those same pollutants during fuel production and distribution; differences in these values primarily reflect differences in population exposure to these separate sources of emissions.[1093] 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 rapidly 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. They also reflect expected future population growth, which is anticipated to increase population exposure to potentially harmful levels of air pollution.

The commenter Growth Energy urged the agency to evaluate the effect of increased use of gasoline direct injection technology on emissions of fine particulate matter, as well as the potential for more widespread ethanol use and after-treatment technologies to decrease such emissions. In response, NHTSA reiterates that this final rule does not require vehicle manufacturers to employ specific technologies; instead, it specifies the fuel economy levels they must achieve, while leaving decisions about the use of available technologies to individual manufacturers. In making these choices, manufacturers must continue to comply with EPA's standards for emissions of fine particulate matter and other criteria air pollutants, and this requirement limits the potential impact of their choices on

[1089] Argonne National Laboratories, *The Greenhouse Gas and Regulated Emissions from Transportation (GREET) Model,* Version 1.8c.0, April 2008. This version of the model is no longer available; for updated versions, see *http://greet.es.anl.gov/greet_1_series* (last accessed July 12, 2012).

[1090] 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.

[1091] 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.

[1092] 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.

[1093] 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.

fleet-wide average emissions of each pollutant.

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 a small but growing share of energy consumption by cars and light trucks produced in the model years that would be subject to the final standards. By reducing the volume of fuel consumed by passenger cars and light trucks, higher CAFE standards will reduce GHG emissions generated by fuel combustion, 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 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 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. For other GHGs, NHTSA calculates annual emissions from vehicle use by multiplying its estimates of car and light truck use during each future year by per-mile emission rates for each vehicle class, fuel type, model year, and age.

NHTSA estimates emissions of CO_2 and other GHGs 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 GHG 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 other effects of alternative CAFE standards, the reductions in emissions of CO_2 and other GHGs resulting from each alternative increase is measured by the difference in total emissions from producing and consuming fuel energy used by MY 2017–25 cars and light trucks with a higher CAFE standard in effect, and total emissions from supplying and using fuel energy consumed under the baseline alternative. Unlike criteria pollutants, the agency's estimates of GHG emissions include those occurring in overseas production of petroleum and refined fuel for export to the U.S., as well as during domestic fuel production and consumption. Overseas emissions are included because GHG emissions throughout the world contribute equally to the potential for future changes in the global climate.

iii. Economic Value of Reducing 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, although they can also be measured in other ways. While the agency did not include estimates of the economic benefits from reducing GHGs other than CO_2 in its analysis of alternative CAFE standards for the NPRM, in response to comments from CBD [1094] and EDF,[1095] we have added a sensitivity analysis that estimates these benefits using the ''GWP method'' for the final rule; see Chapter X of the Final RIA for details and results.

NHTSA estimates the value of the reductions in emissions of CO_2 resulting from adopting alternative CAFE standards using a measure usually referred to as the ''social cost of carbon'' (or 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 future year. The SCC is higher for more distant future years, because the climate-related economic damages caused by an additional ton of emissions are projected to increase as larger concentrations of CO_2 accumulate 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 each alternative estimate of the SCC. This calculation is repeated for the reductions in CO_2 emissions projected to result from each alternative increase in CAFE standards.

NHTSA's 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

[1094] CBD, Docket No. NHTSA–2010–0131–0255, at 7.

[1095] EDF, Docket No. NHTSA–2010–0131–0302, at 11–14.

social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions that have individually 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 2014–18 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. 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 extreme climate impacts from the accumulation of GHGs in the earth's atmosphere, and the consequently larger economic damages.

Table IV–15 summarizes the interagency group's estimates of the SCC during various future years, which the agency has updated to 2010 dollars to correspond to the other values it uses to estimate economic benefits from the alternative CAFE standards considered in this final rule.[1096]

TABLE IV–15—NHTSA ESTIMATE OF SOCIAL COST OF CO_2 EMISSIONS FOR SELECTED FUTURE YEARS

[2010$ per metric ton]

Discount rate	5%	3%	2.5%	3%
Source	Average of estimates			95th percentile estimate
2012	$5.33	$23.26	$37.87	$70.88
2015	5.97	24.82	39.94	75.77
2017	6.39	25.86	41.32	79.10
2020	7.03	27.42	43.38	83.99
2025	8.59	30.77	47.73	94.09
2030	10.14	34.12	52.07	104.08
2035	11.70	37.48	56.42	114.17
2040	13.26	40.83	60.76	124.16
2045	14.82	43.794	64.22	133.01
2050	16.38	46.76	67.68	141.75

As Table IV–15 shows, the four SCC estimates selected by the interagency group for use in regulatory analyses are $6, $26, $41, and $79 per metric ton (in 2010 dollars) for emissions that occurr during the year 2017. 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, which corresponds to the $26 per metric ton figure shown in the table for 2017. 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 $47 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.[1097]

The agencies received a number of lengthy, detailed comments on the SCC values recommended by the interagency group, as well as on the process the group used to develop them. Most of these comments addressed the topics of incorporating updated knowledge about climate impacts, more fully considering the potential for catastrophic impacts of future climate change, valuing the population's presumed aversion to the risk of significant climate impacts on economic well-being, and the discount rate used to convert distant future economic impacts to their present values. EDF, NRDC, and IPI each urged the agency to revise its estimates of the SCC to incorporate recent improvements in understanding the range and severity of economic impacts from climate change. NRDC and EDF noted that the three integrated assessment models used

[1096] 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.

[1097] This document is available in the docket for the 2012–2016 rulemaking (NHTSA–2009–0059).

by the federal interagency group to develop the SCC estimates used to analyze the proposed rule have been updated to reflect recent estimates of climate sensitivity to GHG accumulations and to expand the range of monetized economic damages resulting from climate change, and encouraged the agency to update its estimates of the SCC using these newest versions of these models. NRDC further recommended that these models be updated to reflect recent research identifying adverse climate impacts on agricultural productivity. EDF and IPI recommended that the agency provide a complete listing of known and potential economic damages resulting from climate change, identify which of these were monetized in the interagency group's estimates of the SCC, and explicitly note which of them were excluded. NRDC urged NHTSA to develop ''multipliers'' that could be applied to reductions in the use value of natural resources and ecosystem services to account for accompanying reductions in their non-use values (that is, the value that non-users attached to the option of having them available).

All three commenters also urged the agency to revise its SCC estimates to more fully reflect the potential for catastrophic economic damages resulting from future climate change. NRDC recommended doing so by integrating such damages directly into the three integrated assessment models used by the interagency group, while IPI recommended adjusting those models' estimates of benefits from reducing GHG emissions to account for their undervaluation of the risk and magnitude of catastrophic damages. EDF urged revisions to the mathematical form of the models' functions relating GHG accumulations to changes in global climate indicators and resulting economic damages, in order to remedy what EDF views as their underestimation of the probability that such damages will result. NRDC also recommended that the agency report the magnitude of extremely low-probability economic damages in order to inform the public and decision-makers about the impact of catastrophic scenarios. NRDC also urged the agency to conduct sensitivity analysis of the SCC using various ''equity weights,'' which would increase the value of climate damages likely to be experienced by lower-income regions of the world.

IPI, EDF, and NRDC each urged the agency to incorporate the economic value of the population's aversion to the risk of large losses in welfare in its SCC estimates. Specifically, the commenters recommended that the SCC be revised to include a measure of the typical consumer's willingness to sacrifice current income to avoid being exposed to the risk of a large welfare loss from potential climate change. Including such a ''risk premium,'' which would be in addition to the conventional expected value of damages from different degrees of potential climate change, could increase the agency's estimates of the SCC significantly. IPI noted that such a risk premium could be approximated by reducing the discount rate applied to future climate-related economic damages if it could not be estimated directly, while NRDC referred the agency to published research describing a recently-developed alternative method for incorporating the value of risk aversion.

Finally, all three of the same commenters urged NHTSA to base its estimates of the SCC on lower discount rates than those the interagency group applied to future economic damages, which would increase the agency's SCC values. NRDC noted that OMB Circular A–4 recommends a 1% rate as a lower bound for discounting where future benefits or costs will be experienced by future generations, and also pointed out that short-term interest rates are currently well below this figure. As an alternative, NRDC recommended using declining future discount rates to account for more fully for long-run uncertainty about interest rates than the procedure used by the interagency group. EDF similarly encouraged the agency to reduce the discount rates incorporated in the interagency group's SCC estimates below 3%, and also to consider using declining discount rates to account more appropriately for scientific and economic uncertainty surrounding the correct social discount rate for use over long time periods.

Finally, NRDC noted than an alternative to using the SCC to value reductions in GHG emissions would be to estimate the cost of achieving the final reduction in emissions necessary to reach a target emissions level (or ''marginal abatement cost'') that is consistent with the maximum acceptable degree of climate change. While NRDC acknowledged that the determination of what constitutes an acceptable degree of climate change would ultimately be a political decision, the associated level of emissions and the marginal cost of reducing emissions to that level from today's baseline could be determined scientifically with reasonable accuracy and allowing some margin for error.

The agency appreciates the careful thought and detailed analyses that are reflected in the extensive comments it received on the SCC. In the time frame for evaluating and adopting this final rule, however, NHTSA judged that it would be impractical to replicate the detailed process the federal interagency group used to produce its recommended values for the SCC, and to develop the updated input assumptions and revised modeling procedures advocated by the commenters. Additionally, other federal agencies use the SCC estimates to analyze benefits of rulemakings, and consistency across government analyses is useful in this regard. If the SCC estimates are to be updated in the future, an interagency-group approach is likely to be a more fruitful way of accomplishing that than NHTSA attempting the process on its own. Recognizing this, the agency has elected to continue using the interagency group's recommended SCC values to estimate the economic benefits stemming from the reductions in GHG emissions that are projected to result from this final rule.

m. Discounting Future Benefits and Costs

Discounting future fuel savings and other benefits is intended to account for the reduction in their value when they are deferred or will not occur 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 the same amount of 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 employs discount rates of both 3 and 7 percent per year, in accordance with OMB guidance.

While we present 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 should be discounted at consumers' rate of time preference.[1098]

Current OMB guidance further 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 more 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.[1099] 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.

UCS supported the agencies' use of 3 and 7 percent discount rates in the analysis for the final rule,[1100] while API commented that EIA used a discount rate of 15 percent in the analysis for AEO 2011 when evaluating the cost-effectiveness of vehicle fuel efficiency-improving technology, and stated that a similar rate employed in the CAFE analysis would reduce the present value of fuel savings by about 40–50 percent.[1101] NHTSA notes that the 15 percent rate recommended by API is more than double the higher rate prescribed by OMB for use in regulatory analysis. It is thus likely to be more appropriate for evaluating investments in future fuel-saving technologies that are as yet unknown or unproven, and are consequently viewed as extremely risky from today's perspective. Thus the agency has elected to retain the 3 and 7 percent discount rates in its evaluation of future benefits from adopting this final rule.

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–15 above, these rates are 2.5 percent, 3 percent, and 5 percent depending on which estimate of the SCC is being employed.[1102]

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 that are subject to the most uncertainty, and where alternative values are likely to have the largest effect. These include the distribution of sales of MY 2017–25 vehicles between passenger cars and light trucks, expected lifetime utilization of cars and light trucks, the payback period assumed by manufacturers when choosing to adopt fuel economy technologies, 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 value of reducing CO_2 emissions (the SCC), and the reduction in external economic costs resulting from lower U.S. oil imports. 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 limits between which 90 percent of observed values are expected to fall. In cases where the data on the possible distribution of parameters was relatively sparse, making the 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. 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. 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 FRIA, and a discussion of how NHTSA and EPA jointly reviewed and updated economic assumptions for purposes of this final rule is available in Chapter 4 of the Joint TSD. In addition, all of NHTSA's model input and output files are now public and available for the reader's review and consideration. The economic input files can be found in the docket for this final rule, NHTSA–2010–0131, and on NHTSA's Web site.[1103]

Finally, because much of NHTSA's economic analysis for purposes of this final rule 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

[1098] For example, OMB Circular A–4 states that ''When regulation primarily and directly affects private consumption (e.g., through higher consumer prices for goods and services), a lower [than 7 percent] discount rate is appropriate. The alternative most often used is sometimes called the ''social rate of time preference.'' This simply means the rate at which ''society'' discounts future consumption flows to their present value. Available at *http://www.whitehouse.gov/omb/circulars_a004_a-4* (last accessed Jul. 10, 2012).

[1099] *Id.*

[1100] UCS, Docket No. EPA–HQ–OAR–2010–0799–9567, at 13.

[1101] API attachment, Docket No. NHTSA–2010–0131–0238, at 10.

[1102] 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.

[1103] *See http://www.nhtsa.gov/fuel-economy.*

the agency's growing experience with this type of analysis.[1104]

4. How does NHTSA use the assumptions in its modeling analysis?

In developing today's 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, expanded, and refined over time 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.[1105] The model documentation is also available in the docket for today's rule, as are inputs for and outputs from analysis of today's CAFE standards.[1106]

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 forecasts 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.[1107] 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[1108] 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;[1109]

(2) The manufacturer ''exhausts''[1110] 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.[1111]

As discussed below, the model has also been modified in order to—as an option—apply more technology than may be necessary for a manufacturer to achieve compliance in a given model year, or to facilitate compliance in later model years. This ability to simulate ''market-driven 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 once they are applied (until, if applicable, they are superseded by other technologies). The CAFE model accounts explicitly for each model year because EPCA/EISA 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.[1112]

[1104] 74 FR 14308–14358 (Mar. 30, 2009).

[1105] *http://www.nhtsa.gov/fuel-economy.*

[1106] Docket No. NHTSA–2010–0131.

[1107] 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).

[1108] Prior to the NPRM, DOT modified the model 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 the effect of maximum feasible CAFE standards, NHTSA cannot consider these mechanisms, and exercises the CAFE model without enabling these options.

[1109] In preparation for the MYs 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 (often described as ''multi-year planning''). NHTSA believes that integrating multi-year planning in the modeling analysis better informs the agency with regard to what levels of standards may be maximum feasible in each model year, as required by EPCA/EISA, because it better replicates manufacturers' actual behavior as compared to the year-by-year evaluation which EPCA/EISA would otherwise imply.

[1110] 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, the CAFE model concludes that technologies are ''exhausted'' for that manufacturer in that model year.

[1111] This possibility was added to the model to account for the fact that under EPCA/EISA, manufacturers must pay civil penalties 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 civil penalties than to achieve compliance, and believes that to assume these manufacturers would exhaust available technologies before paying civil penalties would cause unrealistically high estimates of market penetration of expensive technologies such as diesel engines and strong HEVs, 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 civil penalties 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).

[1112] 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

The multi-year planning capability, (optional) simulation of ''market-driven 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.[1113] It calculates costs by applying the cost estimation techniques discussed above in Section IV.C.2 (*i.e.,* incrementally accumulating additive incremental technology costs specified separately for discrete technological steps along several ''decision trees,'' and applying adjustments to account for, among other things, ''learning'' effects), 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 (*i.e.,* incrementally accumulating multiplicative incremental technology fuel consumption reductions specified separately for discrete technological steps along several ''decision trees,'' and applying ''synergy'' factors to account for interactions between some technologies), 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, and benefits facilitates the agency's analysis of the 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 to 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 estimated 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, transparently, and reproducibly conduct key analyses relevant to the formulation and evaluation of new CAFE standards.[1114]

NHTSA notes that the CAFE model not only has been formally peer-reviewed and tested and reviewed through three rulemakings (not include the current rulemaking), 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. This requires the ability to analyze each model year covered by the regulatory period to account for the interdependency in terms of the appropriate levels of stringency for every model year. 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 by combining technologies incrementally and on a model-by-model basis, and thus reduce the risk of creating unlikely technology combinations by applying technologies that may be incompatible with or already present on a given vehicle model. The CAFE model 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 members of the public can assist the agency if they are so inclined, 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 last year's proposal regarding MY 2017–2025 standards, the CAFE model was 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

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.

[1113] 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 July 4, 2012).

[1114] 75 FR 25598–25599.

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.

To support evaluation of the effects that electric vehicles (EVs) and plug-in hybrid vehicles (PHEVs) could have on energy consumption and associated costs and environmental effects, DOT 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), taking into account input assumptions regarding the share of PHEV operation that would rely on electricity. The model calculates the cost of this electricity, as well as the accompanying upstream criteria pollutant and greenhouse gas emissions. Related inputs applied for today's analysis are presented in chapters V and VIII of the FRIA.

Similar to this expansion to account for the potential that PHEVs can be refueled with gasoline or recharged with electricity, DOT expanded the CAFE model to account for the potential that other flexible-fuel vehicles (FFVs) can be operated on multiple fuels. In particular, the model can account for ethanol FFVs consuming E85 or gasoline, taking into account input assumptions regarding the share of FFV operation that would rely on E85 (see chapters V and VIII of the FRIA), and 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 modified the CAFE model to apply a stream of costs representing the stranded capital cost of a replaced technology when that technology is replaced by a newly applied technology, if specified for a given technology. This cost is in addition to the cost for producing the newly applied technology in the first year of production. Stranded capital costs are discussed more generally in Section II.D above, in Chapter 3 of the joint TSD, and in Chapter V of NHTSA's FRIA.

As documented in prior CAFE rulemakings and in Chapter V of NHTSA's FRIA, the CAFE model applies ''phase-in caps'' to constrain technology application at the vehicle manufacturer level. These caps are intended to reflect a manufacturer's overall resource capacity available for implementing new technologies (such as engineering and development personnel and financial resources), 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. In the MY 2012–2016 rulemaking analysis, 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 subsequently 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. In NHTSA's judgment, doing so better represents constraints on the rates at which each manufacturer can add various technologies, thereby providing a better means of accounting for technological feasibility and economic practicability of potential standards.

The CAFE model requires inputs defining the technology-specific cost and effectiveness (*i.e.,* percentage reduction of fuel consumption). Considering that some technologies may 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), the CAFE accepts and applies technology-specific estimates of any value gain realized or loss incurred by vehicle purchasers.[1115]

[1115] 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.

For the MYs 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 primary 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 multi-year planning aspects of the CAFE model. DOT subsequently 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 promulgating CAFE standards reflecting EPA's changing 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 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. Similarly, NHTSA's new CAFE standards reflect EPA's further changing fuel economy calculation procedures to account for some other technologies that reduce fuel consumption under conditions not represented by the city or highway test procedures. While DOT was not able to modify the CAFE model prior to the NPRM to account for these adjustments, it has since done so.

Considering that past CAFE rulemakings indicate that most of the benefits of CAFE standards are realized by vehicle owners, DOT modified the CAFE model prior to the NPRM in order 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 the NPRM, DOT has further modified the CAFE model to provide the ability to account for owners' operating costs including financing, insurance, scheduled maintenance, and out-of-warranty repairs in response to comment from NADA suggesting that the agencies should evaluate the effect of the rulemaking on a vehicle's total cost of ownership.[1116] Among these, the model includes only scheduled maintenance and out-of-warranty repairs in overall estimates of societal costs.

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 penalties 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 simulate, if specified, 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 fleet, even if it already complies with the CAFE standard in that model year, until applying further technology will incur more in cost than it will yield in calculated fuel savings over a specified ''payback period'' (this payback period is set separately from the payback period that is 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. At that time, 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 based on the underlying statistical analysis of the safety impacts of vehicle mass reductions discussed in Section II.G above and in Chapter IX of the FRIA. 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 and U.C. Irvine) to develop a vehicle choice model estimated at the vehicle configuration level that can be implemented as part of DOT's CAFE model. As discussed further in Chapter V of the FRIA for MYs 2012–2016, 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. While the NHTSA-sponsored effort is still underway and was not completed in time to incorporate in the analysis for this final rule, if a suitable and credibly calibrated vehicle choice model becomes available in the future, DOT may integrate a vehicle choice model into the CAFE model to support future rulemakings.

NHTSA anticipates this integration of a vehicle choice model would be structurally and operationally similar to the integration we implemented previously. As in today's analysis, 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 vehicle choice 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 inputted 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 vehicle choice model would impact estimates of all of the following for a given schedule of CAFE standards: overall market volume, individual manufacturer market shares and product mix, required and achieved CAFE levels, technology application rates and corresponding incurred costs, fuel consumption, greenhouse gas emissions, 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) with less lead time and relatively less stringent standards than reflected in today's final rule. 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 invited comment on changes made to the CAFE model prior to the NPRM's release, and regarding the above-mentioned prospects for inclusion of a vehicle choice model. The agency only received comments regarding the possibility of utilizing a vehicle choice model. Two environmental organizations—the

[1116] NADA, Docket No. NHTSA–2010–0131–0261, at 10.

National Resources Defense Council (NRDC) and the Union of Concerned Scientists (UCS)—urged the agency not to include any vehicle choice model in its analysis, citing concerns regarding uncertainties surrounding such models, and in NRDC's case, the potential that use of a choice model would lead NHTSA to adopt less stringent standards than if the agency continues not to analyze potential market effects.[1117] NRDC argued that vehicle choice models may be useful for analyzing the potential result of some market-based policies, but not for standards that drive the adoption of technology. NRDC suggested that choice models rely on stated and/or revealed preferences that are based only on existing vehicles, not a future market in which vehicles widely offer higher fuel economy than today's vehicles. On the other hand, the American Fuel and Petrochemical Manufacturers (AFPM) expressed concern that the proposal was based on an analysis that did not incorporate a vehicle choice model, citing this as a serious deficiency that must be addressed to properly understand the implications of the proposal.[1118] AFPM suggested that the proposed standards were not feasible, and indicated that use of a peer-reviewed consumer choice model would show less reliance on HEVs, PHEVs, and EVs, and that a corresponding new proposal would assist NHTSA's development of a revised proposal that is feasible and coincides with Congress' mandate in this area.[1119] The Alliance supported NHTSA's development of a vehicle choice model to inform the planned mid-term evaluation and forthcoming rulemaking to establish final standards for MYs 2022–2025, stating that such a model should use real-world data, be developed in a transparent manner with full peer review, and assess uncertainties in its predictions.[1120] IPI commented that a vehicle choice model should incorporate positional goods theory (a theory describing the value of a product as significantly determined by the product's value to others), and be used to explain why the agency's cost estimates are not likely to underestimate consumer welfare losses, but rather predict that the cost projections are more likely to be overestimates (because they do not reflect that the positional aspect of light vehicles—that is, their role in defining owners' ''status''—artificially inflates the value of vehicle performance and utility).[1121]

As mentioned above, we do not yet have available a credible vehicle choice model suitable for integration with our CAFE modeling system. However, we disagree with NRDC's comment that vehicle choice models are not useful toward evaluation of standards that drive the adoption of technology: market effects are among the range of consequences that—intended or not—could be real, important, and warranting evaluation. NHTSA also disagrees with NRDC's suggestion that that choice models based on current vehicles cannot reasonably be applied to future vehicle markets, and with UCS's suggestion that application of a choice model should be rejected out of hand. While we acknowledge that future consumer preferences could be different from those evidenced by currently-available data, we disagree that these potential differences provide an *a priori* basis not to use a choice model to estimate potential market impacts of fuel economy standards. In our judgment, such uncertainties should be instead considered and, as practicable, addressed through sensitivity analysis (*e.g.,* to test a choice model's sensitivity to changes in defining coefficients). We also disagree with NRDC that application of a vehicle choice model would lead the agency to adopt less stringent standards. We expect that a choice model would show sales shifting among different vehicle models and among manufacturers, and that specific characteristics of such shifts would depend heavily on different model inputs, not just on standards. While such shifts would impact results relevant to consideration of statutory factors governing decisions regarding maximum feasible stringency, we consider it just as likely that such shifts could support more stringent standards as that they could support less stringent standards.

Nor do we agree with AFPM that the proposed standards were beyond maximum feasible; the agency's assessment of why the final standards, which are identical to the proposed standards, are maximum feasible is discussed below in Section IV.F. We do not agree with AFPM that a choice model would, by definition, indicate less reliance on HEVs, PHEVs, or EVs: a choice model could show shifts either toward such technologies or away from such technologies, based on a range of model inputs and on comparative implications for specific vehicle models. In any event, we also disagree with AFPM's suggestion that such shifts would necessarily indicate that maximum feasible standards would be less stringent than we proposed in the NPRM and are promulgating today, just as we disagree with NRDC's suggestion that application of a choice model would lead the agency to promulgate less stringent standards.

We agree with the Alliance that NHTSA should continue efforts to develop a vehicle choice model suitable for integration with the CAFE modeling system and application toward informing the planned mid-term evaluation and future rulemaking for MYs 2022–2025. NHTSA considers it possible that a vehicle choice model would be informed by consideration of economic theory regarding ''positional goods,'' and has provided copies of IPI's comments on this theory to the U.C. Davis and U.C. Irvine researchers supporting NHTSA. However, in our judgment, IPI's comments prejudge the applicability, relevance, and implications of such theory in this context. Section IV.G, below, discusses IPI's comments regarding the theory's relevance to estimates of consumer benefits of fuel economy standards.

The researchers supporting NHTSA in the development of a vehicle choice model suitable for use in the analysis of CAFE standards have made significant progress collecting and integrating data to support the estimation of a choice model, developing options for structuring such a model in a manner that allows for integration with DOT's CAFE modeling system, and developing and testing algorithms to statistically estimate coefficients defining a choice model. NHTSA is hopeful that continuation of this effort will lead to development of a vehicle choice model that can be integrated with the CAFE modeling system and used for CAFE rulemaking analysis.

In preparation for today's analysis, DOT also made some further (*i.e.,* beyond those discussed above) changes to the CAFE modeling system. To facilitate external analysis, the CAFE model now produces ''flat'' text files (comma separated value or ''CSV'', format) as model output. DOT also corrected some errors DOT staff identified in the version of the model supporting the NPRM, the most significant of which include the following: First, the model was corrected to ensure that advanced diesel technology is not applied without accounting for incremental costs and effects of TURB2, CEGR1, or CEGR2—

[1117] NRDC, Docket No EPA–HQ–OAR–2010–0799–9472, at 19, UCS, Docket No. EPA–HQ–OAR–2010–0799–9567, at 14.

[1118] AFPM, Docket No EPA–HQ–OAR–2010–0799–9485, at 4.

[1119] AFPM, at 8.

[1120] Alliance, Docket No. NHTSA–2010–0131–0262, at 19.

[1121] IPI, Docket No.EPA–HQ–OAR–2010–0799–9480, at 19.

engine technologies placed before diesels on the model's decision tree for engine technologies. Second, the model was corrected to ensure that when fuel-saving technologies are applied to a flexible fuel vehicle (FFV), the vehicle's fuel economy when operating on E85 is increased in parallel with its fuel economy when operating on gasoline. Third, the model was corrected to ensure that, when calculating the ''effective cost'' for purposes of deciding among potential technology applications, the model refers to fuel prices estimated to prevail after the vehicle's purchase. Further details regarding the model's design and operation are presented in the model documentation available on NHTSA's Web site.

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 the final rule establishing CAFE standards for MYs 2012–2016, this is incorrect.[1122] 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, among other factors.

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) [1123] 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 today's final rule are available to the public at Docket No. NHTSA–2010–0131, which can be accessed at *http://www.regulations.gov*. 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, but we continue to encourage interested parties to contact the agency if they encounter difficulties using the model or have questions about it that are not answered here or in the model documentation.

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 plans to arrange for a formal peer review of the CAFE model after the pending integration of a vehicle choice model. All relevant materials will be docketed as part of that peer review, and NHTSA expects to re-release a new version of the integrated CAFE model once the peer review is completed.

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 [1124] for each model year,[1125] and each standard must be the maximum feasible that NHTSA believes the manufacturers can achieve in that model year.[1126] 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.[1127] 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.[1128]

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-

[1122] 75 FR 25600.

[1123] We note, however, that files from any supplemental analysis conducted that relied in part on confidential manufacturer product plans cannot be made public, *see* 49 CFR part 512.

[1124] 49 U.S.C. 32902(b)(1).

[1125] 49 U.S.C. 32902(a).

[1126] *Id.*

[1127] 49 U.S.C. 32902(f).

[1128] *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.'').

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.[1129] Third, between MY 2011 and MY 2020, the standards must ''increase ratably'' in each model year.[1130] 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.'' [1131] This issue is discussed in section IV.A above.

Commenters raised a number of issues regarding NHTSA's authority to set CAFE standards under EPCA/EISA, which will be discussed throughout this section. For example, Securing America's Energy Future (SAFE) commented that NHTSA should consider setting CAFE standards in gallons per mile rather than miles per gallon, because consumers often do not understand mpg and the agency could more effectively incentivize alternative fuel vehicles by using gallons per mile, since the numerator of ''gallons'' would be zero.[1132] In response, NHTSA is required by statute to set CAFE standards in terms of miles per gallon—''fuel economy,'' as expressly defined in EPCA, means ''the average number of miles traveled by an automobile for each gallon of gasoline (or equivalent amount of other fuel) used.'' [1133] NHTSA agrees that gallons per mile, as a metric, may more accurately describe to consumers the fuel savings impacts of their vehicle choices, which is why the newly-revised fuel economy and environment label for which NHTSA is also responsible under EISA contains a gallons per mile metric. NHTSA does not, however, currently have discretion under the statute to set CAFE standards in terms of anything but mpg. NHTSA agrees with SAFE that changing this requirement would be up to Congress. The agency has, however, presented the estimated required mpg levels in this final rule in terms of gallons per mile in Section IV.G, for the reader's reference.

Two commenters, CBD and ICCT, stated that the agencies should set a single footprint curve for both passenger cars and light trucks, to avoid manufacturers deliberately classifying their vehicles as light trucks in order to obtain a less stringent target.[1134] Ford, in contrast, commented in support of separate footprint curves for passenger cars and light trucks, providing the example of the different towing (and thus fuel economy) capabilities of the Ford Taurus (a passenger car) and the Ford Edge (a light truck) as a reason why targets should be different for cars and trucks even if they have the same footprint.[1135] NHTSA continues to interpret the clear statutory requirement that separate standards be set for passenger cars and for light trucks in each model year [1136] as indicating Congress' intent that the separate standards reflect the distinct capabilities of those fleets of vehicles, particularly given that NHTSA must balance the four statutory factors each time it determines maximum feasible average fuel economy.[1137] Given that requirement, if a consistent approach to balancing is taken for the separate passenger car and light truck fleets, then the agency believes that the passenger car and light truck standards in a given model year could only be identical (in terms of both the shape of the function and the given mpg values at each footprint target) if the capabilities of each fleet happened to be identical, which is highly unlikely given the differences between those fleets. To the extent that CBD and ICCT mean to comment on the related question of the classification of vehicles as passenger cars or light trucks, those issues will be addressed in Section IV.H below.

CBD also expressed concern that the fleet would not meet the required 35 mpg average in 2020 because the standards would encourage manufacturers to build larger passenger cars and light trucks, which would lower the overall achieved levels given the attribute-based nature of the standards.[1138] It is true that attribute-based standards do not, by themselves, guarantee that the industry will achieve a particular mpg level, but NHTSA disagrees that the proposed standards (and the final standards, which are identical to the proposal) create any incentive for manufacturers to essentially backslide as CBD suggests. The MY 2010 unadjusted composite fleet fuel economy, according to EPA, is a record high 28.3 miles per gallon.[1139] Market trends indicate that as fuel prices remain high and as manufacturers are providing more and more vehicle offerings with better fuel economy, consumers are responding by prioritizing fuel economy, and its associated cost savings, as a key purchase consideration.[1140] Even under the agency's analysis, which is based on market forecasts purchased in 2009 and 2011, and therefore may not fully incorporate the most recent trends, we currently estimate that manufacturers will achieve an average fleet fuel economy of 33.9–34.1 mpg by MY 2016, and of 39.9–40.8 mpg by MY 2020. We have also evaluated the extent to which we believe the target curves might incentivize vehicle upsizing beyond what the market could demand—see Section II.C and Chapter 2 of the joint TSD—and we continue to disagree that this is likely.

Moreover, NHTSA has the authority to revise CAFE standards at any time, up or down, given sufficient lead-time. If the market changes to the extent feared by CBD, it is well within NHTSA's authority to revise the standards to ensure that the 35 mpg fleetwide achieved levels occur—indeed, we believe that is what Congress intended. Thus, we disagree that the final standards would be likely to result in fleetwide average fuel economy levels that fall below the 35-in-2020 requirement.

CBD further commented that NHTSA's proposed truck standards did not increase ratably, because the targets for the largest light trucks remain the same for several years, and because the average increase in stringency for light trucks is ''a mere 0.6 mpg * * * per year from 2017 to 2020,'' and then ''jump[s] to 2.1 mpg in 2021, a near four-fold increase, and stays in a higher

[1129] 49 U.S.C. 32902(b)(2)(A).

[1130] 49 U.S.C. 32902(b)(2)(C).

[1131] 49 U.S.C. 32902(b)(3)(B).

[1132] SAFE, Docket No. NHTSA–2010–0131–0259, at 16–18.

[1133] 49 U.S.C. 32901(a)(10).

[1134] CBD, Docket No. NHTSA–2010–0131–0255, at 17; ICCT, Docket No. NHTSA–2010–0131–0258, at 50–51.

[1135] Ford, Docket No. NHTSA–2010–0131–0235, at 8.

[1136] 49 U.S.C. 32902(b)(1)(A) and (b)(1)(B); 32902(b)(2)(A), etc.

[1137] 49 U.S.C. 32902(g).

[1138] CBD, Docket No. NHTSA–2010–0131–0255, at 15.

[1139] ''Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2011,'' at iv. *Available at http://www.epa.gov/oms/cert/mpg/fetrends/2012/420r12001a.pdf* (last accessed July 11, 2012).

[1140] ''Fuel Economy, GHG, Other Emissions, and Alternative Fuels Consumer Education Program: Quantitative Survey Report,'' available at Docket No. NHTSA–2011–0126.

range for the remaining rulemaking period * * *.'' [1141] Because those increases did not meet the agency's definition of ratable as ''increases that are not disproportionately large or small in relation to each other,'' either temporally or between passenger cars and light trucks, CBD argued that NHTSA had failed to propose ratable standards.[1142] CBD mistakes the statutory requirement: EISA clearly states that standards must only increase ratably ''beginning with model year 2011 and ending with model year 2020.'' [1143] Thus, if the standards increase at different rates between 2017–2020 and 2021 and thereafter, as long as they are maximum feasible, there is no other statutory requirement with respect to the rate of their increase. NHTSA explained above that the agency interprets the requirement for ratable increases to mean that the annual increases should not be disproportionately large or small in relation to each other. NHTSA believes that the increases in light truck stringency from 2017–2020 are indeed ratable, increasing slowly but proportionately during those model years at rates between 0.2 and 0.6 mpg. It is also an inaccurate reading of the statute to focus on increases in target stringency for a particular subset of vehicles—the increases that must be ratable are increases in the *standards,* and the standards are corporate average requirements that apply to the fleet as a whole, not to particular subsets of the fleet, or even to every subset of the fleet. Moreover, the plain language of the statute indicates that the question of whether increases are ratable applies separately to cars and trucks—that is, the question is not whether increases in stringency for cars are ratable compared to increases in stringency for trucks, or vice versa, but only whether the increases in stringency for cars (or for trucks) are themselves ratable. 49 U.S.C. 32902(b)(2)(C) states that NHTSA ''shall prescribe annual fuel economy standard increases that increase the applicable average fuel economy standard ratably * * *.'' Average fuel economy standards are set separately for (are separately *applicable to*) passenger cars and light trucks. NHTSA therefore disagrees that Congress intended for the ratable requirement to apply between cars and trucks rather than within cars and within trucks separately.

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.

CBD commented that given the extended timeframe of the rulemaking, NHTSA *must* set technology forcing standards. CBD argued that standards set so far in advance could not reasonably be set based on technology already in use today or projected to be in use a few years from today, and that NHTSA is required to drive technology innovation and force manufacturers to invent new technologies.[1144] CBD further argued that uncertainty about future technologies is not an excuse for failing to set more technology-forcing standards, and the agency should ''assess those uncertainties within reasonable ranges, and include the clearly foreseeable impact of technological innovations rather than to disregard research-stage technology altogether,'' by assuming that technological innovation in the rulemaking timeframe will proceed at the same rate as it has in the past decade.[1145] NADA, in contrast, commented that technological feasibility directly relates to what manufacturers can accomplish and when they can accomplish it, and that the further in the future the standards are set, the less likely NHTSA is to have credible information to accurately predict technological feasibility.[1146] NADA therefore argued that setting standards too far in advance significantly increases the risk that they will turn out to be technologically infeasible.[1147]

NHTSA agrees with CBD that given the timeframe of the rulemaking, the technological feasibility factor may encourage the agency to look toward more technology-forcing standards, which could certainly be appropriate given EPCA's overarching purpose of energy conservation depending on the rulemaking. For example, in the analysis for this final rule, the agency is projecting that manufacturers could meet the standards by using research-stage high Brake Mean Effective Pressure engines across a significant portion of the fleet by MY 2021. At the same time, however, it would not be reasonable for the agency to predicate stringency on completely unforeseen future improvements in unknown technologies. It is important to remember that technological feasibility 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. NHTSA believes that this is what NADA refers to by arguing that setting the standards too far in advance could result in standards that are technologically infeasible, which we do not believe we have done in this rulemaking. 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. Moreover, as will be true for all of the factors, NHTSA will have the opportunity to revisit the technological feasibility of the augural MYs 2022–2025 standards in the future rulemaking concurrent with the mid-term evaluation.

[1141] *Id.,* at 10.

[1142] *Id.*

[1143] 49 U.S.C. 32902(b)(2)(C).

[1144] CBD, Docket No. NHTSA–2010–0131–0255, at 5.

[1145] CBD, Docket No. NHTSA–2010–0131–0255, at 20.

[1146] NADA, Docket No. NHTSA–2010–0131–0261, at 11.

[1147] *Id.*

(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.'' [1148] 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.[1149] 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.'' [1150] 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.'' [1151] 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 relative 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 were, 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 technologies 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, discussed in Section IV.F below, 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 Executive Orders 12866 and 13563.[1152]

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 impacts estimate; however, it is difficult to capture every such constraint. Therefore, it is well within the agency's discretion to deviate from the level at which modeled net benefits are maximized in the face of evidence of economic impracticability, and if the agency concludes that the level at which modeled net benefits are maximized 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 at the limits of economic practicability, and thus potentially the maximum feasible level, depending on the other factors to be balanced.

Comments varied on whether the proposed standards were at, or above or below, the limits of economic practicability. CBD suggested that the proposed standards were below the economically practicable levels, commenting that NHTSA had unduly focused on consumer choice in tentatively determining the proposed maximum feasible standards, and that the agency should not be seeking through its stringency determination to preserve the same mix of vehicles that are currently in the marketplace or the current mix of vehicle attributes available to consumers.[1153] CBD stated that the purpose of EPCA/EISA is to drive market forces ''toward the conservation of energy,'' and that instead, NHTSA had proposed standards ''that will create the market forces that drive increased production of the least energy efficient vehicles on our highways.'' [1154] CBD further argued that the fact that the rulemaking's benefits

[1148] 67 FR 77015, 77021 (Dec. 16, 2002).

[1149] *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).

[1150] *CEI–I,* 793 F.2d 1322, 1352 (D.C. Cir. 1986).

[1151] *Id.*

[1152] *See* 70 FR 51435 (Aug. 30, 2005); *CBD* v. *NHTSA,* 538 F.3d at 1197 (9th Cir. 2008).

[1153] CBD, Docket No. NHTSA–2010–0131–0255, at 4.

[1154] *Id.,* at 12–13.

''exceed its costs by hundreds of billions of dollars'' was evidence that NHTSA had ''left substantial, achievable fuel economy improvements and public benefits unrealized due to industry objections,'' which was contrary to EPCA/EISA.[1155]

Growth Energy (a biofuels company) and NADA, in contrast, argued that the standards may be beyond the limits of economic practicability. Growth Energy argued that the proposed standards' feasibility depended heavily on sales of grid-electricity-powered vehicles, the cost of which Growth Energy argued the agencies had underestimated.[1156] Given that the agencies had, in its view, underestimated the costs of implementing such a crucial technology, Growth Energy argued that NHTSA could not establish the economic practicability of the proposed standards. NADA argued more generally that while it was confident that manufacturers would be able to ''research, design, manufacture, and incorporate technologies and designs aimed to meet the proposed standards, serious questions exist regarding whether they will be able to do so in a cost effective or economically practicable manner.'' [1157] Therefore, NADA argued, given how many variables are involved with the reasonable modeling of economic practicability, such as fuel costs, materials costs, general economic conditions, interest rates, and so forth, standards should be set only for MYs 2017–2021, and not for MYs 2022–2025.

NHTSA agrees that many variables are involved in assessing economic practicability, and, as required by statute, is setting final standards only for MYs 2017–2021. That said, NHTSA does not believe that the consideration of consumer demand for fuel economy during the rulemaking timeframe leads, in any way, to the standards being below the maximum feasible level. As the Ninth Circuit has noted, NHTSA may consider consumer demand, as long as it does not ''rely on consumer demand to such an extent that it ignore[s] the overarching goal of energy conservation.'' [1158] As the D.C. Circuit has held, however, ''[a]t the other extreme, a standard with harsh economic consequences for the auto industry also would represent an unreasonable balancing of EPCA's policies.'' [1159] By the test of whether the standards conserve energy, there can be no question that they do: NHTSA estimates that the final standards for MYs 2017–2021 will save 65–67 billion gallons of fuel over the lifetimes of the vehicles subject to those standards, and when combined with the augural standards for MYs 2022–2025, that number rises to 169–171 billion gallons. This would be more than a decade's total petroleum imports from Venezuela, for example.[1160] By the test of whether more stringent standards would conserve more energy, our analysis suggests that they would, but they could only do so if manufacturers are able to sell the vehicles that they build to meet those higher standards. As discussed below in Section IV.F, NHTSA continues to believe that the evidence presented by manufacturers during the summer of 2011 warrants consideration in choosing the appropriate levels of the final standards. Therefore, the agency cannot reasonably avoid consideration of consumer demand as part of its analysis of economic practicability, and thus as part of its analysis of what standards will be maximum feasible.

NHTSA also notes that Growth Energy's comment is misplaced—grid-electricity-powered vehicles do not play such a significant role in the agency's analysis. In fact, our analysis assumes that in order to meet the standards, the industry as a whole need produce no grid-powered PHEVs or EVs in MY 2021, and only up to 3 percent in MY 2025. Moreover, NHTSA is statutorily prohibited from considering the fuel economy of dedicated alternative fuel vehicles like EVs in determining the maximum feasible levels of the standards, so manufacturers' ability to sell EVs is actually irrelevant to our determination of stringency. Thus, NHTSA disagrees that the standards are not economically practicable because they ''rely too heavily'' on PHEVs and EVs.

(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 [1161] 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.'' [1162] 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.[1163] EPCA did not permit NHTSA to amend those standards based on a finding that the maximum feasible level of average fuel economy for any of those three years was greater or less than the standard specified for that year. Instead, it provided that the agency could only reduce the standards and only on one basis: if the agency found that there had been a Federal standards fuel economy reduction, *i.e.,* a reduction in fuel economy due to changes in the Federal vehicle standards, *e.g.,* emissions and safety, relative to the year of enactment, 1975.

The ''other motor vehicle standards'' provision is broader than the Federal standards fuel economy reduction provision. Although the effects analyzed to date under the ''other motor vehicle standards'' provision have been negative, there could be circumstances in which the effects are positive. In the event that the agency encountered such

[1155] *Id.,* at 8.

[1156] Growth Energy, Docket No. EPA–HQ–OAR–2010–0799–9540, at 2.

[1157] NADA, Docket No. NHTSA–2010–0131–0261, at 11.

[1158] *CBD* v. *NHTSA,* 538 F.3d 1172, 1197 (9th Cir. 2008).

[1159] *Center for Auto Safety* v. *NHTSA,* 793 F.2d 1322, 1340 (D.C. Cir. 1986).

[1160] EIA indicates U.S. imports of Venezuelan crude oil and petroleum products averaged 912 thousand barrels per day in 2011. (Data obtained July 12, 2012 from *http://www.eia.gov/dnav/pet/pet_move_neti_dc_NUS-NVE_mbblpd_a.htm*).

[1161] 42 FR 63184, 63188 (Dec. 15, 1977). *See also* 42 FR 33534, 33537 (Jun. 30, 1977).

[1162] 42 FR 33534, 33537 (Jun. 30, 1977).

[1163] That provision was deleted as obsolete when EPCA was codified in 1994.

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.

NHTSA sought comment 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 Sierra Club commented in response, and stated that ''the process of joint standard setting with California and EPA carries out the Mass. v. EPA decision.'' [1164] Thus, NHTSA believes that further consideration of this issue is unnecessary.

(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.'' [1165] 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.

ii. Fuel Prices and the Value of Saving Fuel

Projected future fuel prices are a critical input into the economic analysis of alternative CAFE standards, because they determine the value of fuel savings both to new vehicle buyers and to society, 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) Annual Energy Outlook (AEO) 2012 Early Release for this analysis. Federal government agencies generally use EIA's projections in their assessments of future energy-related policies. A number of commenters discussed our use of the AEO in the proposal, generally stating that we should use a higher price forecast; these comments and NHTSA's response are discussed fully in Section IV.C.3 above.

iii. 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. A number of commenters raised the issue of petroleum consumption and import externalities; these comments and NHTSA's response are discussed fully in Section IV.C.3 above.

iv. 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 [1166] 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.[1167] 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. A number of commenters noted this point as well, and cited the agencies' estimates of the considerable GHG-reducing benefits of the proposed standards.

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,[1168] 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.'' [1169] In 1988, NHTSA included climate change concepts in its CAFE notices and prepared its first environmental assessment addressing that subject.[1170] 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.[1171] 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

[1164] Sierra Club *et al.,* Docket No. EPA–HQ–OAR–2010–0799–9549, at 10.

[1165] 42 FR 63184, 63188 (1977).

[1166] 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.

[1167] *See* Section IV.G below for NHTSA's evaluation of this effect.

[1168] *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).

[1169] 42 FR 63184, 63188 (Dec. 15, 1977).

[1170] 53 FR 33080, 33096 (Aug. 29, 1988).

[1171] 53 FR 39275, 39302 (Oct. 6, 1988).

the nation's need to conserve energy by reducing fuel consumption.

v. 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 established 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,[1172] but for purposes of today's final 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. A number of commenters raised issues related to the potential safety effects of the CAFE standards and on the agency's approach to mass reduction. More information on the approach to modeling manufacturer use of mass reduction is available in Chapter 3 of the Joint TSD and in Chapter V of the FRIA; and the estimated safety effects that may be due to the final MY 2017–2021 CAFE standards and augural MY 2022–2025 CAFE standards are described in Section II.G above and Section IV.G below.

vi. 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.[1173] 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. EPCA also provides that manufacturers can increase their CAFE levels through MY 2019 by producing dual-fueled 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 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 has therefore considered manufacturers' ability to increase the calculated fuel economy levels of their vehicles through A/C efficiency improvements, as finalized by EPA, in the presented CAFE stringency levels for passenger cars and light trucks for MYs 2017–2025. NHTSA similarly considers 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 did not believe that we could reasonably predict an average amount by which manufacturers will take advantage of this opportunity, the agencies did not include off-cycle credits in our stringency determination for the proposal. Since the proposal, the agencies have developed estimates for the cost and effectiveness of two off-cycle technologies, active aerodynamics and stop-start. For the final rule analysis, NHTSA assumed that these two technologies are available to manufacturers for compliance with the standards, similar to all of the other fuel economy-improving technologies that the analysis assumes are available. The costs and benefits of these technologies are included in the analysis, similar to all other available technologies, and NHTSA has consequently included the assessment of some amount of off-cycle credits in the determination of the maximum feasible standards.

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 standards at a higher level, if possible, by considering the fuel economy of dual-fueled automobiles as measured by EPA. The overarching purpose of EPCA is better served by

[1172] *See* 74 FR 14396–14407 (Mar. 30, 2009).

[1173] 49 U.S.C. 32902(h).

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) state 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 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 unreasonable 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, which are 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.

vii. Determining the Level of the Standards by Balancing the Factors

As discussed further below in Section IV.F, 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.'' [1174] 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 need to ensure that NHTSA's balancing supports the fundamental purpose of EPCA, energy conservation,[1175] as long as that balancing reasonably accommodates ''conflicting policies that were committed to the agency's care by the statute.'' [1176] The balancing of the factors in any given rulemaking depends highly 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.[1177] 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 a different balancing of those policies and concerns, to aid it in discerning the maximum feasible fuel economy levels. 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.

viii. 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.[1178] 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 proposed minimum standards for domestically-manufactured passenger cars in Section IV.E of the NPRM, but we also sought

[1174] *Center for Auto Safety* v. *NHTSA,* 793 F.2d 1322, 1341 (C.A.D.C. 1986).

[1175] *Center for Biological Diversity* v. *NHTSA,* 538 F.3d 1172, 1195 (9th Cir. 2008).

[1176] *CAS,* 1338 (quoting *Chevron U.S.A., Inc.* v. *Natural Resources Defense Council, Inc.,* 467 U.S. 837, 845).

[1177] *CBD* v. *NHTSA,* 538 F.3d 1172, 1198 (9th Cir. 2008).

[1178] 49 U.S.C. 32902(b)(4).

comment on whether to consider, for the final rule, the possibility of minimum standards for imported passenger cars and light trucks. NHTSA stated that although we were not proposing such standards, 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, Section IV.E presented illustrative levels of minimum standards for those other fleets.

In the MY 2011 final rule, having received 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.[1179]

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.[1180] 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.[1181]

NHTSA explained in the NPRM that the agency continued to believe that the risk of additional minimum standards imposing inequitable regulatory burdens on certain manufacturers is real, but at the same time, to 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 could be possible in the 2017–2025 time frame, particularly in the later years.

Thus, because the agency did not have sufficient information at the time of the NPRM regarding what tradeoffs might be associated with additional minimum standards, specifically, whether the risk of backsliding during MYs 2017–2025 sufficiently outweighed the possibility of imposing inequitable regulatory burdens on certain manufacturers, we sought comment in the NPRM on these issues but did not propose additional minimum standards. We also sought 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.

Industry commenters opposed the inclusion of additional backstop standards for imported passenger cars and for light trucks. The Alliance commented that it disagreed that NHTSA might have authority to adopt backstop standards for those other fleets, and argued that doing so would be inconsistent with the principle of attribute-based standards, because they could ''unduly limit[ ] consumer choice and hamper[ ] the industry's ability to achieve the goals of continuing the national program as cost-effectively as possible.'' [1182] While the Alliance agreed with NHTSA that future uncertainty could lead to market shifts, it maintained that the appropriate way to address such issues was through the future rulemaking to develop final standards for MYs 2022–2025, rather than through adding new regulatory requirements.[1183] Daimler [1184] and Toyota [1185] made similar arguments. The UAW neither opposed nor encouraged the adoption of additional backstop standards, but simply approved of what the agency had proposed as being consistent with EISA.

Environmental and consumer group commenters, on the other hand, strongly supported the inclusion of additional backstop standards for imported passenger cars and light trucks. CBD expressed concern that without a backstop, manufacturers would be encouraged by the footprint-based target curves to increase the size of their vehicles and would take advantage of numerous available flexibilities, and thus undermine the anticipated fuel economy and GHG gains estimated by the agencies.[1186] CBD further stated that the amount of lead time provided by the agencies in this rulemaking gave manufacturers ample time to adjust their fleets to obtain lower targets, and argued that *given* so much lead time, a backstop could not be unduly burdensome to industry, because industry would have ample time to adjust to the new requirements.[1187] CBD insisted that NHTSA determine whether or not to adopt a backstop based on 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 nation to conserve energy.[1188] The Sierra Club [1189] and NRDC expressed similar concerns; NRDC recommended that NHTSA ''adopt manufacturer-specific backstops on the combined car and light truck standards that that bar an individual automaker from exceeding its forecast * * * fuel economy levels by

[1179] 74 FR 14412 (Mar. 30, 2009).

[1180] 75 FR 25324, at 25368–70 (May 7, 2010).

[1181] *Id.* at 25369.

[1182] Alliance, at 87.

[1183] *Id.* at 87–88.

[1184] Daimler, at 21.

[1185] Toyota, at 6.

[1186] CBD, at 18–19.

[1187] *Id.*

[1188] *Id.,* citing *CBD* v. *NHTSA,* 538 F.3d at 1206.

[1189] Sierra Club, at 5–6.

approximately 0.5 mpg,'' allowing a manufacturer ''no more than three years to make up any exceedance in its manufacturer-specific backstop standard.'' [1190] UCS and Consumers Union, in contrast, suggested that a backstop include ''an automatic re-computation or 'ratchet' of stringencies for subsequent years,'' so that total anticipated oil savings are fully achieved in 2025 regardless of outcomes in earlier years.[1191] All of the commenters supporting additional backstop standards strongly urged NHTSA to revisit this question as part of its future rulemaking to develop final standards for MYs 2022–2025.

As proposed, the agency will not be establishing any additional backstop standards as part of this final rule. We continue to agree with the environmental and consumer group commenters that we have authority to adopt additional backstop standards if we deem it appropriate to do so. However, we also continue to conclude that insufficient time has passed in which manufacturers have been subject to the attribute-based standards to assess whether or not backstops would in fact help ensure that fuel savings anticipated by the agency at the time of the final rule are met, and even if they did, whether the benefits of that insurance outweigh potential impacts consumer choice that could occur by heading down the road that Congress rejected when it required CAFE standards to be attribute-based. If we determined that backstops for imported passenger cars and light trucks were necessary, it would be because consumers are choosing different (likely larger) vehicles in the future than the agencies assumed in this rulemaking analysis. Imposing additional backstop standards for those fleets would require manufacturers to build vehicles which the majority of consumers (under this scenario) would presumably not want. Vehicles that cannot be sold are the essence of economic impracticability, and vehicles that do not sell cannot save fuel or reduce emissions, because they are not on the roads, and thus do not meet the need of the nation to conserve fuel.

On the other hand, based on the assumptions underlying the analysis for this rulemaking, consumers will experience significant benefits as a result of buying the vehicles manufactured to meet these standards. We have no reason to expect that consumers will turn a blind eye to these benefits, and recent trends indicate that fuel economy is rising in importance as a factor in vehicle purchasing decisions. We thus conclude, for purposes of this final rule, that imposing additional backstop standards for imported passenger cars and light trucks would be premature. As stated in the NPRM, NHTSA will continue to monitor vehicle sales trends and manufacturers' response to the standards, and we will revisit this issue as part of the future rulemaking to develop final standards for MYs 2022–2025.

(2) Alternative standards for certain manufacturers

Because EPCA states that standards must be set for ''* * * automobiles manufactured by manufacturers,'' [1192] 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 the 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 sought comment in the NPRM on whether or how EPCA, as amended by EISA, could be interpreted to allow such alternate standards for certain parts of the industry.

Two commenters, Daimler and Volkswagen, requested that both NHTSA and EPA consider allowing manufacturers to meet an ''alternate stringency pathway'' for the passenger car standards. Both defined the alternate pathway in terms of a ''slower ramp-up'' in stringency, with lower increases in stringency in early years and higher increases in later years (which Volkswagen clarified would only occur ''should technology and market factors make this feasible'').[1193] The increases would lead manufacturers who chose this approach to meet the same rough mpg level in, for example, MY 2021 as the rest of the manufacturers in the passenger car fleet, but would provide additional flexibility through the less stringent requirements in the earlier model years,[1194] although that flexibility would presumably disappear as the standards grew tighter to make up for the slower start. Volkswagen suggested that this approach was similar to what the agencies had already proposed for the truck fleet in terms of stringency increases over time.[1195] Neither commenter provided legal analysis in response to the agency's request.

NHTSA continues to interpret EPCA, as amended by EISA, as directing the agency to set only one passenger car and one light truck standard for each model year that applies to the fleet as a whole, with the exception of the small volume manufacturer standards permitted by 49 U.S.C. 32902(d) and the minimum standard for domestically manufactured passenger cars required under 49 U.S.C. 32902(b)(4). While there have been instances in the past when NHTSA allowed multiple standards for light trucks to co-exist in a given model year, such as the ''flat'' and ''Reformed'' options for the MYs 2008–2010 light truck standards, or the different light truck standards for 2WD, 4WD, and captive import light trucks in MYs 1979–1981, NHTSA believes that those situations are distinguishable from the ''alternate pathway'' standards sought by Daimler and Volkswagen for several reasons.

First, when NHTSA previously allowed different classes of light trucks to meet different standards, or when NHTSA allowed different options for complying with light truck standards, we did that under statutory language that expressly authorized the agency to set multiple standards for light trucks if the agency deemed that appropriate.[1196] The EISA revisions removed that language, so it is not clear that Congress intended the agency to continue offering separate standards for different classes of light trucks, and even less clear that the agency would have authority to offer separate standards for different types of passenger cars, when we never had such authority to begin with. Moreover, the EISA revisions already added ways in which there can be multiple standards

[1190] NRDC, at 17.

[1191] UCS, at 8; Consumers Union, at 7.

[1192] 49 U.S.C. 32902(b)(1)(A) and (B).

[1193] Daimler, Docket No. EPA–HQ–OAR–2010–0799–9483, at 2, 4–5; Volkswagen, Docket No. NHTSA–2010–0131–0247, at 28.

[1194] *Id.*

[1195] Volkswagen, Docket No. NHTSA–2010–0131–0247, at 28.

[1196] Under EPCA prior to the EISA revisions, 49 U.S.C. 32902(a) expressly stated that separate standards could be prescribed for different classes of non-passenger automobiles.

for passenger cars in a given model year: there is the backstop standard of 32902(b)(4) for domestically-manufactured passenger cars,[1197] and there is the exemption provision of 32902(d) for low-volume manufacturers. The latter is the provision that speaks most clearly to this question of whether Congress has considered the possibility of multiple standards being ''maximum feasible'' for the passenger car fleet—NHTSA has the authority to set alternate ''maximum feasible'' standards for passenger cars, but only for manufacturers producing fewer than 10,000 cars in a model year.

Second, the fact patterns under which NHTSA previously set multiple standards for a compliance category in the same model year are different from the fact pattern presented in the current rulemaking for the ''alternate pathway'' standards. In the most recent example, the MYs 2008–2011 rulemaking, NHTSA was changing both the structure of CAFE standards (from the flat MY 2007 standard to the attribute-based MY 2011 standard) and changing the technical approach to determining maximum feasible stringency (from a ''stage analysis''/''least-capable'' approach in MY 2007 to an industry-wide net benefit maximizing approach in MY 2011). To manage this change, the ''flat'' and ''reformed'' light truck standards co-existing during MYs 2008–2010 were set with reference to each other: specifically, the agency first used the ''stage analysis'' approach to determine the maximum feasible ''flat'' standard in each model year, and then used the CAFE model to set the stringency of the ''reformed'' standard in each model year at a level producing approximately the same level of cost to the industry as a whole. After this transition period, the MY 2011 standard was promulgated as a single attribute-based standard, the stringency of which was set at a level estimated to maximize net benefits to society. This cost equalization between the two sets of standards established for MYs 2008–2010 helped ensure that the reformed standards would be feasible for the industry as a whole, and was intended to avoid a situation in which one form of the standards would be so much easier to meet than the other that all manufacturers would choose that form and not gain experience with the other. Both sets of standards, thus, were designed to require a similar ''lift'' from the industry as a whole in any given model year. The fact pattern for the ''alternate pathway'' would be designed to require exactly the opposite: the ''alternate pathway'' standards would be much easier in some years, and much more difficult in others, than the ''main pathway'' standards. EPCA/EISA expressly requires that standards must be maximum feasible in each separate model year. Based on the suggestions from Daimler and Volkswagen, there is no indication that the ''main pathway'' and ''alternate pathway'' standards would be similar in any given year in terms of costs, technology required, fuel saved, or any other metric that NHTSA considers for determining maximum feasible. It is difficult to see how two completely different standards can both be maximum feasible for the industry as a whole in the same model year.

And finally, NHTSA did not suggest in the NPRM that it might be considering setting multiple ''maximum feasible'' passenger car standards for MYs 2017–2021, and nothing in NHTSA's past practice[1198] suggests that this might be something the agency would consider in the CAFE context, particularly for passenger car standards. Since first promulgating attribute-based CAFE standards, NHTSA has interpreted the maximum feasible requirement as no longer requiring a ''least capable manufacturer'' approach, and the proposed standards were consistent with that interpretation by being maximum feasible for the industry as a whole, if not necessarily feasible for every manufacturer in every model year. EPCA/EISA expressly provides a solution for the manufacturers who cannot meet the main standards in the civil penalty provisions of § 32912. If NHTSA had to account for the traditional fine payers in determining the maximum feasible standards, we would fundamentally be precluded from pushing the rest of the industry as far as we thought it could go. The NPRM was based on this interpretation, as is the final rule, and the analysis supporting both rulemaking documents accounted for it.

For these reasons, NHTSA is not finalizing the ''alternate pathway'' approach requested by the commenters. If commenters wish to pursue this issue again in the future rulemaking to develop final standards for MYs 2022–2025, NHTSA again requests that they provide legal analysis of EPCA/EISA in support of their position.

2. Administrative Procedure Act

To be upheld under the ''arbitrary and capricious'' standard of judicial review in the APA, an agency rule must be rational, based on consideration of the relevant factors, and within the scope of the authority delegated to the agency by the statute. The agency must examine the relevant data and articulate a satisfactory explanation for its action including a ''rational connection between the facts found and the choice made.'' *Burlington Truck Lines, Inc.* v. *United States,* 371 U.S. 156, 168 (1962).

Statutory interpretations included in an agency's rule are subjected to the two-step analysis of *Chevron, U.S.A., Inc.* v. *Natural Resources Defense Council,* 467 U.S. 837, 104 S.Ct. 2778, 81 L.Ed.2d 694 (1984). Under step one, where a statute ''has directly spoken to the precise question at issue,'' *id.* at 842, 104 S.Ct. 2778, the court and the agency ''must give effect to the unambiguously expressed intent of Congress,'' *id.* at 843, 104 S.Ct. 2778. If the statute is silent or ambiguous regarding the specific question, the court proceeds to step two and asks ''whether the agency's answer is based on a permissible construction of the statute.'' *Id.*

If an agency's interpretation differs from the one that it has previously adopted, the agency need not demonstrate that the prior position was wrong or even less desirable. Rather, the agency would need only to demonstrate that its *new* position is consistent with the statute and supported by the record, and acknowledge that this is a departure from past positions. The Supreme Court emphasized this recently in *FCC* v. *Fox Television,* 129 S.Ct. 1800 (2009). When an agency changes course from earlier regulations, ''the requirement that an agency provide a 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.''[1199] The APA also requires

[1197] We note that taking the ''doesn't say we can't'' approach with backstop authority (*i.e.,* that just because Congress established a backstop requirement for domestic cars doesn't mean we can't also create backstop standards for import cars and light trucks) is different from taking the same approach with multiple standards being maximum feasible for the same fleet in a single model year. Having additional backstops for other fleets does not defeat the purpose of the Congressionally-required backstop. Having multiple standards be simultaneously ''maximum feasible'' for passenger cars seems to defeat the purpose of ''maximum,'' which is inherently singular.

[1198] Having allowed multiple light truck CAFE standards and having allowed alternate phase-ins for safety standards would not be sufficient indication that NHTSA might suddenly be considering multiple passenger car CAFE standards.

[1199] *Ibid.,* 1181.

that agencies provide notice and comment to the public when proposing regulations,[1200] as we did in the NPRM.

3. National Environmental Policy Act

As discussed above, EPCA requires the agency to determine the level at which to set 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. The National Environmental Policy Act (NEPA) directs that environmental considerations be integrated into that process.[1201] 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 of the agency's action in depth, NHTSA has prepared a Final Environmental Impact Statement (''Final 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 545, 557 (2nd Cir. 2003). 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.

This final rule contains the Record of Decision (ROD) for NHTSA's rulemaking action, pursuant to NEPA and the Council on Environmental Quality's (CEQ) implementing regulations, in Section IV.J.[1202] *See* 40 CFR § 1505.2. The ROD explains NHTSA's decision and the considerations relevant to NHTSA's decision, including the information contained in the Final EIS. *Id.*

E. What are the CAFE standards?

1. Form of the Standards

Each of the CAFE standards that NHTSA is promulgating 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.[1203]

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:

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

Equation IV-1 NHTSA Passenger Car Fuel Economy Target Calculation

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 establishing, 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 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 final standards for passenger cars are, therefore, specified by the four coefficients defining fuel economy targets:

a = upper limit (mpg)

[1200] 5 U.S.C. 553.

[1201] NEPA is codified at 42 U.S.C. §§ 4321–47.

[1202] CEQ NEPA implementing regulations are codified at 40 Code of Federal Regulations (CFR) Parts 1500–08.

[1203] Required CAFE levels shown here are estimated required levels based on NHTSA's current projection of manufacturers' vehicle fleets in MYs 2017–2025, given the MY 2008-based and MY 2010-based market forecasts. 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 promulgated today.

b = lower limit (mpg)
c = slope (gallon per mile per square foot)
d = intercept (gallon per mile)

For light trucks, NHTSA is defining 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:

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

Equation IV-3 NHTSA Light Truck Fuel Economy Target Calculation

The final 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 establishing CAFE standards for MYs 2017–2021 and presenting augural standards for MYs 2022–2025 defined by the following coefficients:

TABLE IV–16—NHTSA COEFFICIENTS DEFINING FINAL 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

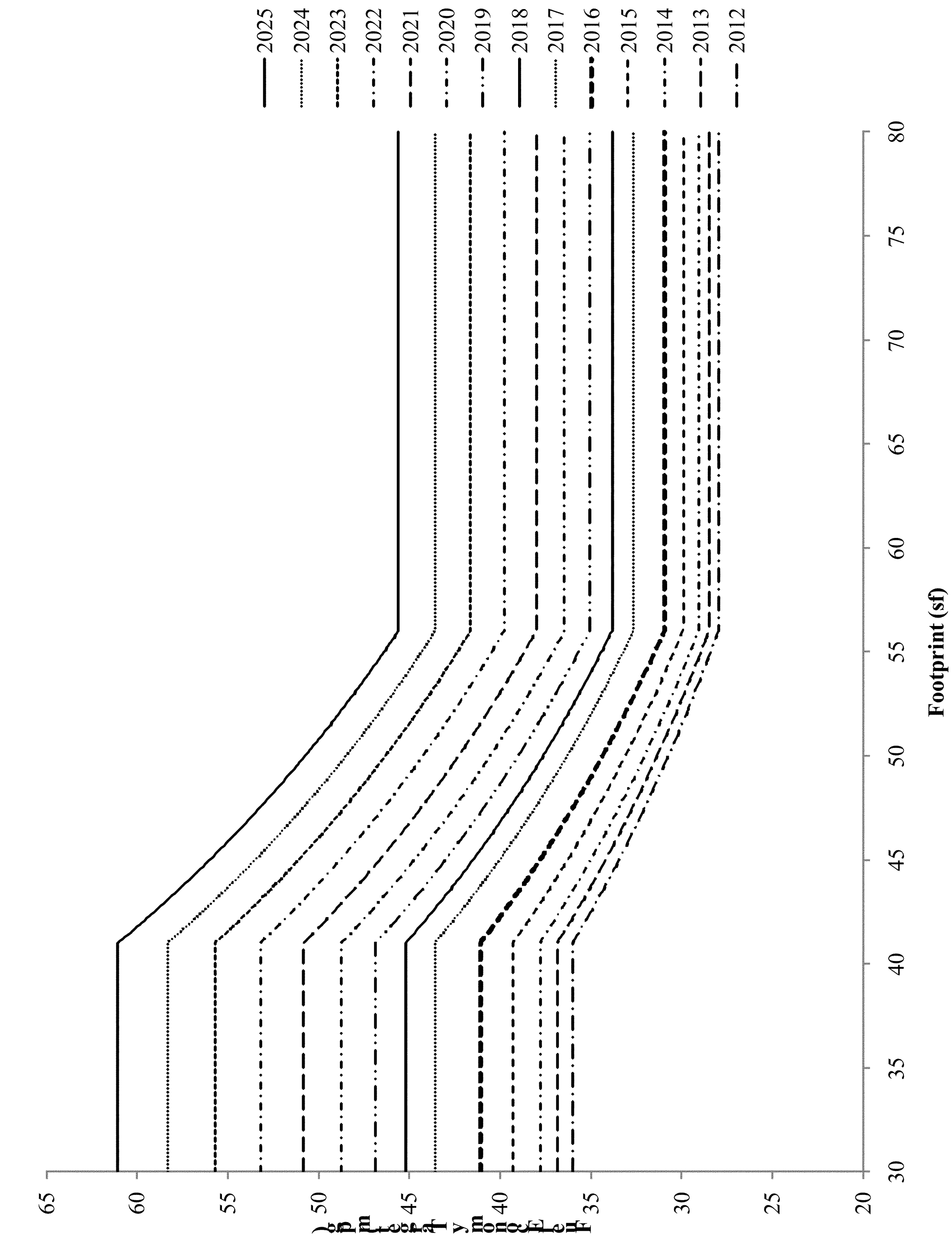
For reference, the coefficients defining the MYs 2012–2016 passenger car standards are also provided below:

TABLE IV–17—NHTSA COEFFICIENTS DEFINING FINAL MYS 2012–2016 FUEL ECONOMY TARGETS FOR PASSENGER CARS

Coefficient	2012	2013	2014	2015	2016
a (mpg)	35.95	36.80	37.75	39.24	41.09
b (mpg)	27.95	28.46	29.03	29.90	30.96
c (gpm/sf)	0.0005308	0.0005308	0.0005308	0.0005308	0.0005308
d (gpm)	0.0060507	0.005410	0.004725	0.003719	0.002573

Section II.C above and Chapter 2 of the Joint TSD discusses how the coefficients in Table IV–16 were developed for this final rule. The 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.

Figure 0-1 NHTSA 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 forecasts of future sales that NHTSA has used to examine today's final and augural 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).[1204] This table has changed since the NPRM in that it now shows the estimated required levels starting from both the MY 2008-based market forecast and the MY 2010-based market forecast, as follows:

[1204] 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 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 estimates that the average required fuel economy level for passenger cars will be 38.2–38.7 mpg in MY 2016.

TABLE IV–18—NHTSA ESTIMATED AVERAGE FUEL ECONOMY REQUIRED UNDER FINAL MY 2016 AND FINAL AND AUGURAL MYS 2017–2025 CAFE STANDARDS FOR PASSENGER CARS

	MY baseline	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Aston Martin	2008	39.0–	40.5–	41.9–	43.5–	45.2–	47.2–	49.4–	51.7–	54.1–	56.6–
	2010	37.4	38.8	40.2	41.6	43.3	45.1	47.3	49.5	51.8	54.2
BMW	2008	38.0–	39.4–	40.9–	42.4–	44.1–	46.0–	48.1–	50.4–	52.7–	55.2–
	2010	37.9	39.4	40.8	42.3	43.9	45.8	47.9	50.1	52.5	55.0
Daimler	2008	37.3–	38.6–	39.9–	41.4–	43.0–	44.9–	47.0–	49.2–	51.4–	53.9–
	2010	36.7	38.0	39.4	40.9	42.5	44.3	46.4	48.5	50.9	53.2
Fiat	2008	37.3–	39.1–	40.6–	42.1–	43.7–	45.7–	47.9–	50.2–	52.6–	55.1–
	2010	37.3	38.7	39.9	41.4	43.0	44.9	47.0	49.2	51.6	54.0
Ford	2008	37.9–	39.1–	40.6–	42.1–	43.7–	45.6–	47.7–	49.9–	52.3–	54.7–
	2010	38.1	39.5	41.0	42.5	44.1	46.0	48.2	50.4	52.8	55.3
Geely	2008	37.4–	38.8–	40.3–	41.7–	43.4–	45.3–	47.4–	49.6–	51.9–	54.4–
	2010	38.7	40.1	41.5	43.0	44.7	46.6	48.7	50.9	53.3	55.8
General Motors	2008	37.9–	39.6–	41.1–	42.6–	44.3–	46.2–	48.4–	50.7–	53.1–	55.6–
	2010	37.9	39.3	40.8	42.2	43.9	45.7	47.9	50.1	52.5	54.9
Honda	2008	38.9–	40.4–	41.9–	43.4–	45.2–	47.1–	49.3–	51.6–	54.0–	56.6–
	2010	38.2	39.7	41.1	42.6	44.2	46.1	48.3	50.5	52.9	55.4
Hyundai	2008	39.0–	40.4–	41.9–	43.4–	45.2–	47.1–	49.3–	51.6–	54.1–	56.6–
	2010	38.3	39.8	41.3	42.7	44.5	46.4	48.6	50.8	53.2	55.7
Kia	2008	39.9–	41.1–	42.6–	44.2–	46.0–	48.0–	50.3–	52.6–	55.1–	57.7–
	2010	39.4	40.8	42.3	43.8	45.6	47.5	49.8	52.1	54.5	57.1
Lotus	2008	42.0–	43.6–	45.2–	46.9–	48.7–	50.8–	53.2–	55.7–	58.3–	61.1–
	2010	40.3	41.8	43.3	44.9	46.7	48.7	51.0	53.4	55.9	58.5
Mazda	2008	39.9–	41.5–	43.0–	44.5–	46.3–	48.3–	50.6–	53.0–	55.5–	58.1–
	2010	38.7	40.1	41.6	43.0	44.7	46.6	48.8	51.1	53.5	56.0
Mitsubishi	2008	38.9–	40.5–	42.0–	43.6–	45.3–	47.3–	49.5–	51.8–	54.2–	56.8–
	2010	40.3	41.8	43.3	44.9	46.7	48.7	51.0	53.4	55.9	58.6
Nissan	2008	38.4–	39.8–	41.2–	42.8–	44.4–	46.3–	48.5–	50.7–	53.1–	55.6–
	2010	38.2	39.6	41.0	42.5	44.2	46.0	48.2	50.4	52.8	55.2
Porsche	2008	42.0–	43.6–	45.2–	46.9–	48.7–	50.8–	53.2–	55.7–	58.3–	61.1–
	2010	37.6	39.1	40.5	42.0	43.6	45.4	47.5	49.7	52.1	54.5
Spyker/Saab	2008	39.6–	41.1–	42.6–	44.2–	46.0–	47.9–	50.2–	52.5–	55.0–	57.6–
	2010	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0
Subaru	2008	41.1–	42.6–	44.2–	45.8–	47.6–	49.7–	52.0–	54.4–	57.0–	59.6–
	2010	39.6	41.1	42.6	44.1	45.8	47.7	49.9	52.2	54.7	57.2
Suzuki	2008	41.7–	43.3–	44.9–	46.5–	48.4–	50.5–	52.8–	55.3–	57.9–	60.6–
	2010	40.6	42.1	43.6	45.2	46.9	48.9	51.2	53.6	56.1	58.7
Tata	2008	35.6–	36.9–	38.3–	39.7–	41.2–	43.0–	45.0–	47.1–	49.3–	51.7–
	2010	36.0	37.4	38.8	40.4	41.9	43.8	45.9	48.0	50.3	52.7
Tesla	2008	42.0–	43.6–	45.2–	46.9–	48.7–	50.8–	53.2–	55.7–	58.3–	61.1–
	2010	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0 ...	0.0
Toyota	2008	39.2–	40.6–	42.1–	43.7–	45.4–	47.4–	49.6–	51.9–	54.3–	56.9–
	2010	38.3	39.7	41.2	42.7	44.3	46.2	48.4	50.7	53.0	55.5
Volkswagen	2008	39.9–	41.4–	43.0–	44.5–	46.3–	48.3–	50.6–	52.9–	55.4–	58.0–
	2010	39.0	40.5	41.9	43.5	45.2	47.1	49.3	51.6	54.1	56.6
Average	2008	38.7–	40.1–	41.6–	43.1–	44.8–	46.8–	49.0–	51.2–	53.6–	56.2–
	2010	38.2	39.6	41.1	42.5	44.2	46.1	48.2	50.5	52.9	55.3

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.

3. Minimum Domestic Passenger Car Standards

EISA expressly requires each manufacturer to meet a minimum flat 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 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 lead-time involved and the necessity of a new rulemaking to develop and establish the MYs 2022–2025 standards. We sought comment in the NPRM 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 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. While NHTSA received a number of comments on the topic of ''backstops'' generally, no commenters addressed this particular question. We are therefore finalizing the approach proposed, but we will continue to monitor this issue going forward to assess whether the difference between the final required passenger car standards and the minimum standards promulgated today grows over time.

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). No comments were received on this position as stated in the NPRM, and NHTSA continues to believe that this interpretation is appropriate for the final rule.

The determination of the minimum domestic passenger car standard is complicated somewhat in this final rule by the fact that the 92 percent calculation depends on the agency's assessment of the estimated required passenger car mpg level in a given model year—with two baseline market forecasts, the estimated required mpg levels are presented throughout this document as a range. The minimum domestic passenger car standard, however, must be a single mpg level. Given the uncertainty associated with the baseline market forecasts that led the agencies to use both for the final rule analysis, the agency concluded that it would be reasonable to determine 92 percent of the estimated required level in each year under both the MY 2008-based market forecast and the MY 2010-based market forecast, and average the two. Table IV–19 below shows the 92 percent mpg levels for both forecasts:

TABLE IV–19—NHTSA VALUES FOR 92 PERCENT OF THE ESTIMATED REQUIRED MYS 2017–2025 MPG LEVELS FOR PASSENGER CARS UNDER BOTH MARKET FORECASTS

	2017	2018	2019	2020	2021	2022	2023	2024	2025
MY 2008	36.9	38.3	39.7	41.2	43.0	45.0	47.1	49.4	51.7
MY 2010	36.4	37.8	39.1	40.6	42.4	44.4	46.4	48.6	50.9

The final minimum standards for domestically manufactured passenger cars for MYs 2017–2021 and the augural standards for MYs 2022–2025 (and, for comparison, the final MY 2016 minimum domestic passenger car standard) are presented below in Table IV–20.

TABLE IV–20—NHTSA ESTIMATED MINIMUM STANDARD FOR DOMESTICALLY MANUFACTURED PASSENGER CARS UNDER FINAL MY 2016 AND FINAL AND AUGURAL MYS 2017–2025 CAFE STANDARDS FOR PASSENGER CARS

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
34.7	36.7	38.0	39.4	40.9	42.7	44.7	46.8	49.0	51.3

As discussed in Section IV.D, NHTSA also sought comment on whether to consider, for the final rule, the possibility of minimum standards for imported passenger cars and light trucks. Although we did not propose such standards, we explored this concept again in the NPRM in light of 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, which we explained might make such minimum standards relevant to help ensure that currently-expected fuel economy improvements occur during that time frame. Comments received on this question were decidedly mixed; NHTSA's full discussion of this issue is presented in Section IV.D. In summary, NHTSA believes it is likely most prudent to wait until we are able to observe potential market changes during the implementation of the MYs 2012–2016 standards and to 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 a part of the future rulemaking concurrent with the mid-term evaluation, and potentially revised at that time.

4. Light Truck Standards

For light trucks, NHTSA is promulgating final CAFE standards for MYs 2017–2021 and presenting augural standards for MYs 2022–2025 defined by the following coefficients:

TABLE IV–21—NHTSA COEFFICIENTS DEFINING FINAL AND AUGURAL 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

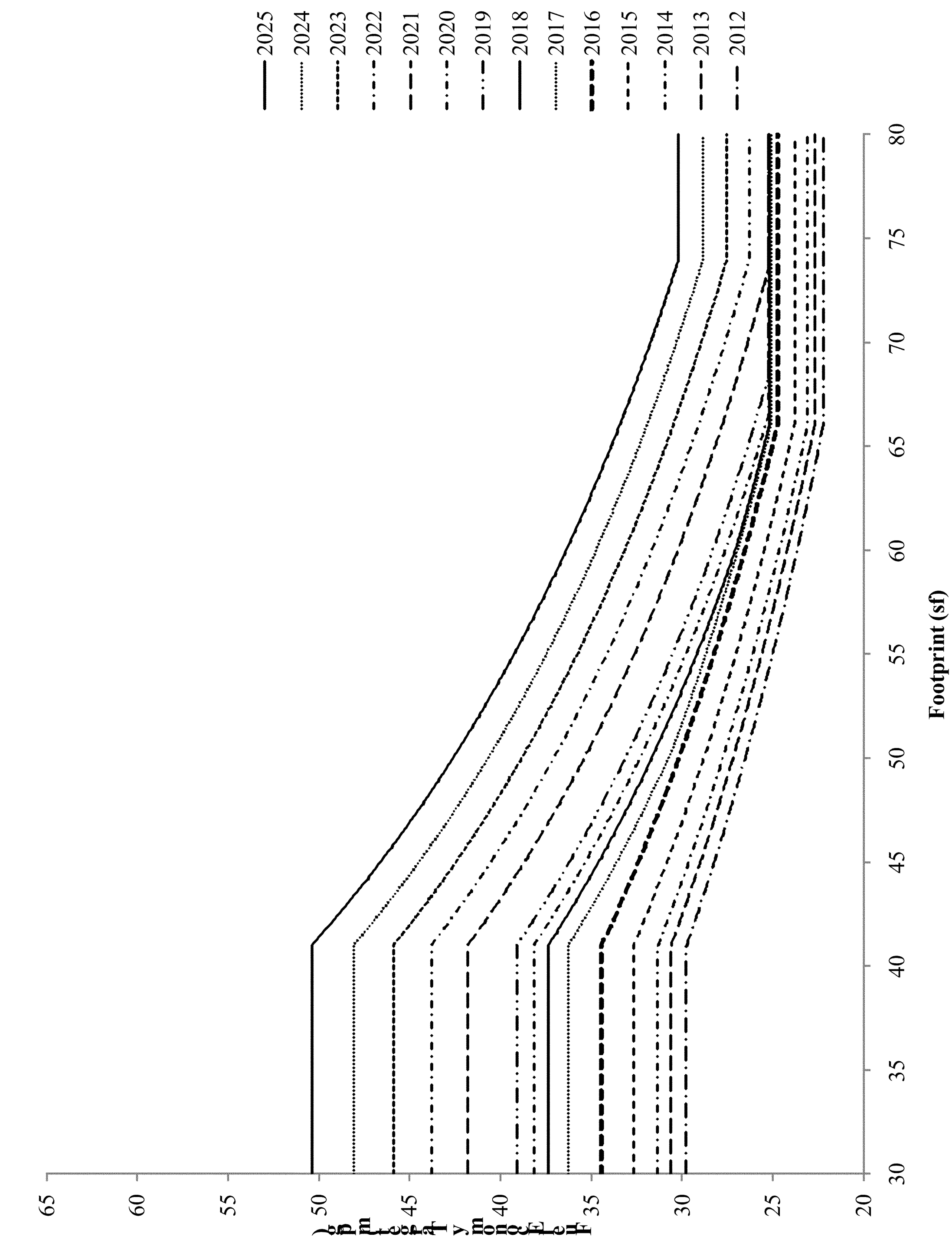
For reference, the coefficients defining the MYs 2012–2016 light truck standards (which did not include a "floor" term, defined by coefficients *e, f, g,* and *h*) are also provided below:

TABLE IV–22—NHTSA COEFFICIENTS DEFINING FINAL MYS 2012–2016 FUEL ECONOMY TARGETS FOR LIGHT TRUCKS

Coefficient	2012	2013	2014	2015	2016
a (mpg)	29.82	30.67	31.38	32.72	34.42
b (mpg)	22.27	22.74	23.13	23.85	24.74
c (gpm/sf)	0.0004546	0.0004546	0.0004546	0.0004546	0.0004546
d (gpm)	0.014900	0.013968	0.013225	0.011920	0.010413

The 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-3 NHTSA Fuel Economy Targets for MYs 2012–2016 and 2017–2025 Light Trucks



Again, given these targets, the CAFE levels required of individual manufacturers will depend on the mix of vehicles they produce for sale in the United States. Based on the market forecasts that NHTSA has used to examine today's final and augural 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 shown for comparison).[1205] This table has changed since the NPRM in that it now shows the estimated required levels starting from both the MY 2008-based market forecast and the MY 2010-based market forecast, as follows:

[1205] 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 forecasts of the MY 2016 light truck market, NHTSA estimates that the required fuel economy levels will average 28.9–29.2 mpg in MY 2016. 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—NHTSA ESTIMATED AVERAGE FUEL ECONOMY REQUIRED UNDER FINAL MY 2016 AND FINAL AND AUGURAL MYS 2017–2025 CAFE STANDARDS FOR LIGHT TRUCKS

	MY baseline	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Aston Martin	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BMW	2008	30.7–	30.6–	31.4–	32.1–	32.9–	35.1–	36.7–	38.4–	40.2–	42.1–
	2010	31.0	31.2	32.0	32.7	33.5	35.8	37.5	39.3	41.1	43.1
Daimler	2008	29.5–	29.1–	29.6–	30.2–	30.9–	32.9–	34.5–	36.1–	37.8–	39.5–
	2010	30.0	30.1	30.8	31.4	32.2	34.4	36.0	37.7	39.5	41.4
Fiat	2008	29.4–	29.6–	30.2–	30.8–	31.5–	33.7–	35.3–	37.0–	38.8–	40.6–
	2010	29.5	29.6	30.2	30.7	31.5	33.6	35.2	36.9	38.6	40.4
Ford	2008	28.5–	28.6–	29.1–	29.6–	30.0–	32.0–	33.5–	35.2–	37.0–	38.8–
	2010	27.3	27.5	27.8	28.0	28.4	30.2	31.7	33.1	34.7	36.4
Geely	2008	31.0–	31.1–	32.1–	32.7–	33.5–	35.8–	37.5–	39.3–	41.2–	43.1–
	2010	31.2	31.4	32.4	33.0	33.9	36.2	37.9	39.7	41.6	43.6
General Motors	2008	27.7–	28.0–	28.5–	29.1–	29.6–	31.7–	33.2–	34.9–	36.6–	38.4–
	2010	27.7	27.8	28.1	28.6	29.2	31.2	32.8	34.3	36.0	37.8
Honda	2008	30.9–	31.0–	31.7–	32.3–	33.1–	35.4–	37.0–	38.8 –	40.7–	42.6–
	2010	30.2	30.4	31.1	31.7	32.5	34.7	36.4	38.1	39.9	41.8
Hyundai	2008	31.2–	31.3–	32.1–	32.8–	33.6–	35.9–	37.6–	39.4–	41.3–	43.2–
	2010	31.7	32.1	33.0	33.7	34.6	36.9	38.7	40.5	42.5	44.5
Kia	2008	30.0–	30.0–	30.6–	31.2–	32.0–	34.2–	35.8–	37.5–	39.3–	41.1–
	2010	30.1	30.3	31.0	31.7	32.5	34.8	36.5	38.3	40.1	42.1
Lotus	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mazda	2008	31.7–	31.4–	32.4–	33.1–	33.8–	35.9–	37.6–	39.3–	41.2–	43.2–
	2010	31.3	31.6	32.5	33.1	33.9	36.2	38.0	39.8	41.7	43.6
Mitsubishi	2008	32.5–	32.9–	33.9–	34.6–	35.5–	37.9–	39.7–	41.6–	43.6–	45.7–
	2010	33.4	34.1	35.1	35.9	36.7	39.3	41.1	43.1	45.2	47.3
Nissan	2008	29.4–	29.6–	30.3–	30.9–	31.6–	33.5–	35.1–	36.8–	38.7–	40.6–
	2010	29.4	29.6	30.1	30.5	31.1	33.1	34.6	36.2	37.9	39.7
Porsche	2008	30.3–	30.3–	31.2–	31.8–	32.6–	34.8–	36.5–	38.2–	40.0–	41.9–
	2010	30.2	30.3	31.1	31.8	32.6	34.8	36.4	38.2	40.0	41.9
Spyker/Saab	2008	31.1–	31.2–	32.1–	32.8–	33.6–	35.9–	37.6–	39.4–	41.3–	43.3–
	2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subaru	2008	33.7–	34.4–	35.4–	36.1–	37.1–	39.6–	41.5–	43.5–	45.5–	47.7–
	2010	34.0	34.9	35.9	36.7	37.6	40.2	42.1	44.1	46.2	48.4
Suzuki	2008	31.9–	32.2–	33.2–	33.9–	34.7–	37.1–	38.9–	40.7–	42.7–	44.7–
	2010	33.5	34.2	35.2	36.0	36.9	39.4	41.3	43.3	45.3	47.5
Tata	2008	31.8–	32.1–	33.1–	33.8–	34.6–	37.0–	38.8–	40.6–	42.6–	44.6–
	2010	31.4	31.6	32.5	33.2	34.0	36.3	38.1	39.9	41.8	43.8
Tesla	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toyota	2008	29.5–	29.7–	30.4–	31.0–	31.6–	33.7–	35.3–	37.0–	38.9–	40.7–
	2010	29.2	29.4	30.0	30.5	31.1	32.9	34.4	36.1	37.8	39.6
Volkswagen	2008	29.7–	29.5–	30.1–	30.8–	31.5–	33.5–	35.1–	36.7–	38.5–	40.3–
	2010	30.7	30.9	31.7	32.4	33.2	35.4	37.1	38.9	40.8	42.7
Average	2008	29.2–	29.4–	30.0–	30.6–	31.2–	33.3–	34.9–	36.6–	38.5–	40.3–
	2010	28.9	29.1	29.6	30.0	30.6	32.6	34.2	35.8	37.5	39.3

As discussed above with respect to the estimated final 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.

F. How do the final standards fulfill NHTSA's statutory obligations?

1. Overview

The discussion that follows is necessarily complex, but the central points are straightforward. NHTSA has concluded that the standards presented above in Section IV.E are the maximum feasible standards for passenger cars and light trucks in MYs 2017–2021. EPCA/EISA requires NHTSA to consider four statutory factors in determining the maximum feasible CAFE standards in a rulemaking: specifically, technological 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 final standards,[1206] and some are less

[1206] We recognize that more stringent 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 do not believe 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

Continued

stringent.[1207] As the discussion below explains, we 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. 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 $137–192 billion over the lifetime of the vehicles covered by the final standards for MYs 2017–2021.[1208] In full consideration of all of the information currently before the agency, we have weighed the statutory factors carefully and selected final passenger car and light truck standards that we believe are the maximum feasible for MYs 2017–2021. We have also conducted a similar analysis for the augural standards presented for MYs 2022–2025, which represent the agency's best estimate of what standards would be maximum feasible, based on the information currently before us, had we the authority to set standards for 9 model years at a time.

2. 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 prepared an EIS to inform its development and consideration of the final standards. The agency has evaluated the environmental impacts of a range of regulatory alternatives in the Final EIS and this final rule, 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 those 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 concludes that the final standards would satisfy this requirement. NHTSA has carefully examined the relevant data and other considerations, as discussed below in the explanation of our conclusion that the final standards are the maximum feasible levels for MYs 2017–2021 based on our evaluation of the information before us for this final rule.

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.[1209] NHTSA has developed definitions for these terms over the course of multiple CAFE rulemakings [1210] and determines the appropriate weight and balancing of the terms given the circumstances in each CAFE rulemaking.[1211] 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 briefly how the agency balanced the factors for the proposal, and why we tentatively concluded at that time that the proposed standards were the maximum feasible; the following section discusses the comments received on that tentative conclusion; and the final section discusses how the agency balanced the factors for this final rule and why the agency believes that the final standards are, indeed, maximum feasible.

3. How did the agency balance the factors for the NPRM?

In the NPRM, the agency explained that there are numerous ways in which the relevant factors can be balanced to determine what standards would be maximum feasible, depending on the information and the policy priorities before the agency at the time. We explained that standards that may meet the objectives of one factor, such as technological feasibility, may not meet the objectives of other factors, such as economic practicability, and may thus not be maximum feasible. We discussed the preliminary analysis conducted following the first SNOI and prior to the second SNOI—thus, between the end of 2010 and July 2011, 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, but that the alternatives including up to 4% per year for cars and 4% per year for trucks should reasonably remain under consideration. We further discussed the intensive discussions 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. Manufacturer stakeholders provided

the conclusion reached in the MY 2012–2016 analysis.

[1207] We also recognize that less stringent 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.

[1208] This range represents the agency's estimates of monetized net benefits under both a 3% and a 7% discount rate. For purposes of monetized net benefits associated with both the final and augural standards (MYs 2017–2025, aggregated), the range becomes $372–507 billion, under both a 3% and a 7% discount rate.

[1209] 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.

[1210] These factors are defined in Section IV.D; for brevity, we do not repeat those definitions here.

[1211] *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).

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.[1212]

Regarding passenger cars, in meetings prior to the NPRM, 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 new technologies quickly enough to achieve the required levels, based on the following considerations: 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.

Most manufacturers expressed significantly greater concerns over the 4% alternative for light trucks than for passenger cars. Many 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 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[1213] 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. 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. 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 than in 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.

Prior to the NPRM, other stakeholders, such as environmental and consumer groups, consistently stated that stringent standards are technologically 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.

We thus explained in the NPRM that, in collaboration with EPA and in coordination with CARB, NHTSA carefully considered the inputs received from all stakeholders, conducted additional independent analyses, and deliberated over the feedback received on the agencies' analyses. Based on our own analysis of manufacturers' capabilities and based on that feedback, particularly as it concerned consumer acceptance of some advanced technologies and consumers' willingness to pay for improved fuel economy, we tentatively concluded 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 MYs 2017–2021, so the agency tentatively concluded 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 MYs 2017–2025 period, the maximum feasible stringency curves increase on average at 4.1%/year, and our analysis in the proposal indicated that the costs and benefits attributable to the 4% alternative and the preferred alternative for passenger cars are very similar: the preferred alternative was 8.8 percent less expensive for manufacturers than the 4% alternative (estimated total costs were $113 billion for the preferred alternative and $124 billion for the 4% alternative), and achieved 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), which the agency stated was a very small difference given that benefits are spread across the entire lifetimes of all vehicles subject to the standards. The analysis also showed that the lifetime cumulative fuel savings was only 5 percent higher for the 4% alternative than the preferred alternative (the estimated fuel savings was 104 billion

[1212] Feedback from these stakeholder meetings is summarized in section IV.B and documents that are referenced in that section.

[1213] 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.

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 in the NPRM was 9.4 percent higher for the 4% alternative (the estimated cost increase for the average vehicle was $2,023 for the preferred alternative, and $2,213 for the 4% alternative).[1214]

NHTSA explained in the NPRM that we were 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 tentatively 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.

Regarding light trucks, we explained that while NHTSA did not agree with the manufacturer's overall cost assessments and believed that our technology cost and effectiveness methodology allowed manufacturers to preserve all necessary vehicle utility, the agency also believed there was 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 NHTSA's preliminary analysis, which 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 the agencies through that feedback, NHTSA explained that we believed 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 had at the NPRM, therefore, indicated that requiring light truck fuel economy improvements at the 4% annual rate could create potentially severe economic consequences. Our NRPM analysis indicated that the preferred alternative had 48 percent lower cost than the 4% alternative (estimated total costs were $44 billion for the preferred alternative and $83 billion for the 4% alternative), and the total benefits of the preferred alternative were 30 percent lower ($87 billion lower) than the 4% alternative (estimated total benefits were $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 showed that the lifetime cumulative fuel savings was 42 percent higher for the 4% alternative than the preferred alternative (the estimated fuel savings was 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 in the NPRM was 54 percent higher for the 4% alternative (the estimated cost increase for the average vehicle was $1,578 for the preferred alternative, and $2,423 for the 4% alternative).

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 concluded in the NPRM that 4%/year CAFE stringency increases for light trucks in MYs 2017–2021 were 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 were also likely beyond maximum feasible. NHTSA therefore tentatively concluded 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, was 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 agency also explained that NHTSA had accounted 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 made to conduct joint analysis and jointly deliberate on information and tentative conclusions,[1215] the agencies have sought to harmonize and align their proposed standards to the greatest extent possible, consistent with their respective statutory authorities. Thus, NHTSA tentatively concluded that the standards represented by the preferred alternative were the maximum feasible standards for passenger cars and light trucks in MYs 2017–2025, based on the information before the agency at the time of the NPRM. We explained that while we recognized 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, based on our analysis and the evidence presented by the industry, higher standards would not appear to represent the proper balancing for MYs 2017–2025 cars and trucks. We therefore concluded in the NPRM that the correct balancing would recognize economic practicability concerns as discussed above, and proposed standards based on the preferred alternative for MYs 2017–2025.

4. What comments did the agency receive regarding the proposed maximum feasible levels?

Of the several hundred thousand commenters, including industry and union commenters, environmental and consumer groups, national security interest groups, U.S. senators and representatives, State legislators, State and local government organizations and representatives, and many individual citizens, the considerable majority supported the proposed levels of stringency, citing the significant benefits associated with the standards.

However, many commenters urged the agencies to set more stringent standards. Individual commenters sent in thousands of form letters calling on the agencies to set standards that require 60 mpg in 2025, which they described as equivalent to a 6 percent/year rate of

[1214] *See* discussion at 76 FR 75243 *et seq.*

[1215] 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.

increase.[1216] NESCAUM also supported a 6 percent/year rate of increase,[1217] as did UCS, which stated that the agencies' analysis showed that many current vehicles already meet the targets that would apply to them under the future standards, and that the technology exists to set standards that increase at 6 percent/year.[1218] Ceres,[1219] Consumers Union,[1220] and UCS [1221] argued that the higher the standards, the greater the economic benefits (both to consumers individually in terms of fuel savings and to the economy as a whole), and therefore the final standards should be as stringent as possible. NRDC commented that the agencies' determination of stringency should account for the higher fuel price projections in the AEO 2012 Early Release, and that higher fuel prices would justify more application of technology, and thus more stringent standards.[1222] ACEEE commented that the agencies' analyses appeared to show that more stringent alternatives than the one proposed were feasible for the majority of the industry, and that the agencies' rejection of those more stringent alternatives was insufficient given the relatively low cost and considerable benefits associated with them.[1223] ACEEE suggested that the agencies show the cost of compliance in each year for each manufacturer rather than focusing on MYs 2021 and 2025.[1224] ICCT supported the proposed stringency increases, but expressed concern that the proposed rule was not sufficiently technology-forcing, and that credits and incentives might undermine the projected fuel savings and emissions reductions.[1225]

CBD provided extensive comments regarding why it thought the final standards should be more stringent, commenting that the most stringent alternative analyzed by NHTSA was the maximum feasible alternative, since that is the only alternative that CBD believed would actually reduce emissions.[1226] CBD stated that given that much fuel economy-improving technology already exists today (including mass reduction, which CBD said should be mandated in greater amounts [1227]), given that real-life technology costs will be much lower than the agencies estimate, and given the tremendous benefits associated with the most stringent alternative, therefore the most stringent alternative represented the best balancing of the EPCA factors,[1228] and choosing the proposed alternative would leave ''substantial, achievable fuel economy improvements and public benefits unrealized due to industry objections.'' [1229] CBD argued that the agencies appeared to be over-emphasizing the importance of consumer choice ''and the continued production of every vehicle in its current form over the need to conserve energy,'' as evidenced by what CBD saw ''as soon as increased FE begins to affect any attribute of any existing vehicle, stringency increases cease.'' [1230] CBD further argued that without an analysis of ''maximized social benefits, where the benefits most optimally compare to the anticipated costs,'' ''there is no rigorous analysis of economic feasibility that justifies rejecting [the most stringent alternative] as the appropriate standard for this rulemaking.'' [1231] As discussed above in Section IV.D, CBD asserted that the proposed standards were below the maximum feasible level because they were not sufficiently technology-forcing, and because the agency had given too much weight in the balancing of relevant factors to consumer demand.

Other commenters argued that the final standards should be less stringent than what was proposed. AFPM argued that because the agencies had not employed a vehicle choice model in the NPRM analysis, the agencies had chosen an alternative that required too much in the way of electrification technologies, stating that ''[t]he agency predicts that annual sales of hybrids, plug-in hybrids and all electric vehicles could represent 15% of new sales by 2025,'' while ''[i]n reality, EVs, HEVs, etc have been a huge disappointment for automakers.'' [1232] AFPM stated that therefore the standards were beyond maximum feasible. Environmental Consultants of Michigan similarly argued that the proposed standards are arbitrary and capricious because most vehicles in existence today could not meet the 2025 standards, and the few that could are all HEVs, PHEVs, or EVs, which cost significantly more than the agencies' per-vehicle cost estimates for the 2025 standards, and the agencies' cost estimates must therefore be incorrect.[1233]

The Alliance commented that its members supported the proposed increases in stringency, but that consumers had to purchase the vehicles that were made to meet those standards,[1234] while several individual industry commenters argued that the standards were very challenging and possibly too stringent as applied to them. BMW, for example, commented that because its vehicles are very ''content-heavy,'' it had already implemented much of the technology examined by the agencies, and thus would have to work harder than other manufacturers to meet the standards.[1235] BMW stated that in order to comply, it would have to build significant numbers of EVs, which might need government subsidies to encourage consumers to purchase them.[1236] VW presented analysis to make a similar argument for itself,[1237] and commented that the standards for cars were significantly more stringent than the standards for trucks, and that the car standards exceeded what VW would consider to be feasible and balanced.[1238] VW further stated that the standards for MYs 2022–2025 were too aggressive, and based on ''critical assumptions about the market and technologies which are simply too uncertain to appropriately comprehend.'' [1239]

Many commenters focused on the stringency of the truck standards. Some argued that the truck standards should be more stringent, and suggested that the agencies should have required more improvements in the largest trucks rather than implementing the curve adjustments and technology incentives proposed for those vehicles. Many of these commenters focused on the relative burden of the standards on small trucks versus large trucks, or on

[1216] *See, e.g.,* Care2 form letters, Docket No. NHTSA–2010–0131–0190; Sierra Club member form letters, Docket No. NHTSA–2010–0131–0189.

[1217] NESCAUM, Docket No. EPA–HQ–OAR–2010–0799–9476, at 1–2.

[1218] UCS, Docket No. EPA–HQ–OAR–2010–0799–9567, at 6–8.

[1219] Ceres, Docket No. EPA–HQ–OAR–2010–0799–9475, at 3.

[1220] Consumers Union, Docket No. EPA–HQ–OAR–2010–0799–9454, at 6.

[1221] UCS at 6.

[1222] NRDC, Docket No. EPA–HQ–OAR–2010–0799–9472, at 9.

[1223] ACEEE, Docket No. EPA–HQ–OAR–2010–0799–9528, at 7.

[1224] *Id.*

[1225] ICCT, Docket No. NHTSA–2010–0131–0258, at 2.

[1226] CBD, Docket No. NHTSA–2010–0131–0255, at 23.

[1227] *Id.* at 6.

[1228] *Id.* at 23.

[1229] *Id.* at 8.

[1230] *Id.* at 4

[1231] *Id.* at 23.

[1232] AFPM, Docket No. EPA–HQ–OAR–2010–0799–9485, at 4–5.

[1233] Environmental Consultants of Michigan, NHTSA–2010–0131–0166, at 5–6.

[1234] Alliance, Docket No. NHTSA–2010–0131–0262, at 3.

[1235] BMW, Docket No. NHTSA–2010–0131–0250, at 3–4.

[1236] *Id.* at 2.

[1237] VW, Docket No. NHTSA–2010–0131–0247, at 10–12.

[1238] *Id.* at 8.

[1239] *Id.*

the burden on cars versus on trucks. VW, for example, commented that the lower stringency for larger trucks,[1240] ''combined with segment-exclusive credit opportunities has the potential to distort the future light duty market,'' and that even if the agencies are correct that ''work trucks have special needs,'' ''the agencies could have still created a regulation that was more equitable with equal stringency for cars and trucks.'' [1241] VW suggested that both the car and the truck standards should increase at roughly 4 percent/year, and that manufacturers who struggle with the truck standards could simply over-comply with the car standards and transfer credits.[1242] Nissan, in contrast, stated that it would not be feasible to rely on transfers of car credits to cover truck fleet shortfalls under CAFE, since EISA limits the amount of credits that can be transferred in a given year.[1243] VW stated that the difference in stringency between trucks and cars ''may disproportionately drive cost into passenger cars versus trucks and may ultimately discourage customer consideration of lower CO_2-emitting passenger cars,'' which VW stated ''seems counterintuitive to environmental and energy goals.'' [1244] Sierra Club [1245] and CBD [1246] provided similar comments. VW suggested that the agencies may have underestimated the domestic manufacturers' future truck share.[1247]

Toyota [1248] and Honda objected to the relative stringency of the truck curve for small trucks as compared to large trucks, with Honda stating that based on its review of EPA's analysis, a small footprint light truck like a Honda CR–V and a large truck like a Ford F150 may receive similar technology ''packages'' at similar costs, but based on the target curves, the small truck's proposed target would require an 18 percent increase in stringency, while the large truck's target would require an increase of less than 5 percent.[1249] Consumers Union took a slightly different approach, arguing that while it is ''counterintuitive and counterproductive to let the least fuel efficient models improve more slowly than more efficient models,'' the light truck curve should be made more stringent overall: not just for larger light trucks, but also for smaller light trucks (more similar to the car standards), so that manufacturers of CUVs are not encouraged to reclassify cars as trucks.[1250]

CBD commented that the proposed standards ''substantially and improperly favor light trucks, particularly the largest and least fuel efficient trucks,'' and argued that the shape of the curves and the rate of increase of the truck standards would encourage manufacturers to build more and larger trucks, thus undermining the goals of the program.[1251] NACAA expressed similar concern.[1252] CBD stated that the Ricardo analysis of technology effectiveness showed that manufacturers should be capable of improving the fuel economy of their large trucks while maintaining towing and hauling, so the agencies should not cite the need to preserve truck utility in setting the truck standards, and that since big trucks are the most profitable vehicles, the cost of applying technology should not be a factor for the agencies in determining the rate of stringency increase for those vehicles.[1253] CBD argued that the light truck curve should increase at the same rate as the passenger car curve in order to ''comport with Congressional intent'' that the standards be ratable and conserve energy.[1254]

In contrast, some commenters described the MYs 2022–2025 targets for the largest light trucks as especially challenging, arguing that the cost feasibility of applying the advanced technologies necessary to meet the standards in that time frame may be limited, given the cost sensitivity of buyers in that market segment, and suggesting that sales may be impacted.[1255] Ford provided extensive comments on the utility requirements of large trucks, and argued that consumers who purchase these trucks do so for the utility, and consumers who purchase these trucks without a need for the utility will dwindle over the rulemaking timeframe.[1256]

And finally, a number of industry commenters commented that NHTSA's standards would harmonize better with EPA's standards if NHTSA allowed additional credit flexibilities or modified its curves to make the standards less difficult in case manufacturers were relying heavily on the flexibilities provided by EPA. For example, the Alliance argued that because NHTSA does not offer certain flexibilities that EPA offers, ''While the impact of the program differences is relatively small in the early years of the program, it will increase with the passage of time, particularly as manufacturers rely more and more on vehicle electrification in order to comply with the standards.'' [1257] The Alliance further stated that ''Unless this imbalance is corrected, it will result in significant disharmony in the middle and later years of the time period covered by this proposal.'' [1258] Toyota provided similar comments; [1259] GM supported the Alliance comments.[1260]

5. How has the agency balanced the factors for this final rule?

a. What alternatives did the agency consider, and why?

The relevant factors (and thus the weight given to each factor) can be balanced in many different ways depending on the agency's policy priorities and on the information before the agency regarding any given model year. The agency thus considered a range of alternatives that represent different regulatory options that seemed potentially reasonable for purposes of this rulemaking. For this final rule, as for the proposal, the agency considered nine regulatory alternatives, including what we describe as the ''preferred alternative'' in the Draft and Final EIS, which is what the agency proposed and is finalizing. The other regulatory alternatives include six in which fuel economy levels increase annually, on average, at set rates as follows:

- 2%/year,
- 3%/year,
- 4%/year,
- 5%/year,
- 6%/year, and

[1240] VW stated that while EPA described the average annual truck stringency increase as 3.5 percent/year, the increase for the larger trucks was 1 percent or less in the first several years of the program. *Id.* at 20–21.

[1241] *Id.* at 8–9.

[1242] *Id.*

[1243] Nissan, Docket No. EPA–HQ–OAR–2010–0799–9471, at 8.

[1244] VW at 9.

[1245] Sierra Club *et al.,* Docket No. EPA–HQ–OAR–2010–0799–9549, at 6.

[1246] CBD, Docket No. NHTSA–2010–0131–0255, at 13.

[1247] VW at 12.

[1248] Toyota, Docket No. EPA–HQ–OAR–2010–0799–9586, at 5.

[1249] Honda, Docket No. NHTSA–2010–0131–0239, at 1.

[1250] Consumers Union, Docket No. EPA–HQ–OAR–2010–0799–9454, at 6.

[1251] CBD, Docket No. NHTSA–2010–0131–0255, at 9–10.

[1252] NACAA, Docket No. EPA–HQ–OAR–2010–0799–8084, at 3.

[1253] CBD at 11–12.

[1254] *Id.* at 14.

[1255] Nissan, Docket No. EPA–HQ–OAR–2010–0799–9471, at 8; RVIA, Docket No. EPA–HQ–OAR–2010–0799–9550, at 1–2.

[1256] Ford, Docket No. NHTSA–2010–0131–0235, at 9.

[1257] Alliance, Docket No. NHTSA–2010–0131–0262, at 14–15.

[1258] *Id.* at 15.

[1259] Toyota, Docket No. EPA–HQ–OAR–2010–0799–9586, at 6

[1260] GM, Docket No. NHTSA–2010–0131–0236, at 2.

• 7%/year.[1261]

We considered these alternatives because 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 that are 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'').[1262] These alternatives are discussed in more detail in Chapter III of the FRIA accompanying this final rule.[1263] Because the agency could conceivably select any of the regulatory alternatives above, all of which fall between 2%/year and 7%/year, inclusive, the Final EIS that informed this final rule analyzes these lower and upper bounds as well as the preferred alternative. Additionally, the Final 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.

This approach to selecting regulatory alternatives clearly communicates the level of stringency of each alternative and allows us to identify alternatives that would represent different ways to balance the relevant factors. Each of the 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, (other than No Action), 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 other factors 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. Whether different alternatives may be maximum feasible 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 valued. While NHTSA believes that our analysis for this final rule 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 the inputs were different. When the agency undertakes the future rulemaking to develop final standards for MYs 2022–2025, for example, we expect that much new information will inform that future analysis, which may potentially lead us to choose different standards than the augural ones presented today.[1264]

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. The following discussion explains what we believe each factor means in the context of this rulemaking, and how the agency therefore balanced the factors for determining the maximum feasible final and augural passenger car and light truck standards.

b. What does technological feasibility mean in the context of this rulemaking?

Technological feasibility, as the agency defines it, is less constraining in this rulemaking than it has been in the past in light of the rulemaking time frame. ''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 in question. For this longer term rulemaking, 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. The agencies expect all of these to be commercially applicable by the rulemaking time frame. In terms of what would be technologically feasible, then, 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, based on our analysis, all of the alternatives appear as though they could narrowly be considered *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. Any of the alternatives could thus 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.

Many commenters agreed with this assessment, and urged the agency to set more stringent standards than those we proposed. If the technology exists or is projected to exist, and if the agency's assessment is that benefits (fuel savings and emissions avoided) only increase as

[1261] 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 final rule, as for the 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.

[1262] 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.

[1263] Chapter III of the FRIA contains an extensive discussion 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.

[1264] We emphasize, nevertheless, that the augural standards for MYs 2022–2025 represent the agency's best judgment of what standards *would be* maximum feasible for those model years, based on the information before us today, if the agency had authority to set standards for 9 model years at a time.

stringency increases, why would the most stringent standards assessed not be maximum feasible? The reason they might not is that 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.

c. What does economic practicability mean in the context of this rulemaking?

''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.[1265] In a rulemaking such as this, 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 modeling 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. 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 cannot be known. The agency must thus account for uncertainty in the context of economic practicability in other ways as best as we can, given the entire record before us.

The agency does not believe that there is necessarily a bright-line test for whether a regulatory alternative is economically practicable, but there are several metrics that we discuss below that we find useful for making the assessment, as follows:

- Compliance ''shortfalls''—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.''[1266] If it appears, in our modeling analysis, that a significant portion of the industry cannot meet the standards defined by a regulatory alternative in a model year, given that our modeling analysis accounts for manufacturers' expected ability to design, produce, and sell vehicles (through redesign cycle cadence, technology costs and benefits, etc.), then that suggests that the standards may not be economically practicable.
- Application rate of technologies—even if shortfalls are not extensive, whether it appears that a regulatory alternative would impose undue burden on manufacturers in either or both the near and long term in terms of how much and which technologies might be required. For example, NHTSA currently estimates that the cumulative effect of CAFE standards promulgated under the previous and current administrations will require considerable technology and cost beyond that reflected by technology present in the most recent fleet (MY 2010) for which complete transparent information is available.
- Other technology-related considerations—related to the application rate of technologies, whether it appears that the burden on several or more manufacturers might cause them to respond to the standards in ways that compromise, for example, vehicle safety, or other aspects of performance that are important to consumer acceptance of new products.
- Cost of meeting the standards—even if the technology exists and it appears that manufacturers can apply it consistent with their product cadence, if meeting the standards will raise per-vehicle cost more than we believe consumers are likely to accept, which could negatively impact sales and employment in this sector, the standards may not be economically practicable.
- Uncertainty and consumer acceptance of technologies—considerations not accounted for expressly in our modeling analysis, but important to an assessment of economic practicability given the time frame of this rulemaking.

We discuss below how some of the alternatives compare in terms of these metrics.

d. What do other motor vehicle standards of the government mean in the context of this rulemaking?

As discussed in Section IV.D above, ''other motor vehicle standards of the government'' 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 addition to the expected and possible NHTSA safety standards and known EPA emissions standards, in developing this joint final rule with EPA, NHTSA has also sought to harmonize the final and augural standards with EPA's.

e. What does the need of the nation to conserve energy mean in the context of this rulemaking?

''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.'' Environmental implications principally include those associated with reductions in emissions of criteria pollutants, mobile source air toxics, and GHGs (including CO_2). NHTSA has been informed regarding the environmental implications of the final and augural standards by the Final EIS, which analyzes the environmental impacts of the regulatory alternatives discussed above. A prime example of foreign policy implications are energy independence and energy security concerns.

A number of commenters raised environmental and energy security concerns as paramount for the agency's consideration, and urged the agency both to quantify impacts related to these concerns and to set as stringent standards as possible to address them. The need of the nation to conserve energy has long operated to push the balancing toward more stringent standards, given that the overarching purpose of EPCA is energy conservation.

[1265] *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).

[1266] 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. In response to comments suggesting that the agency mandate higher levels of certain technologies, such as mass reduction, 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.

In this final rule, then, the question raised by this factor, combined with technological feasibility, becomes ''how stringent can NHTSA set standards before economic practicability concerns intercede?''

f. Given what the factors mean in the context of this rulemaking, which alternative is maximum feasible for the final standards, and why?

If the need of the nation to conserve energy always pushes the balancing toward greater stringency and technological feasibility is 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 before we reach a tipping point that presents risk of significantly adverse economic consequences. While determination of that tipping point is within the agency's discretion to balance the relevant factors, 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.

The question of the tipping point is slightly different in the context of the final standards and augural standards. The final standards for MYs 2017–2021 are nearer-term, albeit still several years away; the augural standards for MYs 2022–2025, clearly, are even more distant, and the inputs that inform our balancing are less certain. Based on the information currently before the agency, we continue to believe that the standards as proposed are maximum feasible for MYs 2017–2025.

For the final standards, the annual rate of increase in the passenger car and light truck standards is as follows (in terms of average required fuel economy levels estimated using the MY 2010-based market forecast):

TABLE IV–24—NHTSA ANNUAL RATE OF INCREASE IN THE STRINGENCY OF THE FINAL STANDARDS FOR EACH MODEL YEAR FROM 2017 TO 2021

Model year	Passenger car (percent)	Light truck (percent)
2017	3.7	0.6
2018	3.6	1.7
2019	3.6	1.5
2020	3.9	2.1
2021	4.2	6.5
2017–2021	3.8	2.5

For the augural standards, the annual rate of increase in the passenger car and light truck standards is as follows:

TABLE IV–25—NHTSA ANNUAL RATE OF INCREASE IN THE STRINGENCY OF THE AUGURAL STANDARDS FOR EACH MODEL YEAR FROM 2022 TO 2025

Model year	Passenger car (percent)	Light truck (percent)
2022	4.8	4.9
2023	4.6	4.7
2024	4.7	4.8
2025	4.7	4.8

As the tables show, in terms of the average rate of increase over the MYs 2017–2021 period, the final passenger car standards fall between the 3/yr and 4/yr alternatives, while the final light truck standards fall between the 2/yr and the 3/yr alternatives. The average rate of increase for the augural passenger car and light truck standards for MYs 2022–2025 falls between the 4/y and 5/y alternatives.

The overall average annual rate of increase over the different periods covered by this rulemaking, for the reader's reference, is thus as follows:

TABLE IV–26—NHTSA ANNUAL RATE OF INCREASE IN THE STRINGENCY OF THE FINAL AND AUGURAL STANDARDS OVER VARIOUS PERIODS

Model years	Passenger car (percent)	Light truck (percent)
2017–2021	3.8	2.5
2022–2025	4.7	4.8
2017–2025	4.2	3.5

Part of the way that we try to evaluate economic practicability, and thus where the tipping point in the balancing of factors might be for a given model year, is through a variety of model inputs, such as phase-in caps (the annual rate at which we estimate that 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, which attempts to simulate a way for the manufacturer to comply with different regulatory alternatives. If a sufficient number of manufacturers do not appear able to meet the standards in a given model year; if the amounts of technology or per-vehicle cost increases required to meet the standards appear to be beyond what we believe the market would bear, or if the limits (and technology cost-effectiveness) prevent enough manufacturers from meeting the required levels of stringency,[1267] the agency may decide that the standards under consideration may not be economically practicable. 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.

g. Compliance Shortfalls

In looking at the projected compliance shortfall results from our modeling analysis, the agency concludes, based on the information before us at the time, that for both passenger car and for light trucks, the MNB and TC=TB alternatives, 6/Year and 7/Year alternatives do not appear to be economically practicable, and are 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.[1268]

For purposes of passenger cars, the agency's analysis indicates the following levels of compliance shortfall, by manufacturer and by model year, for the following regulatory alternatives (a dash indicating cases where the manufacturer exceeds a standard):

TABLE IV–27—NHTSA—ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR PASSENGER CARS BY MANUFACTURER UNDER THE PREFERRED ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat	....	0.0	....	....	....	....	....	....	0.0
Ford	....	....	....	....	....	....	....	0.0	0.0
General Motors	....	....	....	....	....	....	....	0.0	....
Honda	....	....	....	....	....	....	....	....	0.0
Hyundai	....	....	....	....	....	....	....	....	0.0
Kia	....	....	....	....	....	....	....	....	....
Mazda	....	....	....	....	....	....	....	....	....
Mitsubishi	....	....	0.5	....	....	....	....	....	0.8
Nissan	....	....	....	....	....	....	....	....	....
Subaru	1.9	2.6	....	....	....	0.1	1.7	....	....
Suzuki	....	....	....	....	....	....	....	1.1	0.0
Toyota	....	....	....	....	....	....	....	....	....

TABLE IV–28—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR PASSENGER CARS BY MANUFACTURER UNDER THE 5%/y ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat	....	....	....	....	....	....	0.0	2.5	0.2
Ford	....	....	....	....	....	....	2.1	....	0.3
General Motors	....	....	....	....	....	....	....	....	....
Honda	....	....	....	....	....	....	....	....	0.0
Hyundai	....	....	....	....	....	....	....	....	....
Kia	....	....	....	....	....	....	....	....	0.0
Mazda	....	....	....	....	0.0	....	....	....	2.6
Mitsubishi	....	0.5	2.8	....	....	0.8	3.8	6.9	1.7
Nissan	....	....	....	....	....	....	....	....	....
Subaru	2.6	4.0	0.7	....	0.9	3.8	6.0	8.3	9.0
Suzuki	....	....	....	....	....	....	....	....	0.5
Toyota	....	....	....	....	....	....	....	....	0.0

[1267] 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.'' 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. In response to comments suggesting that the agency mandate higher levels of certain technologies, such as mass reduction, 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.

[1268] Lead time is incorporated into our modeling analysis through redesign/refresh schedules, phase-in caps, estimates of the first model year by which some technologies (*e.g.,* high BMEP engines) are assumed to be available for commercial application, consideration of stranded capital costs, and representation of multi-year planning effects. However, there are many factors related to lead time that, though considered generally when specifying phase-in caps, we are not able to represent explicitly, and that introduce uncertainty and risk vis-à-vis the rate at which CAFE standards can feasibly be increased. Examples include, but are not limited to the following: availability and cost of capital, supply and cost of engineering and other labor resources, capability and extent of supporting infrastructure (e.g., maintenance and repair facilities), and consumer acceptance.

TABLE IV–29—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR PASSENGER CARS BY MANUFACTURER UNDER THE 6%/Y ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat					0.1	3.2	5.4	8.8	7.7
Ford					0.3	2.9	6.3	4.2	6.6
General Motors						0.8	3.9	6.5	6.7
Honda									1.3
Hyundai									
Kia								0.8	2.9
Mazda					0.8	1.1	3.6	7.2	0.7
Mitsubishi		1.5	4.4			0.1	3.9	8.0	12.1
Nissan							1.6	2.8	6.1
Subaru	3.0	5.0	2.3	0.4	3.8	7.4	10.5	13.8	15.6
Suzuki							0.9	5.1	7.8
Toyota									

TABLE IV–30—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR PASSENGER CARS BY MANUFACTURER UNDER THE “MNB” ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat	1.4	2.2	1.0			0.3			0.0
Ford	0.3	2.4	2.4	0.1	0.9	0.2	1.0		0.0
General Motors	1.9	0.4	1.9						0.0
Honda									
Hyundai									0.0
Kia									0.0
Mazda	0.0	1.4	2.8						
Mitsubishi	2.6	5.2	7.5					1.9	2.6
Nissan		0.0					0.0		0.0
Subaru	7.0	8.7	5.3	1.9	3.3	4.2	4.6	6.2	5.8
Suzuki		2.3					0.0	2.4	2.2
Toyota									

TABLE IV–31—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR PASSENGER CARS BY MANUFACTURER UNDER THE “TC=TB” ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat	2.1	2.5	1.0		0.4	1.7		1.2	0.4
Ford	1.0	2.6	2.4	0.1	1.4	1.6	2.7	1.8	1.1
General Motors	2.6	0.6	1.9			0.7		0.5	
Honda									
Hyundai				0.0					
Kia									
Mazda	0.7	1.6	2.8						0.0
Mitsubishi	3.3	5.5	7.5				0.5	3.5	4.2
Nissan		0.1					0.8		0.8
Subaru	7.7	8.9	5.3	1.9	3.9	5.7	6.4	8.6	8.3
Suzuki	0.5	2.5				0.9	1.7	4.8	4.8
Toyota									0.0

Thus, for alternatives that increase at 6%/y and faster, the majority of the industry would face compliance shortfalls for passenger cars, according to our analysis, which seems to indicate economic impracticability.[1269] Standards that increase less rapidly, such as under the 5%/y and slower alternatives, thus remain under consideration for being economically practicable for passenger cars. We note that the maximizing net benefits alternative, while showing relatively little shortfalling by industry in later years of the rulemaking time frame, shows considerable shortfalling for a number of major manufacturers' passenger car fleets early in the program. This is due to the fact that the maximizing net benefits standards are fairly front-loaded and require more rapid increases at first, which we believe would be exceedingly difficult for manufacturers following the challenging MYs 2012–2016 standards, as discussed further below,[1270] and likely beyond economically practicable levels.

For purposes of light trucks, the agency's analysis indicates the

[1269] We note here that even if manufacturers could conceivably comply through use of credits, the agency is barred by statute from considering availability of credits in the determination of maximum feasible standards.

[1270] It should be noted that in discussing the MYs 2012–2016 standards, NHTSA is not reconsidering those standards. Rather, NHTSA's analysis of today's post-MY 2016 standards considers impacts the baseline standards could have after MY 2016, as well as impacts today's post-MY 2016 standards could have prior to MY 2017 (due to multiyear planning effects).

following levels of compliance shortfall, by manufacturer and by model year, for the following regulatory alternatives:

TABLE IV–32—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR LIGHT TRUCKS BY MANUFACTURER UNDER THE PREFERRED ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat						0.5			0.0
Ford									0.0
General Motors									0.0
Honda									0.0
Hyundai									
Kia									
Mazda									
Mitsubishi									
Nissan									
Subaru									
Suzuki									
Toyota									

TABLE IV–33—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR LIGHT TRUCKS BY MANUFACTURER UNDER THE 5%/Y ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat	0.0	1.7	2.9	2.2	3.5	5.5	1.3	3.4	4.3
Ford								0.2	2.4
General Motors		0.1					1.0	2.6	0.1
Honda									0.7
Hyundai									
Kia									
Mazda	0.2								
Mitsubishi			1.9	4.2					1.4
Nissan		0.0							0.0
Subaru									
Suzuki			0.7	2.9			1.1	3.9	6.8
Toyota									

TABLE IV–34—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR LIGHT TRUCKS BY MANUFACTURER UNDER THE 6%/Y ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat	0.3	2.4	4.1	3.8	5.7	8.3	4.7	7.5	9.3
Ford			0.5	1.1		0.2	2.8	4.8	5.3
General Motors		0.8				1.2	3.2	5.3	4.0
Honda									2.8
Hyundai									
Kia									
Mazda	0.6					1.2	1.6	2.8	6.4
Mitsubishi		0.7	3.3	6.1				1.5	5.4
Nissan						0.1	2.7	1.7	4.5
Subaru						0.1	3.5		
Suzuki		0.2	2.1	4.9		1.8	5.2	8.9	12.8
Toyota									2.4

TABLE IV–35—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR LIGHT TRUCKS BY MANUFACTURER UNDER THE "MNB" ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat	1.6	2.4	4.3	3.9	6.8	7.4	1.8	2.4	2.1
Ford			0.7	1.2					
General Motors	0.8	0.8			0.0	0.2	0.5	0.7	0.0
Honda									
Hyundai									
Kia									
Mazda	1.9				1.0	1.7			
Mitsubishi		0.7	3.5	6.2					
Nissan		0.0							0.0
Subaru									

TABLE IV–35—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR LIGHT TRUCKS BY MANUFACTURER UNDER THE "MNB" ALTERNATIVE—Continued

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Suzuki		0.3	2.3	5.0		0.7	1.7	2.8	4.2
Toyota									0.0

TABLE IV–36—NHTSA ESTIMATED ANNUAL COMPLIANCE SHORTFALLS (MPG) FOR LIGHT TRUCKS BY MANUFACTURER UNDER THE "TC=TB" ALTERNATIVE

Manufacturer	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fiat	1.9	2.8	4.3	3.9	7.0	7.6	2.0	2.4	2.3
Ford		0.0	0.7	1.2				0.0	
General Motors	1.1	1.2			0.2	0.4	0.7	0.7	
Honda									0.0
Hyundai									
Kia									
Mazda	2.3					0.1			
Mitsubishi	0.1	1.1	3.5	6.2					
Nissan		0.0					0.0		0.0
Subaru									
Suzuki		0.7	2.3	5.0	0.1	0.9	2.0	2.8	4.5
Toyota									0.0

For light trucks, the 5%/y alternative appears to present significant risk of several manufacturers facing shortfalls in most model years. Thus, for alternatives that increase at 5%/y and faster, the majority of the industry would face compliance shortfalls for light trucks, according to our analysis, which indicates economic impracticability. Standards that increase less rapidly, such as under the 4%/y and slower alternatives, thus remain under consideration for being economically practicable for light trucks. Again, we note that the maximizing net benefits alternative, while showing relatively little shortfalling by industry in later years of the rulemaking time frame, shows considerable shortfalling for a number of major manufacturers' light truck fleets early in the program. This is due to the fact that the maximizing net benefits standards are fairly front-loaded and require more rapid increases at first, which we believe would be exceedingly difficult for manufacturers following the challenging MYs 2012–2016 standards, as discussed further below, and likely beyond economically practicable levels.

h. Application Rate of Technologies

As discussed above, when considering the economic practicability of a regulatory alternative in terms of how much technology manufacturers have to apply in order to meet it, the agency must consider both which technologies appear to be necessary and when they would have to be applied, given manufacturers' product redesign cadence. While the need of the nation to conserve energy encourages the agency to be more technology-forcing in its balancing, and while technological feasibility is arguably less limiting in this rulemaking given its time frame, regulatory alternatives that require extensive application of very advanced technologies (that may have known or unknown consumer acceptance issues) or that require manufacturers to apply additional technology in earlier model years, in which meeting the standards is already challenging, may not be economically practicable, and thus may be beyond maximum feasible.

The first issue is timing of technology application. The MYs 2012–2016 standards, in the agency's view, are feasible but challenging, and represent some of the most rapid increases in stringency in the history of the CAFE program. In NHTSA's judgment, technology deployment necessitated by these baseline standards poses a considerable challenge to the industry, at least through MY 2016. Most manufacturers indicated during meetings with the agency that, even considering flexibilities (*e.g.,* FFV credits, credit transfers, and credit carry-forward) that the agency may not consider for purposes of determining maximum feasible stringency, CAFE standards already in place through MY 2016 will require significant application of technology and will leave some manufacturers' reserves of CAFE credits largely depleted going into MY 2017. Tables IV–37 through IV–40 show significant additional application of technology during those earlier model years to enable compliance with the more stringent post-MY 2016 standards defined by the Preferred Alternative and some of the other regulatory alternatives the agency has considered. Many commenters noted the lead time available in this rulemaking, since the first standards would not be effective until MY 2017, and suggested that such ample lead time should certainly make higher standards economically practicable in that time frame. While consideration of future model years in isolation might suggest manufacturers have ample lead time to make further improvements, NHTSA does not consider model years in isolation, because that is not consistent with how industry responds to standards, and thus would not accurately reflect practicability. NHTSA's analysis tries to estimate manufacturers' product "cadence," representing them in terms of estimated schedules for redesigning and "freshening" vehicles, and assuming that significant technology changes will be implemented during vehicle redesigns, and that once applied, a technology will be carried forward to future model years until superseded by a more advanced technology. If manufacturers are already applying technology widely and intensively to meet standards in earlier years, requiring manufacturers to add yet more technology in those model years in order to meet future standards may not be economically practicable. The question is not whether a standard is economically practicable in the model year in which the standard is effective, but whether getting to that model year's standard (in part, through the application of technologies in earlier model years) is economically practicable. The tables below illustrate how the agency has modeled that process of manufacturers applying technologies in order to comply with different alternative standards; the technologies are described in more detail in Section IV.D and in Chapter V of NHTSA's FRIA:

TABLE IV–37—NHTSA ESTIMATED APPLICATION OF SELECTED TECHNOLOGIES—PASSENGER CARS

Technology	Standards	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)
SGDI	Baseline	10	11	13	16	18	18	18	18
	2%/Year	14	20	24	30	37	40	41	42
	3%/Year	17	24	32	40	48	60	63	71
	Preferred	21	29	41	48	57	69	72	78
	4%/Year	18	27	38	47	58	70	72	78
	5%/Year	25	37	47	55	68	72	75	78
Turbocharging	Baseline	13	15	17	19	21	20	20	21
	2%/Year	20	25	28	33	39	43	46	46
	3%/Year	23	33	40	46	53	66	71	80
	Preferred	29	36	47	54	63	74	82	88
	4%/Year	25	34	45	54	65	76	82	88
	5%/Year	32	45	53	62	74	78	85	88
Cooled EGR	Baseline	0	0	2	2	2	2	2	2
	2%/Year	0	0	2	2	2	3	3	3
	3%/Year	0	0	2	2	3	5	5	6
	Preferred	0	0	2	2	4	7	11	15
	4%/Year	0	0	4	4	5	6	15	19
	5%/Year	0	1	4	5	7	15	20	27
High BMEP	Baseline	0	0	0	0	0	0	0	0
	2%/Year	0	0	0	0	0	0	0	0
	3%/Year	0	0	0	0	0	0	0	1
	Preferred	0	0	0	0	0	0	1	2
	4%/Year	0	0	0	0	0	1	2	2
	5%/Year	0	0	0	0	0	1	4	5
Diesel	Baseline	0	0	0	0	0	0	0	0
	2%/Year	0	0	0	0	0	0	0	0
	3%/Year	0	0	0	0	0	0	0	0
	Preferred	0	0	0	0	0	0	0	0
	4%/Year	0	0	0	0	0	1	1	1
	5%/Year	0	0	0	0	0	1	1	3
Advanced Transmissions	Baseline	24	31	36	36	38	38	39	38
	2%/Year	23	30	35	36	41	47	52	58
	3%/Year	24	31	36	39	47	63	65	70
	Preferred	24	31	36	39	47	61	66	70
	4%/Year	28	39	45	47	59	69	69	70
	5%/Year	26	33	45	51	63	79	80	76

TABLE IV–38—NHTSA ESTIMATED APPLICATION OF SELECTED TECHNOLOGIES—PASSENGER CARS

Technology	Standards	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)
Electric Power Steering	Baseline	15	26	37	38	38	38	38	38
	2%/Year	20	31	48	52	53	60	61	64
	3%/Year	20	31	47	50	51	60	63	64
	Preferred	17	28	43	46	52	62	62	62
	4%/Year	28	39	56	60	62	63	63	66
	5%/Year	28	39	58	62	64	65	65	66
Micro & Mild Hybrids	Baseline	2	3	4	4	4	4	4	4
	2%/Year	2	4	4	4	4	4	4	4
	3%/Year	2	4	4	4	5	5	6	6
	Preferred	2	4	5	5	5	6	11	12
	4%/Year	3	4	5	5	6	6	11	11
	5%/Year	4	10	10	10	16	26	36	46
Strong Hybrid	Baseline	0	0	0	0	0	0	0	0
	2%/Year	0	0	0	0	0	0	0	0
	3%/Year	0	0	0	0	0	0	0	0
	Preferred	0	0	0	0	0	0	0	0
	4%/Year	0	0	0	0	0	1	1	1
	5%/Year	0	0	0	0	0	1	1	1
15–20% Mass Reduction	Baseline	0	2	3	3	3	3	3	3
	2%/Year	0	2	3	4	5	6	8	8
	3%/Year	0	2	3	4	5	5	5	6
	Preferred	0	2	3	4	5	7	8	10
	4%/Year	0	2	3	4	6	10	11	12

TABLE IV–38—NHTSA ESTIMATED APPLICATION OF SELECTED TECHNOLOGIES—PASSENGER CARS—Continued

Technology	Standards	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)
	5%/Year	0	2	3	4	6	8	12	13
Aerodynamic Improvements	Baseline	40	50	68	74	77	80	80	80
	2%/Year	40	50	68	74	80	82	85	85
	3%/Year	40	50	68	74	82	84	85	85
	Preferred	40	50	68	74	82	84	85	85
	4%/Year	40	50	68	74	82	84	85	85
	5%/Year	40	50	68	74	82	84	85	85

TABLE IV–39—NHTSA ESTIMATED APPLICATION OF SELECTED TECHNOLOGIES—LIGHT TRUCKS

Technology	Standards	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)
SGDI	Baseline	27	32	39	40	41	41	40	40
	2%/Year	32	47	56	59	63	64	64	66
	3%/Year	34	43	57	60	67	72	71	75
	Preferred	29	36	42	45	49	57	61	73
	4%/Year	33	43	56	61	64	69	69	72
	5%/Year	35	45	57	63	68	72	72	75
Turbocharging	Baseline	34	42	50	52	52	52	52	52
	2%/Year	45	62	70	73	74	75	76	78
	3%/Year	47	63	72	74	79	84	85	88
	Preferred	37	47	55	58	60	69	73	84
	4%/Year	47	63	72	75	76	83	83	86
	5%/Year	49	65	74	77	79	85	84	88
Cooled EGR	Baseline	0	0	4	5	5	5	5	5
	2%/Year	0	0	4	5	5	5	5	6
	3%/Year	0	0	4	5	7	7	7	7
	Preferred	0	0	4	5	5	6	6	6
	4%/Year	0	0	4	5	7	16	23	34
	5%/Year	0	0	4	5	6	14	20	35
High BMEP	Baseline	0	0	0	0	0	0	0	0
	2%/Year	0	0	0	0	0	0	0	1
	3%/Year	0	0	0	0	0	0	0	0
	Preferred	0	0	0	0	0	0	0	0
	4%/Year	0	0	0	0	0	1	1	8
	5%/Year	0	0	0	0	0	1	2	12
Diesel	Baseline	0	0	0	0	0	0	0	0
	2%/Year	0	0	0	0	0	0	0	0
	3%/Year	0	0	0	0	0	1	1	1
	Preferred	0	0	0	0	0	0	1	1
	4%/Year	0	0	0	0	0	1	1	1
	5%/Year	0	0	0	0	2	2	4	4
Advanced Transmissions	Baseline	6	6	10	11	11	14	15	15
	2%/Year	6	7	11	13	16	29	45	56
	3%/Year	8	10	15	17	21	36	42	53
	Preferred	6	6	11	13	18	33	47	62
	4%/Year	8	10	17	22	30	45	53	56
	5%/Year	6	8	15	22	30	46	51	53

TABLE IV–40—NHTSA ESTIMATED APPLICATION OF SELECTED TECHNOLOGIES—LIGHT TRUCKS

Technology	Standards	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)
EPS	Baseline	18	36	60	64	64	64	64	65
	2%/Year	18	35	61	67	70	73	73	78
	3%/Year	18	35	61	67	68	70	72	81
	Preferred	17	35	60	64	64	69	70	79
	4%/Year	18	35	66	72	76	79	80	81
	5%/Year	19	37	67	74	78	80	80	83
Micro & Mild Hybrids	Baseline	4	4	4	3	3	3	3	3
	2%/Year	7	9	12	13	12	13	13	13
	3%/Year	8	9	13	13	13	14	15	15
	Preferred	4	6	9	10	10	10	15	14
	4%/Year	13	18	21	22	23	24	26	26
	5%/Year	24	40	44	45	47	53	59	65
Strong Hybrid	Baseline	0	0	0	0	0	0	0	0
	2%/Year	0	0	0	0	0	0	0	0

TABLE IV–40—NHTSA ESTIMATED APPLICATION OF SELECTED TECHNOLOGIES—LIGHT TRUCKS—Continued

Technology	Standards	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)
	3%/Year	0	0	0	0	0	0	0	1
	Preferred	0	0	0	0	0	0	0	1
	4%/Year	0	0	0	0	0	0	0	0
	5%/Year	0	0	0	0	0	0	0	1
15–20% Mass Reduction	Baseline	1	1	5	6	6	6	6	6
	2%/Year	1	1	5	10	11	12	12	12
	3%/Year	1	1	6	10	11	13	14	22
	Preferred	1	1	6	7	7	8	8	16
	4%/Year	1	1	6	10	20	26	37	39
	5%/Year	1	1	6	11	20	27	41	49
Aerodynamic Improvements	Baseline	57	64	67	76	76	75	76	76
	2%/Year	57	64	67	76	77	79	81	84
	3%/Year	57	64	67	76	77	79	81	84
	Preferred	57	64	67	76	77	79	81	84
	4%/Year	57	64	67	76	77	79	83	86
	5%/Year	57	64	67	76	77	79	83	86

Although NHTSA's analysis is intended to estimate ways manufacturers *could* respond to new standards, not to predict how manufacturers *will* respond to new standards, manufacturers have indicated in meetings with the agency, and in confidential product planning data submitted to the agency, that they do engage in strategic timing of the application of technology, relating product planning cycles to future increases in the stringency of CAFE standards. Thus, insofar as we have estimated that manufacturers will redesign vehicles during MYs 2012–2016, our analysis indicates that many manufacturers may need to add further technology (*i.e.,* more than would be necessitated solely by MYs 2012–2016 standards) in order to facilitate compliance with post-MY 2016 standards.[1271] As discussed below, our selection of the preferred alternative is informed, in part, by consideration of additional technology and corresponding costs that may be incurred in the near term (prior to MY 2017) in order to enable compliance with future standards.

Given that technology that could be applied in response to the baseline standards poses a considerable challenge to the industry, at least through MY 2016, NHTSA is concerned that regulatory alternatives more stringent than the Preferred Alternative would require even further application of technology, including much in earlier model years—beyond levels the agency judges economically practicable. This is the second issue described above: that greater and earlier application of advanced technologies (which may have known or unknown consumer acceptance issues) could affect the economic practicability of certain alternatives. For example, under the 4%/Year Alternative for passenger cars, the agency's analysis indicates that currently-experimental high BMEP engines might need to appear a year earlier and on twice as many vehicles in MY 2020 as under the Preferred Alternative; that diesels and strong hybrids might need to be added beginning MY 2019, versus not at all under the Preferred Alternative; that many more advanced transmissions (*e.g.,* 25% more in MY 2016) and electric power steering (EPS) systems (*e.g.,* 30% more in MY 2016) might need to be applied in early model years as under the Preferred Alternative, and that from MY 2018 forward, and more passenger cars might need to receive significant mass reduction (15–20%) than under the Preferred Alternative.

Much as for passenger cars, NHTSA's analysis indicates that regulatory alternatives more stringent than the Preferred Alternative for light trucks might also need to entail significant increases in technology application—including in earlier model years—beyond that reflected by the Preferred Alternative and, even more so, the baseline standards. In addition to many of the technologies discussed above (*e.g.,* advanced transmissions, EPS, significant mass reduction), the agency's analysis of even the 3%/year alternative for light trucks also shows high early-MY application of technologies such as SGDI (35% more in MY 2016), turbocharging with engine downsizing (31% more in MY 2016), cooled EGR (gradually reaching more than five times as many units in MY 2021), and micro and mild hybrid systems (44% more in MY 2016).

This assessment of technology application is important in response to comments suggesting that if technology to meet future standards exists today, and if vehicles currently on the market might be able to meet or exceed their targets in future model years, that must mean that the standards defining such targets are feasible. There is a significant difference in the level of capital and resources required to implement one or more new technologies on a single vehicle model, and the level of capital and resources required to implement those same technologies across the entire vehicle fleet. NHTSA's analysis tries to estimate both manufacturers' redesign cadence which affects when significant new technologies may be most economically added to individual vehicle models as well as the capital, engineering, and manufacturing capacity resource constraints that affect how quickly new technologies may be expanded across manufacturers' products. As illustrated in the discussion of compliance shortfalls, when considering these resource constraints, it would not be economically practicable to expand some the most advanced technologies to every vehicle in the fleet within the rulemaking timeframe, although it should be possible to increase the application of advanced technologies across the fleet in a progression that accounts for those resource constraints. That is what NHTSA's analysis tries to do.

[1271] As NHTSA has long recognized in CAFE rulemakings, while it may be technologically feasible for manufacturers to add technology to their vehicles outside of their normal product redesign and refresh cycles, doing so tends to be significantly more complicated and expensive than adding technology at redesigns and refresh. *See* Section IV.C.2.c.ii for more information about NHTSA's consideration of product development cycles in its modeling analysis.

i. Other Technology Considerations

The discussion above covers application of technology that the agency projects manufacturers may use to meet the standards defined by different regulatory alternatives, but the agency emphasizes that it models only one path to compliance, and we recognize that each manufacturer will pursue their own path which may or may not align with the one we model for them, as they may focus on a different mix of technologies. In terms of how manufacturers will meet the passenger car standards under different alternatives, the agency is concerned that increasing the stringency of passenger cars beyond the Preferred Alternative would increase the risk that manufacturers might reduce the mass of passenger cars beyond the safety-neutral levels evaluated by the agency. Tables IV–37 through IV–40 show the agency's estimates of the rates at which a number of key technologies could be applied in response to standards defined by the No-Action Alternative, the Preferred Alternative, and alternatives specified as annual rates of increase ranging from 2% to 6%. Most of these technologies are already in use on some vehicles available for sale today in the United States (a few, notably high-BMEP (27 bar) cooled EGR engines, are not). However, these technologies are not currently applied throughout the light vehicle fleet and in meetings with the agency manufacturers have expressed concern regarding the potential to increase application rates given constraints such as component supply, engineering resources, and consumer acceptance. While, in the agency's judgment, most of these technologies can become common in the marketplace by MY 2025, we expect that there are limitations on the rates at which adoption of these technologies can be increased, and we consider the outlook for widespread adoption through MY 2025 to be uncertain. At stringencies that require the application of several, but not all, advanced technologies, if a given technology is not as successful as currently assumed in NHTSA's analysis, manufacturers could likely compensate by substituting one or more of the other advanced technologies, and apply mass reduction levels more in line with NHTSA's analysis. However, for regulatory alternatives more stringent than the Preferred Alternative, the agency is concerned that there would be less ''headroom,'' increasing the risk that some manufacturers would resort to mass reduction in ways that could compromise highway safety. This suggests that passenger car standards defined by the 4%/year and faster (in terms of the pace of stringency increases) regulatory alternatives may not be economically practicable, and thus may be beyond the maximum feasible levels for MYs 2017–2025.

Similarly, for light trucks, while many of these powertrain technologies are already achieving notable marketplace success, some (*e.g.,* high BMEP) are not proven in load- and towing-intensive applications, and the agency is concerned that widespread simultaneous increases in the application of many of these advanced technologies is likely to leave manufacturers little room to adjust should some technologies not be as successful as currently reflected in NHTSA's analysis. This suggests that light truck standards defined by the 3%/year and faster (in terms of the pace of stringency increases) regulatory alternatives may not be economically practicable, and thus may be beyond the maximum feasible levels for MYs 2017–2025.

j. Cost of Meeting the Standards

Another consideration for economic practicability is the extent to which new standards could increase the average cost to acquire new vehicles, because even insofar as the underlying application of technology leads to reduced outlays for fuel over the useful lives of the affected vehicles, these per-vehicle cost increases provide both a measure of the degree of challenge faced by manufacturers, and also the degree of adjustment, in the form of potential vehicle price increases, that will ultimately be required of vehicle purchasers. Tables IV–41 through IV–44, below, show the agency's estimates of average cost increase under the Preferred Alternative for passenger cars and light trucks. Because our analysis includes estimates of manufacturers' indirect costs and profits, as well as civil penalties some manufacturers (as allowed under EPCA/EISA) might elect to pay in lieu of achieving compliance with CAFE standards, we report cost increases as estimated average increases in vehicle price (as MSRP). These are average values, and the agency does not expect that the prices of every vehicle would increase by the same amount; rather, the agency's underlying analysis shows unit costs varying widely between different vehicle models. For example, while our analysis shows (as indicated below) an average cost increase of $1,400 for Fiat/Chrysler's MY 2019 passenger cars under the Preferred Alternative, that $1,400 value is the production-weighted average of values ranging from $0 to $3,282. While we recognize that manufacturers might distribute regulatory costs throughout their fleet in order to maximize profit, we have not attempted to estimate strategic pricing. To provide an indication of potential increase relative to today's vehicles, we report increases relative to the market forecast using technology in the MY 2010 fleet—the most recent actual fleet for which we have information sufficient for use in our analysis. We provide results starting in MY 2014 in part to illustrate the cost impacts in the first model year that we believe manufacturers might actually be able to change their products in preparation for compliance with standards in MYs 2017 and beyond:

TABLE IV–41—NHTSA ESTIMATED TOTAL (VS. MY 2010 TECHNOLOGY) AVERAGE MSRP INCREASES DURING MYS 2014–2019 UNDER PREFERRED ALTERNATIVE—PASSENGER CARS

	2014	2015	2016	2017	2018	2019
Industry	537	711	934	1,044	1,166	1,286
Aston Martin	1,753	1,832	2,250	3,397	3,437	3,281
BMW	490	814	1,104	1,205	1,642	1,579
Daimler	1,033	1,128	1,516	1,616	1,670	1,607
Fiat	794	941	1,256	1,250	1,287	1,400
Ford	601	997	1,081	1,285	1,291	1,319
Geely	896	1,031	1,120	1,229	1,538	1,752
General Motors	569	928	1,146	1,148	1,369	1,304
Honda	401	400	760	901	1,069	1,079
Hyundai	408	449	903	1,096	1,076	1,354
Kia	197	374	428	616	675	1,007
Lotus	709	1,502	1,590	1,879	1,942	2,894

TABLE IV–41—NHTSA ESTIMATED TOTAL (VS. MY 2010 TECHNOLOGY) AVERAGE MSRP INCREASES DURING MYS 2014–2019 UNDER PREFERRED ALTERNATIVE—PASSENGER CARS—Continued

	2014	2015	2016	2017	2018	2019
Mazda	645	660	1,302	1,292	1,394	1,278
Mitsubishi	1,153	1,811	1,778	1,749	1,791	1,667
Nissan	836	857	948	1,192	1,275	1,450
Porsche	728	1,045	1,123	1,480	1,650	1,756
Spyker						
Subaru	1,381	1,551	1,497	1,568	1,660	2,271
Suzuki	932	1,265	1,365	1,349	1,356	1,963
Tata	864	974	1,201	1,616	2,212	2,109
Tesla						
Toyota	235	295	418	482	621	996
Volkswagen	234	445	692	802	1,066	1,099

TABLE IV–42—NHTSA ESTIMATED TOTAL (VS. MY 2010 TECHNOLOGY) AVERAGE MSRP INCREASES DURING MYS 2020–2025 UNDER PREFERRED ALTERNATIVE—PASSENGER CARS

	2020	2021	2022	2023	2024	2025
Industry	1,480	1,608	1,699	1,821	2,074	2,153
Aston Martin	3,338	3,963	4,026	4,296	4,765	4,719
BMW	1,652	1,792	1,996	2,128	2,594	2,595
Daimler	1,821	1,893	2,157	2,476	2,566	2,905
Fiat	1,623	1,878	1,888	2,314	2,464	2,666
Ford	1,814	1,850	2,018	2,020	2,477	2,588
Geely	1,784	1,868	1,961	2,123	2,327	2,472
General Motors	1,562	1,659	1,661	1,831	1,981	2,268
Honda	1,067	1,257	1,255	1,490	1,493	1,460
Hyundai	1,362	1,503	1,662	1,689	1,832	1,833
Kia	1,234	1,324	1,571	1,554	1,538	1,730
Lotus	2,952	3,022	3,109	3,339	3,439	3,381
Mazda	1,586	1,568	1,970	2,073	2,067	2,251
Mitsubishi	2,766	3,052	3,016	2,983	2,950	3,017
Nissan	1,506	1,528	1,647	1,752	2,108	2,071
Porsche	1,834	2,018	2,336	2,457	2,571	2,600
Spyker						
Subaru	2,758	2,694	2,645	2,694	5,228	4,457
Suzuki	2,203	2,533	2,526	2,501	2,522	2,666
Tata	2,188	2,216	2,296	2,633	2,724	2,889
Tesla						
Toyota	1,111	1,341	1,397	1,397	1,640	1,578
Volkswagen	1,298	1,460	1,570	1,707	1,932	2,257

TABLE IV–43—NHTSA ESTIMATED TOTAL (VS. MY 2010 TECHNOLOGY) AVERAGE MSRP INCREASES DURING MYS 2014–2019 UNDER PREFERRED ALTERNATIVE—LIGHT TRUCKS

	2014	2015	2016	2017	2018	2019
Industry	705	931	1,159	1,226	1,264	1,377
Aston Martin						
BMW	581	694	1,223	1,751	1,727	1,614
Daimler	838	1,038	1,117	2,162	2,269	2,115
Fiat	1,102	1,499	2,035	2,064	2,046	1,982
Ford	445	1,146	1,140	1,141	1,153	1,145
Geely	833	1,055	1,217	1,257	1,958	1,828
General Motors	775	844	977	1,006	1,034	1,385
Honda	638	709	883	995	1,032	1,018
Hyundai	380	406	405	747	751	1,360
Kia	285	430	1,070	1,119	1,118	1,146
Lotus						
Mazda	842	855	1,046	1,037	1,771	1,612
Mitsubishi	1,406	1,362	1,341	1,323	1,317	1,215
Nissan	818	870	1,091	1,309	1,313	1,440
Porsche	705	1,294	1,328	1,355	1,434	2,379
Spyker						
Subaru	962	954	938	989	1,005	1,399
Suzuki	1,002	1,110	1,360	1,344	1,329	1,209
Tata	798	1,022	2,260	2,276	2,302	2,235
Tesla						
Toyota	610	615	978	968	1,038	1,166

TABLE IV–43—NHTSA ESTIMATED TOTAL (VS. MY 2010 TECHNOLOGY) AVERAGE MSRP INCREASES DURING MYS 2014–2019 UNDER PREFERRED ALTERNATIVE—LIGHT TRUCKS—Continued

	2014	2015	2016	2017	2018	2019
Volkswagen	398	642	731	725	874	957

TABLE IV–44—NHTSA ESTIMATED TOTAL (VS. MY 2010 TECHNOLOGY) AVERAGE MSRP INCREASES DURING MYS 2020–2025 UNDER PREFERRED ALTERNATIVE—LIGHT TRUCKS

	2020	2021	2022	2023	2024	2025
Industry	1,599	1,866	1,893	1,991	2,070	2,125
Aston Martin						
BMW	1,620	1,772	2,094	2,055	2,050	2,063
Daimler	2,104	2,078	2,524	2,546	2,582	2,551
Fiat	2,629	2,719	2,708	3,119	3,074	3,126
Ford	1,242	2,074	2,037	2,016	2,005	2,074
Geely	1,800	1,795	1,992	2,592	2,585	2,537
General Motors	1,828	1,803	1,776	1,774	1,842	2,025
Honda	1,037	1,435	1,563	1,575	1,698	1,663
Hyundai	1,392	1,370	1,607	1,603	1,836	1,774
Kia	1,133	1,584	1,531	1,831	1,794	1,733
Lotus						
Mazda	1,603	1,570	1,549	1,778	1,917	1,853
Mitsubishi	1,197	2,439	2,380	2,346	2,313	2,206
Nissan	1,621	1,682	1,779	1,762	1,971	1,939
Porsche	2,341	2,302	2,303	2,625	2,672	2,620
Spyker						
Subaru	1,378	1,359	1,379	1,344	1,656	1,607
Suzuki	1,193	2,671	2,607	2,569	2,532	2,406
Tata	2,247	2,822	2,899	2,967	3,031	3,020
Tesla						
Toyota	1,168	1,480	1,492	1,695	1,882	1,875
Volkswagen	1,193	1,173	1,177	1,344	1,673	1,890

Relative to current vehicles (as represented here by technology in the MY 2010 fleet, the most recent for which NHTSA has complete data), NHTSA judges these cost increases to be significant, but considering the accompanying fuel savings, likely to be accepted by consumers well enough to avoid undue distortion (*e.g.,* significant shifts—attributable to today's standards—in manufacturers' respective market shares) of the light vehicle market.

However, relative to the Preferred Alternative, NHTSA noted significant further cost increases for several major manufacturers—even in MY 2016—under the 3%/y and 4%/y alternatives for light trucks. Tables IV–45 and IV–46 below show additional costs estimated to be incurred under the 3%/y and 4%/y alternatives as compared to the preferred alternative:

TABLE IV–45—NHTSA ESTIMATED DIFFERENCE BETWEEN ESTIMATED AVERAGE MSRP INCREASE UNDER 3%/Y AND PREFERRED ALTERNATIVES FOR SELECTED MANUFACTURERS' LIGHT TRUCKS

	2014	2015	2016	2017	2018	2019	2020	2021
Industry	116	173	173	210	261	201	120	8
Fiat	164	63	56	139	159	222	(72)	22
Ford	75	481	474	460	487	408	446	(6)
General Motors	278	251	245	279	335	244	(3)	(7)
Mazda	496	443	450	439	177	142	147	153
Mitsubishi	591	580	517	515	636	600	622	(46)

TABLE IV–46—NHTSA ESTIMATED DIFFERENCE BETWEEN ESTIMATED AVERAGE MSRP INCREASES UNDER 4%/Y AND PREFERRED ALTERNATIVES FOR SELECTED MANUFACTURERS' LIGHT TRUCKS

	2014	2015	2016	2017	2018	2019	2020	2021
Industry	148	224	246	288	374	448	455	387
Fiat	173	73	93	179	230	309	142	228
Ford	75	525	517	507	495	541	694	520
General Motors	426	449	454	486	646	790	735	720
Mazda	650	576	596	587	536	480	459	459
Mitsubishi	733	718	652	647	636	633	716	476

For example, in MY 2016, NHTSA estimates that compliance with already-promulgated light truck CAFE standards could increase average MSRP by $1,053, as mentioned above; under the preferred alternative, we estimate that cumulative compliance costs increase to $1,159 due to early application of technology in order to meet future anticipated standards; under the 3%/y and 4%/y alternatives, we estimate this amount would increase to $1,333 and $1,405, respectively. For some manufacturers (*e.g.,* Ford, GM, Mazda, Mitsubishi), these increases are large even prior to MY 2016. Particularly during the earlier model years, the agency is concerned that these further costs represent significant increases in ''lift'' beyond levels anticipated when the MYs 2012–2016 standards were promulgated in MY 2010. In the agency's judgment, these additional costs augment the basis—discussed above in terms of technology application—to determine that light truck standards increasing at a pace of 3%/year or faster after MY2016 are beyond the maximum feasible levels for MYs 2017–2021.

The above considerations relate to matters of technological feasibility and economic practicability—two of the factors NHTSA must take into account when determining the maximum feasible stringency of each standard in each model year. The agency must also consider the need of the nation to conserve energy. Two of the regulatory alternatives the agency has considered—the maximum net benefit (MNB) and total cost = total benefit (TC=TB) alternatives—are defined in terms of explicit quantitative means of weighing all the social costs NHTSA has attempted to quantify against all of the corresponding monetized social benefits (*e.g.,* reduced fuel outlays, reduced environmental damages from motor vehicle GHG emissions) of energy conservation achieved through increases in the stringency of fuel economy standards. As discussed above, the agency has determined that, considering resultant technology application and costs, the standards defined by these two regulatory alternatives exceed maximum feasible levels. Although NHTSA has quantified all regulatory alternatives in terms of their respective costs and monetized benefits, the agency also considers it appropriate to compare alternatives more simply in terms of total fuel savings and average per-vehicle costs. Below, Tables IV–47 through IV–50 present the agency's findings on this basis for passenger cars and light trucks, respectively. Fuel savings are expressed in terms of cumulative incremental fuel savings throughout the useful lives of fleets in all affected model years through MY 2021, measuring savings relative to fuel consumption estimated to occur under the baseline standards defined by the No-Action Alternative. Costs are measured in terms of average incremental MSRP increases relative to average prices estimated to result under the baseline standards defined by the No-Action Alternative.

TABLE IV–47—NHTSA ESTIMATED PASSENGER CAR CUMULATIVE LIFETIME FUEL SAVINGS THROUGH MY 2021 AND AVERAGE VEHICLE COST INCREASES DURING MYS 2014–2021

Alternative	Fleet MY basis	Ave. MSRP increase relative to no-action alternative				Fuel savings (b. gal.) MY2022–2025	Fuel savings (b. gal.) through MY2025
		2022	2023	2024	2025		
2%	2008	566–	611–	628–	644–	30–	53–
	2010	650	705	728	730	28	50
3%	2008	840–	883–	958–	1,059–	43–	78–
	2010	961	1,027	1,102	1,125	41	70
Final Standards	2008	951–	997–	1,081–	1,183–	46–	71–
	2010	948	1,056	1,148	1,226	42	63
4%	2008	1,300–	1,370–	1,530–	1,654–	54–	101–
	2010	1,375	1,500	1,620	1,746	52	88
MNB	2008	2,149–	2,226–	2,383–	2,525–	62–	133–
	2010	2,000	2,120	2,212	2,247	57	101
TC=TB	2008	2,137–	2,258–	2,430–	2,532–	62–	133–
	2010	1,979	2,097	2,182	2,272	57	102
5%	2008	1,991–	2,151–	2,462–	2,619–	63–	118–
	2010	1,882	2,070	2,313	2,498	57	98
6%	2008	2,493–	2,741–	3,104–	3,250–	67–	131–
	2010	2,302	2,585	2,889	3,168	60	104
7%	2008	2,831–	3,127–	3,504–	3,632–	68–	136–
	2010	2,510	2,817	3,267	3,538	62	109

TABLE IV–48—NHTSA ESTIMATED PASSENGER CAR CUMULATIVE LIFETIME FUEL SAVINGS AND AVERAGE VEHICLE COST INCREASES DURING MYS 2022–2025

Alternative	Fleet MY basis	Ave. MSRP increase relative to no-action alternative				Fuel savings (b. gal.) MY2022–2025	Fuel savings (b. gal.) through MY2025
		2022	2023	2024	2025		
2%	2008	638–	677–	730–	758–	40–	65–
	2010	575	629	675	683	39	66
3%	2008	897–	949–	1,110–	1,174–	56–	93–
	2010	868	939	1,009	1,037	57	99
Final Standards	2008	1,272–	1,394–	1,751–	1,827–	68–	113–
	2010	1,091	1,221	1,482	1,578	69	118
4%	2008	1,341–	1,469–	1,779–	1,865–	69–	121–
	2010	1,153	1,292	1,487	1,577	70	124
MNB	2008	1,739–	1,810–	1,964–	1,943–	73–	148–

TABLE IV–48—NHTSA ESTIMATED PASSENGER CAR CUMULATIVE LIFETIME FUEL SAVINGS AND AVERAGE VEHICLE COST INCREASES DURING MYs 2022–2025—Continued

Alternative	Fleet MY basis	Ave. MSRP increase relative to no-action alternative				Fuel savings (b. gal.) MY2022–2025	Fuel savings (b. gal.) through MY2025
		2022	2023	2024	2025		
	2010	1,593	1,772	2,096	2,104	78	154
TC=TB	2008	2,041–	2,189–	2,568–	2,475–	80–	158–
	2010	1,755	2,086	2,524	2,488	82	159
5%	2008	1,797–	2,152–	2,730–	2,719–	81–	141–
	2010	1,599	1,970	2,624	2,648	82	146
6%	2008	2,245–	2,677–	3,391–	3,513–	86–	152–
	2010	2,183	2,408	3,315	3,461	88	159
7%	2008	2,938–	3,579–	4,223–	4,121–	92–	164–
	2010	3,091	3,514	3,977	3,970	95	172

TABLE IV–49—NHTSA ESTIMATED LIGHT TRUCK CUMULATIVE LIFETIME FUEL SAVINGS THROUGH MY 2021 AND AVERAGE VEHICLE COST INCREASES DURING MYs 2014–2021

Alternative	Fleet MY basis	Ave. MSRP increase relative to no-action alternative								Fuel savings (b. gal.) through MY2021
		2014	2015	2016	2017	2018	2019	2020	2021	
2%	2008	62–	85–	101–	177–	244–	335–	429–	522–	24–
	2010	113	231	266	327	378	452	533	607	22
3%	2008	88–	168–	197–	270–	371–	506–	633–	767–	35–
	2010	129	242	280	357	458	598	750	916	29
Final Standards	2008	04–	07–	14–	78–	192–	423–	622–	854–	25–
	2010	13	69	106	147	196	397	629	908	21
4%	2008	134–	248–	300–	393–	546–	788–	998–	1,201–	46–
	2010	161	294	353	435	571	845	1,085	1,295	36
MNB	2008	595–	823–	973–	1,296–	1,535–	1,684–	1,915–	2,025–	71–
	2010	260	473	535	705	854	1,222	1,593	1,957	44
TC=TB	2008	618–	845–	999–	1,354–	1,572–	1,708–	1,938–	2,062–	71–
	2010	273	482	558	742	903	1,260	1,610	1,943	45
5%	2008	223–	348–	413–	550–	770–	1,125–	1,556–	1,845–	56–
	2010	249	459	504	607	806	1,100	1,434	1,737	41
6%	2008	379–	538–	654–	774–	1,042–	1,344–	1,907–	2,313–	64–
	2010	283	477	539	664	906	1,262	1,630	2,005	44
7%	2008	438–	626–	739–	878–	1,190–	1,565–	2,263–	2,622–	68–
	2010	296	486	566	719	1,018	1,528	1,906	2,316	47

TABLE IV–50—NHTSA ESTIMATED LIGHT TRUCK CUMULATIVE LIFETIME FUEL SAVINGS AND AVERAGE VEHICLE COST INCREASES DURING MY2022–2025

Alternative	Fleet MY basis	Ave. MSRP increase relative to no-action alternative				Fuel savings (b. gal.) MY2022–2025	Fuel savings (b. gal.) through MY2025
		2022	2023	2024	2025		
2%	2008	566–	611–	628–	644–	30–	53–
	2010	650	705	728	730	28	50
3%	2008	840–	883–	958–	1,059–	43–	78–
	2010	961	1,027	1,102	1,125	41	70
Final Standards	2008	951–	997–	1,081–	1,183–	46–	71–
	2010	948	1,056	1,148	1,226	42	63
4%	2008	1,300–	1,370–	1,530–	1,654–	54–	101–
	2010	1,375	1,500	1,620	1,746	52	88
MNB	2008	2,149–	2,226–	2,383–	2,525–	62–	133–
	2010	2,000	2,120	2,212	2,247	57	101
TC=TB	2008	2,137–	2,258–	2,430–	2,532–	62–	133–
	2010	1,979	2,097	2,182	2,272	57	102
5%	2008	1,991–	2,151–	2,462–	2,619–	63–	118–
	2010	1,882	2,070	2,313	2,498	57	98
6%	2008	2,493–	2,741–	3,104–	3,250–	67–	131–
	2010	2,302	2,585	2,889	3,168	60	104
7%	2008	2,831–	3,127–	3,504–	3,632–	68–	136–
	2010	2,510	2,817	3,267	3,538	62	109

Through MY 2021, the Preferred Alternative for passenger cars is more stringent than the 2%/Year and 3%/Year alternatives. In MY 2021, the Preferred Alternative for light trucks is more stringent than the 2%/Year alternative, but it is less stringent than the 2%/Year alternative in earlier model years. During MYs 2022–2025, the preferred alternatives for passenger cars and light trucks are both more than the corresponding 2%/Year and 3%/Year alternatives.The tables above show that, according to our analysis, the Preferred Alternative for passenger cars achieves considerably more in fuel savings through MY 2021 and during MYs 2022–2025 than the less stringent alternatives, still at a cost that the agency deems to be economically practicable if it was passed directly on to consumers in the form of MSRP increases. For light trucks, the agency's analysis indicates that, through MY 2012, the Preferred Alternative achieves fuel savings very similar to the 2%/Year alternative, while incurring early-MY costs the agency considers economically practicable. During MYs 2022–2025, our analysis indicates the Preferred Alternative for light trucks achieves greater fuel savings than the 3%/Year alternative, while still incurring costs the agency considers economically practicable.

Based on recent EIA estimates of future fuel prices, the fuel savings presented above will significantly reduce future outlays for fuel purchases, and will significiantly reduce future CO_2 emissions. Setting aside outlays for fuel taxes (which, as explained below, are economic transfers), accounting for estimated economic externalities associated with petroleum use and CO_2 emissions, and accounting for other impacts (*e.g.,* increased congestion, reduced VOC emissions) with estimable economic value, we have also estimated the total social costs and benefits relative to the baseline standards. Chapter X of the FRIA accompanying today's notice documents these estimates for each regulatory alternative. While the FRIA presents year-by-year results, Tables IV–51 and IV–52, below, summarize cumulative results for model years covered by today's final (*i.e.,* through MY 2021) and augural (*i.e.,* during MYs 2022–2025) standards.

TABLE IV–51—NHTSA ESTIMATED BENEFITS AND COSTS ($B) RELATIVE TO PREFERRED ALTERNATIVE—PASSENGER CARS

Regulatory alternative	MY Basis	Through MY2021			MY2022–2025			Through MY2025		
		Benefits	Costs	Net benefits	Benefits	Costs	Net benefits	Benefits	Costs	Net benefits
2%/Year	2008 2010	90– 97	23– 24	67– 73	145– 142	35– 31	111– 111	235– 239	57– 56	178– 184
3%/Year	2008 2010	131– 148	32– 34	100– 114	203– 208	48– 44	155– 163	334– 356	80– 79	255– 277
Preferred	2008 2010	158– 170	40– 42	118– 128	246– 250	71– 60	175– 190	404– 420	111– 102	293– 317
4%/Year	2008 2010	180– 188	47– 46	133– 142	249– 255	73– 61	176– 193	429– 443	120– 107	309– 336
5%/Year	2008 2010	208– 222	60– 61	148– 162	281– 288	104– 96	177– 192	489– 510	164– 156	326– 354

TABLE IV–52—NHTSA ESTIMATED BENEFITS AND COSTS ($B) RELATIVE TO PREFERRED ALTERNATIVE—LIGHT TRUCKS

Regulatory alternative	MY basis	Through MY2021			MY2022–2025			Through MY2025		
		Benefits	Costs	Net benefits	Benefits	Costs	Net benefits	Benefits	Costs	Net benefits
2%/Year	2008 2010	82– 75	12– 17	70– 59	109– 101	16– 17	92– 84	191– 177	29– 34	162– 143
3%/Year	2008 2010	122– 101	18– 21	104– 79	155– 145	24– 25	131– 120	277– 246	42– 46	235– 200
Preferred	2008 2010	88– 71	13– 14	74– 57	165– 150	26– 26	139– 124	253– 221	40– 40	213– 181
4%/Year	2008 2010	160– 124	28– 28	133– 95	197– 183	35– 36	161– 147	357– 307	63– 64	294– 243
5%/Year	2008 2010	192– 139	41– 39	151– 100	222– 202	54– 49	168– 153	414– 340	95– 88	319– 253

Our analysis indicates that both through MY 2021 and during MYs 2022–2025, the Preferred Alternative for passenger cars yields significantly greater net benefits than the 3%/Year alternative, and yields almost as much net benefit as the 4%/Year alternative. Through MY 2021, our analysis indicates that the Preferred Alternative for light trucks yields greater net benefits that the 2%/Year alternative, at similar social cost. Our analysis also indicates net benefits through MY 2021 would be higher under the 3%/Year alternative for light trucks, but the social costs would potentially be 50% higher than under the Preferred Alternative. During MYs 2022–2025, our analysis indicates that the Preferred Alternative would produce greater net benefits than the 3%/Year alternative, and would do so at very similar cost. Our analysis also that net benefits during MYs 2022–2025 would be higher under the 4%/Year alternative for light trucks, but that social costs would be more than 30% higher than under the Preferred Alternative.

Alternatives less stringent than the Preferred Alternatives would still be economically practicable, but in terms of the technology that they might leave on the table, the agency concludes that they would not meet the need of the nation to conserve energy, and would thus be below maximum feasible.

k. Uncertainty and Consumer Acceptance of Technologies

In evaluating economic practicability, while 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 with manufacturers that there could conceivably be compromises to vehicle utility depending on the technologies chosen to meet the potential new standards. 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 the feedback from stakeholders received prior to and in response to the NPRM, 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 consideration of the information before the agency and how it informs our balancing of the factors, NHTSA concludes that the points raised by stakeholders support NHTSA's careful consideration of the factors described above, which take into account a level of uncertainty that surrounds economic practicability in these future model years. We believe the level of uncertainty that we have factored into the analysis is reasonable and do not agree that uncertainty levels are nearly as significant as a number of manufacturers maintained, especially for passenger cars that would suggest that the preferred alternative is not economically practicable. The most persuasive information received from stakeholders for passenger cars concerned practicability issues in MYs 2017–2021, which the agency's analysis generally supports. 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 impact their ability to also support the development and implementation of technologies across their light truck fleet, and well as to conduct the engineering development and future investment necessary comply with the preferred alternative's more stringent standards in the later years. Thus, after considerable deliberation, we conclude that the stringency levels required by the Preferred Alternative for passenger cars, which increase on average 3.6%/y in MYs 2017–2021 (only slightly different from the 4%/y levels) are economically practicable, but that the 4%/y alternative and higher alternatives are likely not economically practicable.

Regarding light trucks, while NHTSA does not agree with the manufacturers' overall cost assessments expressed to us last summer prior to issuance of the NPRM, and believes, based on our analysis using our technology cost and effectiveness assumptions, that manufacturers should be able to preserve all necessary vehicle utility. NHTSA does 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, and we have incorporated those considerations into our assessment for this final rule. Based on our assessment, we believe that alternatives more stringent than the preferred alternative could lead manufacturers to implement technologies that do not maintain vehicle utility, based on the cadence of the standards under the more stringent alternatives. As discussed above, 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 is 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. Especially for light trucks, these risks appear most pronounced during MYs 2017–2021, as evidenced by the agency's analysis indicating that, given our expectations regarding manufacturers' product cadence (*i.e.,* redesign schedules) increasing stringency beyond baseline standards during the few model years following MY 2016 could necessitate considerable additional technology and cost even prior to MY 2016. The best information that the agency has at this time, therefore, indicates that requiring light truck fuel economy improvements at rates more stringent than the preferred alternative could create potentially severe economic consequences, and likely would not be economically practicable.

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 2017–2021. Based on that consideration of the information before the agency and how it informs our balancing of the factors, NHTSA has concluded for the final standards for MYs 2017–2021 that 4%/y CAFE stringency increases for passenger cars and 3%/y stringency increases for light trucks are economically impracticable. NHTSA therefore concludes that the preferred alternative, which would in MYs 2017–2021 increase on average 3.8%/y for passenger cars and 2.5%/y for light trucks, is the most stringent alternative that is still economically practicable in those model years.

As discussed above, the question of the tipping point is slightly different in the context of the final standards and augural standards. The augural standards for MYs 2022–2025 are distant, and while manufacturers benefit from regulatory certainty, no manufacturer has begun to plan in earnest for vehicles that they expect to produce in that time frame. Moreover, the inputs that inform our balancing are less certain. We reiterate that the agency's assessment of what augural standards would be maximum feasible is based on the best, most transparent information available to the agency today, and that the final standards for

MYs 2022–2025 will be determined in a future rulemaking, at which time the agency expects to have much new information that may affect how it chooses to balance the relevant factors at that time.

Recognizing that the augural standards are distant, and that manufacturers do not yet have fixed plans for those model years, the agency believes that despite considerable uncertainty, economic practicability may not necessarily be as limiting for MYs 2022–2025 as we conclude it is for MYs 2017–2021. Our analysis showed that shortfalls did not begin to accrue for the passenger car standards until the 5%/y alternative, for example, as the table below demonstrates. For light trucks, the analysis showed increasing shortfall risk for more manufacturers in MYs 2022–2025 under the 5%/y alternative. Other indicators of economic practicability confirmed that the 5%/y alternative was likely not economically practicable in MYs 2022–2025, but that the 4%/y and slower alternatives would likely leave technology on the table unnecessarily. NHTSA therefore concludes that the preferred alternative, which would in MYs 2022–2025 increase on average 4.7%/y for passenger cars and 4.8%/y for light trucks, is the most stringent alternative that would still be economically practicable in those model years.

The reader will likely note that in most model years, the difference between the final/augural standards and the next most stringent alternative is minor. The agency grappled with whether the 4%/y alternative for the final passenger car standards, the 3%/y alternative for the final light truck standards, and the 5%/y alternative for the augural standards might be maximum feasible, given that they would save 5–7% and 8–11% more fuel, respectively, for passenger cars and light trucks, respectively, for 5–8% and 5–15% more cost, respectively, as compared to the final and augural standards presented here.

As discussed above, while consideration of future model years in isolation might suggest manufacturers have ample lead time to make further improvements, that is not how industry responds to standards, and NHTSA thus tries to account for manufacturers' product cadence and use of multiyear planning in its analysis in order to improve how accurately we reflect practicability. NHTSA now has standards in place for MY 2012, the current model year, through MY 2016, is finalizing standards for MYs 2017–2021, and is presenting a potential road map of standards for MYs 2022–2025. Manufacturers will be making concurrent and continual fuel economy improvements to both their car and truck fleets in response to these standards for well beyond their current product plans. The agency's analysis includes an assumption of market-driven improvements to fuel economy across a manufacturer's fleet (*i.e.,* improvements beyond those required by the standards); if this is the case, then all of these improvements will be made along with, or at the expense of, improvements to every other facet of vehicle performance during the 2012–2025 time frame. We expect that the standards will therefore cause manufacturers to be more resource-constrained in the future than they may have been in the past, given that improvements will be required in every year for over ten years, and given uncertainty with regard to future fuel prices and consumer demand for fuel economy, and thus manufacturers' ability to sell the vehicles that they make in response to the standards. This uncertainty is inherent in the agency's analysis of alternative standards: We model only one path to compliance, and we cannot possibly have perfect information about every input to that analysis, even if the information is the best and most transparent available. NHTSA believes that standards set at the finalized levels for MYs 2017–2021 will help address concerns raised by manufacturer stakeholders and reduce the risk for adverse economic consequences during that time frame. Given the year-over-year challenge of the standards and the ''lift'' required to meet the final standards for MYs 2017–2021, NHTSA believes that the final standards, as proposed, are maximum feasible for those model years.

With regard to the augural standards for MYs 2022–2025, the time frame and the uncertainty makes evaluation of maximum feasible levels more challenging, but NHTSA believes that 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 considerable increases in stringency by then, and help to ensure most of the substantial improvements in fuel efficiency initially envisioned over the entire period and supported by other stakeholders. This helps give NHTSA more confidence that a balancing that weights the need of the nation to conserve energy slightly more heavily and economic practicability slightly less heavily in MYs 2022–2025 is maximum feasible for the augural standards.

The final and augural 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,[1272] 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 final standards, the agencies' stringency curves are equivalent, except for the fact that the stringency of EPA's 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),[1273] 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 final standards for passenger cars for MYs 2017–2025 align with the stringency of EPA's equivalent standards when these differences are considered.

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 (although EPA predicts 100% of manufacturers will use substitute refrigerants by MY 2021, and the GHG standards assume this rate of substitution) and/or a higher penetration of PHEVs, EVs and FCVs,

[1272] 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.

[1273] 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.

then NHTSA's 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. Several manufacturers commented on this point and suggested that this meant that the standards were not aligned, because NHTSA's standards might be more stringent in some years than EPA's. This reflects a misunderstanding of the agencies' purpose. The agencies have sought to craft harmonized standards such that manufacturers may build a single fleet of vehicles to meet both agencies' requirements. That is the case for these final standards. Manufacturers will have to plan their compliance strategies considering both the NHTSA standards and the EPA standards and assure that they are in compliance with both, but they can still build a single fleet of vehicles to accomplish that goal. NHTSA is thus finalizing 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 final and augural CAFE standards with EPA's final standards.

Thus, NHTSA has concluded that the standards represented by the preferred alternative are the maximum feasible standards for passenger cars and light trucks in MYs 2017–2021, and that the augural standards presented for MYs 2022–2025 would be maximum feasible in those model years, based on the information currently before the agency, had we the authority to finalize them at this time. 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 conclude that higher standards would not represent the proper balancing for MYs 2017–2025 cars and trucks.[1274] We conclude that the correct balancing recognizes economic practicability concerns as discussed above, and sets standards at the levels that the agency is promulgating in this final rule for MYs 2017–2021 and presenting for MYs 2022–2025.[1275] 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 represent 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. 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 $185–192 billion over the lifetime of the vehicles covered by the final standards for MYs 2017–2021, and by $314 billion over the lifetime of the vehicles covered by the final standards for MYs 2022–2025. In full consideration of all of the information currently before the agency, we have weighed the statutory factors carefully and selected final passenger car and light truck standards for MYs 2017–2021 and presented augural passenger car and light truck standards for MYs 2022–2025 that we believe are the maximum feasible.

G. Impacts of the Final 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 final and augural CAFE and CO_2 emissions standards, NHTSA estimates that the final and augural 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 between 48.7 and 49.7 mpg in that model year:

TABLE IV–53—NHTSA ESTIMATED REQUIRED AVERAGE FUEL ECONOMY (MPG) UNDER THE FINAL STANDARDS—MYS 2017–2021

	MY Baseline	2017	2018	2019	2020	2021
Passenger cars	2008–2010	40.1–39.6	41.6–41.1	43.1–42.5	44.8–44.2	46.8–46.1
Light trucks	2008–2010	29.4–29.1	30.0–29.6	30.6–30.0	31.2–30.6	33.3–32.6
Combined	2008–2010	35.4–35.1	36.5–36.1	37.7–37.1	38.9–38.3	41.0–40.3

TABLE IV–54—NHTSA ESTIMATED REQUIRED AVERAGE FUEL ECONOMY (MPG) UNDER THE AUGURAL STANDARDS—MYS 2022–2025

	MY Baseline	2022	2023	2024	2025
Passenger cars	2008–2010	49.0–48.2	51.2–50.5	53.6–52.9	56.2–55.3
Light trucks	2008–2010	34.9–34.2	36.6–35.8	38.5–37.5	40.3–39.3
Combined	2008–2010	43.0–42.3	45.1–44.3	47.4–46.5	49.7–48.7

[1274] 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 concluded would be maximum feasible for MYs 2017–2025, and thus setting standards at that level would be inconsistent with the requirements of EPCA/EISA to set maximum feasible standards.

[1275] We underscore that the agency's 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 final rule. 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 factors.

Accounting for differences between fuel economy levels under laboratory conditions and operating conditions in the real world, NHTSA estimates that these requirements would translate into the following required average on-road fuel economy levels using on-road fuel economy:

TABLE IV–55—NHTSA ESTIMATED REQUIRED AVERAGE FUEL ECONOMY (ON-ROAD MPG) UNDER THE FINAL STANDARDS—MYS 2017–2021

	MY Baseline	2017	2018	2019	2020	2021
Passenger cars	2008–2010	32.1–31.7	33.3–32.8	34.5–34.0	35.9–35.3	37.4–36.8
Light trucks	2008–2010	23.6–23.3	24.0–23.7	24.5–24.0	24.9–24.5	26.6–26.1
Combined	2008–2010	28.3–28.1	29.2–28.9	30.1–29.7	31.1–30.6	32.8–32.3

TABLE IV–56—NHTSA ESTIMATED REQUIRED AVERAGE FUEL ECONOMY (ON-ROAD MPG) UNDER THE AUGURAL STANDARDS—MYS 2022–2025

	MY Baseline	2022	2023	2024	2025
Passenger cars	2008–2010	39.2–38.6	41.0–40.4	42.9–42.3	44.9–44.3
Light trucks	2008–2010	27.9–27.4	29.3–28.7	30.8–30.0	32.2–31.5
Combined	2008–2010	34.4–33.9	36.1–35.5	37.9–37.2	39.8–39.0

For the reader's reference, these mpg levels would translate to the following in gallons per mile:

TABLE IV–57—NHTSA ESTIMATED REQUIRED AVERAGE FUEL ECONOMY (GPM) UNDER THE FINAL STANDARDS—MYS 2017–2021

	MY Baseline	2017	2018	2019	2020	2021
Passenger cars	2008–2010	0.0249–0.0252.	0.0240–0.0244.	0.0232–0.0235.	0.0223–0.0226.	0.0214–0.0217
Light trucks	2008–2010	0.0340–0.0344.	0.0333–0.0338.	0.0327–0.0333.	0.0321–0.0326.	0.0300–0.0306
Combined	2008–2010	0.0282–0.0285.	0.0274–0.0277.	0.0265–0.0270.	0.0257–0.0261.	0.0244–0.0248

TABLE IV–58—NHTSA ESTIMATED REQUIRED AVERAGE FUEL ECONOMY (GPM) UNDER THE AUGURAL STANDARDS—MYS 2022–2025

	MY Baseline	2022	2023	2024	2025
Passenger cars	2008 2010	0.0204 – 0.0207	0.0195 – 0.0198	0.0187 – 0.0189	0.0178 – 0.0181
Light trucks	2008 2010	0.0287– 0.0292	0.0273– 0.0279	0.0260– 0.0266	0.0248– 0.0254
Combined	2008 2010	0.0233– 0.0236	0.0222– 0.0226	0.0211– 0.0215	0.0201– 0.0205

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,[1276] average achieved fuel economy levels would correspondingly increase through MY 2025, but that manufacturers would, on average, under-comply [1277] in some model years and over-comply [1278] in others, reaching a combined average fuel economy in a range from 48.1 mpg to 48.8 mpg (taking into account estimated adjustments reflecting improved air conditioner efficiency) in MY 2025:

[1276] 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.

[1277] ''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.

[1278] 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–59—NHTSA ESTIMATED ACHIEVED AVERAGE FUEL ECONOMY (MPG) UNDER THE FINAL STANDARDS—MYS 2017–2021

	MY Baseline	2017	2018	2019	2020	2021
Passenger cars	2008	40.4–	42.6–	44.7–	47.2–	49.0–
	2010	40.3	41.8	44.1	46.3	48.1
Light trucks	2008	30.0–	31.1–	33.0–	34.5–	36.8–
	2010	29.8	30.2	31.8	33.3	35.5
Combined	2008	35.9–	37.6–	39.7–	41.9–	43.9–
	2010	35.8	36.8	38.8	40.8	42.9

TABLE IV–60—NHTSA ESTIMATED ACHIEVED AVERAGE FUEL ECONOMY (MPG) UNDER THE AUGURAL STANDARDS—MYS 2022–2025

	MY Baseline	2022	2023	2024	2025
Passenger cars	2008	50.2–	51.2–	53.0–	54.4–
	2010	49.2	50.9	52.7	54.1
Light trucks	2008	37.7–	38.4–	39.4–	40.3–
	2010	36.2	37.3	38.4	39.3
Combined	2008	45.0–	46.0–	47.6–	48.8–
	2010	43.8	45.3	46.8	48.1

For the reader's reference, these mpg levels would translate to the following in gallons per mile:

TABLE IV–61—NHTSA ESTIMATED ACHIEVED AVERAGE FUEL ECONOMY (GPM) UNDER THE FINAL STANDARDS—MYS 2017–2021

	MY Baseline	2017	2018	2019	2020	2021
Passenger cars	2008	0.0245–	0.0233–	0.0222–	0.0212–	0.0204–
	2010	0.0248	0.0239	0.0227	0.0216	0.0208
Light trucks	2008	0.0324–	0.0312–	0.0295–	0.0284–	0.0273–
	2010	0.0336	0.0331	0.0315	0.0300	0.0281
Combined	2008	0.0274–	0.0261–	0.0248–	0.0237–	0.0228–
	2010	0.0279	0.0272	0.0258	0.0245	0.0233

TABLE IV–62—NHTSA ESTIMATED ACHIEVED AVERAGE FUEL ECONOMY (GPM) UNDER THE AUGURAL STANDARDS—MYS 2022–2025

	MY Baseline	2022	2023	2024	2025
Passenger cars	2008	0.0199–	0.0195–	0.0188–	0.0184–
	2010	0.0203	0.0197	0.0190	0.0185
Light trucks	2008	0.0266–	0.0261–	0.0254–	0.0249–
	2010	0.0276	0.0268	0.0261	0.0255
Combined	2008	0.0222–	0.0218–	0.0210–	0.0205–
	2010	0.0228	0.0221	0.0214	0.0208

The estimated achieved average fuel economy levels presented above all derive from analysis that does not attempt to estimate the potential that today's attribute-based standards might induce shifts in vehicle footprint—shifts that would change manufacturers' average required and achieved fuel economy levels. As discussed above in Sections II.C and IV.D, the agency judges today's standards unlikely to induce significant shifts in vehicle footprint. We note, however, that comments by CBD, ACEEE, NACAA, and an individual, Yegor Tarazevich, referenced a 2011 study by Whitefoot and Skerlos, ''Design incentives to increase vehicle size created from the U.S. footprint-based fuel economy standards.'' [1279] This study concluded that MY 2014 standards, as proposed, ''create an incentive to increase vehicle size except when consumer preference for vehicle size is near its lower bound and preference for acceleration is near its upper bound.'' [1280] The commenters who cited this study generally did so as part of arguments in favor of flatter standards (*i.e.,* curves that are flatter across the range of footprints) for MYs 2017–2025. While NHTSA considers the concept of the Whitefoot and Skerlos analysis to have some potential merits, it is also important to note that, among other things, the authors assumed different inputs than NHTSA actually used in the MYs 2012–2016 rule regarding the baseline fleet, the cost and efficacy of potential future technologies, and the relationship between vehicle footprint and fuel economy.

[1279] *Available at http://energy.umich.edu/wp-content/uploads/Whitefoot_Skerlos_CAFE–SIZE.pdf, last accessed August 3, 2012.*

[1280] Ibid, pg 9.

Were NHTSA to use the Whitefoot and Skerlos methodology (*e.g.,* methods to simulate manufacturers' potential decisions to increase vehicle footprint) with the actual inputs to the MYs 2012–2016 rules, the agencies would likely obtain different findings. Underlining the potential uncertainty, the authors obtained a wide range of results in their analyses. Insofar as Whitefoot and Skerlos found, for some scenarios, that manufacturers might respond to footprint-based standards by deliberately increasing vehicle footprint, these findings are attributable to a combination of (a) the assumed baseline market characteristics, (b) the assumed cost and fuel economy impacts involved in increasing vehicle footprint, (c) the footprint-based fuel economy targets, and (d) the assumed consumer preference for vehicle size. Changes in any of these assumptions could yield different analytic results, and potentially result in different technical implications for NHTSA action. As the authors note when interpreting their results: ''designing footprint-based fuel-economy standards in practice such that manufacturers have no incentive to adjust the size of their vehicles appears elusive at best and impossible at worst.''

Regarding the cost impacts of footprint increases, that authors make an *ad hoc* assumption that footprint changes would incur costs linearly, such that a 1% change in footprint would entail a 1% increase in production costs. The authors refer to this as a conservative assumption, but present no supporting evidence. NHTSA has not attempted to estimate the engineering cost to increase vehicle footprint, but we expect that it would be considerably nonlinear, with costs increasing rapidly once increases available through small incremental changes—most likely in track width—have been exhausted.[1281] Moreover, we expect that were a manufacturer to deliberately increase footprint in order to ease compliance burdens, it would confine any significant changes to coincide with vehicle redesigns, and engaging in multiyear planning, would consider how the shifts would impact compliance burdens and consumer desirability in ensuing model years. With respect to the standards promulgated today, the standards become flatter over time, thereby diminishing any ''reward'' for deliberately increasing footprint beyond normal market expectations.

Regarding the fuel economy impacts of footprint increases, the authors present a regression analysis based on which increases in footprint are estimated to entail increases in weight which are, in turn, estimated to entail increases in fuel consumption. However, this relationship was not the relationship the agencies used to develop the MY 2014 standards the authors examine in that study. Where the target function's slope is similar to that of the tendency for fuel consumption to increase with footprint, fuel economy should tend to decrease approximately in parallel with the fuel economy target, thereby obviating the ''benefit'' of deliberate increases in vehicle footprint. NHTSA's analysis supporting today's final rule indicates relatively wide ranges wherein the relationship between fuel consumption and footprint may reasonably be specified. The underlying slopes selected for purposes of defining MY 2017 and beyond standards fall toward the flatter end of those reasonable ranges. Therefore, while the agencies expect the standards to have little tendency to induce deliberate changes in vehicle size, the agencies would have more reason to expect that such changes would be slightly in the direction of *reducing* vehicle footprint in order to increase achieved fuel economy levels by more than the increase in the corresponding fuel economy targets.

Nonetheless, NHTSA considers the concept of the authors' investigation to have merits. In support of today's rulemaking, NHTSA considered including footprint increases as a ''technology'' available in its analysis, such that its CAFE model would increase footprint in cases where the cost to do so would be attractive considering both the accompanying decrease in the fuel economy target (if the vehicle is not on the flat portion of the target function) and the accompanying decrease in vehicle fuel economy. However, NHTSA was unable to estimate the underlying cost function and complete and test this approach in time to support today's final rule. In support of future NHTSA rulemakings, NHTSA plans to further investigate methods to estimate the potential that standards might tend to induce changes in the footprint.

Accounting for differences between fuel economy levels under laboratory conditions and real-world driving behavior, NHTSA estimates that these requirements would translate into the following achieved average on-road fuel economy levels:

TABLE IV–63—NHTSA ESTIMATED ACHIEVED AVERAGE FUEL ECONOMY (ON-ROAD MPG) UNDER THE FINAL STANDARDS—MYS 2017–2021

	MY Baseline	2017	2018	2019	2020	2021
Passenger cars	2008	32.3–	34.1–	35.7–	37.8–	39.2–
	2010	32.2	33.4	35.3	37.0	38.5
Light trucks	2008	24–	24.9–	26.4–	27.6–	29.4–
	2010	23.8	24.2	25.4	26.6	28.4
Combined	2008	28.7–	30.1–	31.7–	33.5–	35.1–
	2010	28.6	29.4	31.0	32.6	34.3

TABLE IV–64—NHTSA ESTIMATED ACHIEVED AVERAGE FUEL ECONOMY (ON-ROAD MPG) UNDER THE AUGURAL STANDARDS—MYS 2022–2025

	MY Baseline	2022	2023	2024	2025
Passenger cars	2008	40.1–	41–	42.4–	43.5–
	2010	39.4	40.7	42.2	43.3
Light trucks	2008	30.1–	30.7–	31.5–	32.2–
	2010	29	29.8	30.7	31.4
Combined	2008	36.0–	36.8–	38.1–	39.0–

[1281] See, *e.g.,* 71 FR 17595 (Apr. 6, 2006).

TABLE IV–64—NHTSA ESTIMATED ACHIEVED AVERAGE FUEL ECONOMY (ON-ROAD MPG) UNDER THE AUGURAL STANDARDS—MYS 2022–2025—Continued

	MY Baseline	2022	2023	2024	2025
	2010	35.0	36.2	37.4	38.5

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 final standards could increase achieved fuel economy levels by average amounts of up to 0.7 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.[1282] 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 a range from 180 billion to 184 billion gallons during the useful lives of vehicles manufactured in MYs 2017–2025 and the few MYs preceding MY 2017:

TABLE IV–65—NHTSA ESTIMATED FUEL SAVED (BILLION GALLONS) UNDER THE FINAL AND AUGURAL STANDARDS

Model year	MY Baseline	Earlier	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
PC	2008	5.3–	2.8–	5.3–	7.7–	10.9–	13.0–	14.4–	15.8–	18.0–	19.7–	112.9–
	2010	7.7	3.6	5.3	8.3	10.8	13.0	14.3	16.2	18.3	20.0	117.4
LT	2008	0.5–	1.0–	2.5–	4.8–	6.8–	9.4–	10.3–	10.9–	11.8–	12.7–	70.7–
	2010	0.9	0.8	1.5	3.7	5.6	8.2	8.9	10.0	11.1	12.1	62.9
Combined	2008	5.9–	3.9–	7.8–	12.5–	17.7–	22.3–	24.7–	26.7–	29.8–	32.4–	183.5–
	2010	8.6	4.4	6.7	12.0	16.4	21.1	2.32	26.2	29.5	32.1	180.3

The agency also estimates that these new CAFE standards would lead to corresponding reductions of CO_2 emissions totaling a range from 1,950 million metric tons (mmt) to 1,990 mmt during the useful lives of vehicles sold in MYs 2017–2025 and the few MYs preceding MY 2017:

TABLE IV–66—NHTSA ESTIMATED CARBON DIOXIDE EMISSIONS AVOIDED (MMT) UNDER THE FINAL AND AUGURAL STANDARDS

Model year	MY Baseline	Earlier	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
PC	2008	58–	31–	58–	84–	117–	140–	156–	171–	193–	211–	1,218–
	2010	84	40	57	90	117	141	156	176	199	216	1,276
LT	2008	6–	11–	27–	52–	74–	102–	112–	119–	129–	138–	769–
	2010	10	9	16	40	60	88	96	108	120	131	677
Combined	2008	64–	42–	85–	136–	191–	242–	268–	290–	321–	349–	1,987–
	2010	94	48	73	130	178	229	252	284	318	347	1,953

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 presented today for MY 2025 would be established for subsequent model years, the effects of the 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–67 shows, NHTSA estimates that the fuel economy increases resulting from the final standards will lead to reductions in total fuel consumption by cars and light trucks of 3 billion gallons during 2020, increasing to a range from 38 billion to 44 billion gallons by 2060. Over the period from 2017, when the final standards would begin to take effect, through 2060, cumulative fuel savings would total between 1,080 billion and 1,190 billion gallons, as Table IV–67 also indicates.

[1282] 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 RIA, NHTSA's 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–67—NHTSA ESTIMATED REDUCTION IN FLEET-WIDE FUEL USE (BILLION GASOLINE GALLON EQUIVALENTS) UNDER THE FINAL AND AUGURAL STANDARDS

	MY Baseline	2020	2030	2040	2050	2060	Total 2017–2060
Passenger cars	2008	2–	11–	17–	20–	23–	620–
	2010	2	11	16	18	20	572
Light trucks	2008	1–	10–	16–	19–	22–	574–
	2010	1	9	14	16	18	506
Combined	2008	3–	21–	32–	39–	44–	1,194–
	2010	3	20	30	34	38	1,078

The energy security analysis conducted for this rule estimates that the world price of oil will fall modestly in response to lower U.S. demand for refined fuel. One potential result of this decline in the world price of oil would be an increase in the consumption of petroleum products outside the U.S., which would in turn lead to a modest increase in emissions of greenhouse gases, criteria air pollutants, and airborne toxics from their refining and use. While additional information would be needed to analyze this ''leakage effect'' in detail, NHTSA provides a sample estimate of its potential magnitude in its Final EIS. 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. would decline by between 36 million metric tons (mmt) and 38 mmt in 2020 as a consequence of the new CAFE standards, as Table IV–68 reports. The table also shows that this annual reduction is estimated to grow to a range from 409 mmt to 475 mmt by the year 2060, and will total between 11.6 billion and 12.8 billion metric tons over the period from 2017, when the final and augural standards would take effect, through 2060.

TABLE IV–68—NHTSA ESTIMATED REDUCTION IN FLEET-WIDE CARBON DIOXIDE EMISSIONS (MMT) FROM PASSENGER CAR AND LIGHT TRUCK USE UNDER THE FINAL AND AUGURAL STANDARDS

	MY Baseline	2020	2030	2040	2050	2060	Total 2017–2060
Passenger cars	2008	21–	117–	180–	212–	240–	6,593–
	2010	21	115	172	195	215	6,195
Light trucks	2008	15–	107–	169–	204–	235–	6,239–
	2010	16	100	148	174	194	5,446
Combined	2008	36–	224–	349–	416–	475–	12,832–
	2010	38	215	320	369	409	11,641

These reductions in fleet-wide CO_2 emissions, together with corresponding reductions in other GHG emissions from fuel production and use, would lead to small but significant reductions in projected changes in the future global climate. These changes, based on analysis documented in the Final EIS that informed the agency's decisions regarding this final rule, are summarized in Table IV–69 below.

TABLE IV–69—NHTSA ESTIMATED EFFECTS OF REDUCTION IN FLEET-WIDE CARBON DIOXIDE EMISSIONS (MMT) ON PROJECTED CHANGES IN GLOBAL CLIMATE

Measure	Units	Date	MY Baseline	Projected change in measure		
				No action	With final standards	Difference
Atmospheric CO_2 concentration.	Ppm	2100	2008	677.8	673.8	4.0
			2010	677.8	674.3	3.5
Increase in global mean surface temperature.	°C	2100	2008	2.564	2.548	0.016
			2010	2.564	2.550	0.014
Sea level rise	Cm	2100	2008	33.42	33.29	0.13
			2010	33.42	33.30	0.12
Global mean precipitation	% change from 1980–1999 avg.	2090	2008	3.89%	3.87%	0.02%
			2010	3.89%	3.87%	0.02%

3. How will these standards impact non-GHG emissions and their associated effects?

Under the assumption that CAFE standards at least as stringent as those presented 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 Tables IV–65 and IV–67 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.[1283]

Table IV–70 and Table IV–71 report estimated reductions in emissions of selected criteria air pollutants (or their chemical precursors) and airborne toxics expected to result from the final and augural 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.

TABLE IV–70—NHTSA PROJECTED CHANGES IN EMISSIONS OF CRITERIA AIR POLLUTANTS FROM PASSENGER CAR AND LIGHT TRUCK USE

[calendar year 2040; tons]

Vehicle class	Source of emissions	MY Baseline	Criteria air pollutant			
			Nitrogen oxides (NO_X)	Particulate matter ($PM_{2.5}$)	Sulfur oxides (SO_X)	Volatile organic compounds (VOC)
Passenger cars	Vehicle use	2008	3,433.80	140.75	−2,775.59	1,615.82
		2010	7,108.88	360.68	−2,519.62	4,148.13
	Fuel production and distribution	2008	−20,396.77	−3,040.73	−117.30	−48,321.79
		2010	−26,394.68	−3,083.65	−12,990.78	−44,119.22
	All sources	2008	−16,962.97	−2,899.98	−2,892.89	−46,705.98
		2010	−19,285.80	−2,722.97	−15,510.40	−39,971.09
Light trucks	Vehicle use	2008	5,988.04	432.25	−2,445.61	3,607.27
		2010	8,643.21	316.07	−2,134.45	2,920.02
	Fuel production and distribution.	2008	−26,580.28	−3,042.32	−14,005.44	−42,674.17
		2010	−24,256.73	−2,682.23	−13,277.14	−38,331.48
	All sources	2008	−20,592.23	−2,610.07	−16,451.05	−39,066.90
		2010	−15,613.51	−2,366.16	−15,411.59	−35,411.46
Total	Vehicle use	2008	9,421.85	573.00	−5,221.20	5,223.09
		2010	15,752.09	676.75	−4,654.06	7,068.15
	Fuel production and distribution.	2008	−46,977.04	−6,083.05	−14,122.74	−90,995.96
		2010	−50,651.41	−5,765.88	−26,267.93	−82,450.70
	All sources	2008	−37,555.20	−5,510.05	−19,343.94	−85,772.87
		2010	−34,899.31	−5,089.13	−30,921.99	−75,382.56

TABLE IV–71—NHTSA PROJECTED CHANGES IN EMISSIONS OF AIRBORNE TOXICS FROM PASSENGER CAR AND LIGHT TRUCK USE

[calendar year 2040; tons]

Vehicle class	Source of emissions	MY Baseline	Toxic air pollutant		
			Benzene	1,3-Butadiene	Formaldehyde
Passenger cars	Vehicle use	2008	40.38	9.33	58.94
		2010	121.78	23.50	97.25
	Fuel production and distribution	2008	−215.10	−2.30	−78.85
		2010	−195.05	−2.09	−71.49
	All sources	2008	−174.72	7.03	−19.91
		2010	−73.27	21.41	25.77
Light trucks	Vehicle use	2008	117.46	20.06	49.05
		2010	60.36	17.42	147.09

[1283] 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–71—NHTSA PROJECTED CHANGES IN EMISSIONS OF AIRBORNE TOXICS FROM PASSENGER CAR AND LIGHT TRUCK USE—Continued

[calendar year 2040; tons]

Vehicle class	Source of emissions	MY Baseline	Toxic air pollutant		
			Benzene	1,3-Butadiene	Formaldehyde
	Fuel production and distribution	2008	−188.73	−2.04	−69.87
		2010	−164.99	−1.73	−59.28
	All sources	2008	−71.26	18.02	−20.81
		2010	−104.64	15.69	87.82
Total	Vehicle use	2008	157.85	29.39	108.00
		2010	182.13	40.91	244.35
	Fuel production and distribution	2008	−403.83	−4.34	−148.71
		2010	−360.04	−3.82	−130.76
	All sources	2008	−245.98	25.05	−40.72
		2010	−177.90	37.10	113.58

In turn, the reductions in emissions reported in the tables above are projected to result in significant declines in the adverse health effects that result from population exposure to these pollutants. Table IV–72 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–72 based on analysis documented in the Final EIS that informed the agency's decisions regarding this final 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. The table displays results using both baseline fleets as well as both a reference electricity emissions case and a cleaner alternative side-case. The table also illustrates mortality impacts from the rule using two different source values for marginal mortality rates.

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. Due to timing issues with the analysis, NHTSA conducted such modeling for purposes of the FEIS using data from the NPRM, and we refer the readers to the FEIS for more information.

TABLE IV–72—NHTSA PROJECTED REDUCTIONS IN HEALTH IMPACTS FROM EXPOSURE TO CRITERIA AIR POLLUTANTS DUE TO FINAL AND AUGURAL STANDARDS

[Calendar year 2040]

Health impact	Measure	MY Baseline	Projected reduction (2040)
Mortality (ages 30 and older), Pope et al. (2002)	premature deaths per year	2008	360/420
		2010	390/420
Mortality (ages 30 and older), Laden et al. (2006)	premature deaths per year	2008	920/1,100
		2010	1,000/1,100
Chronic bronchitis	cases per year	2008	230/270
		2010	250/260
Emergency room visits for asthma	number per year	2008	320/370
		2010	350/370
Work loss	workdays per year	2008	40,000/46,000
		2010	43,000/46,000

4. What are the estimated costs and benefits of these standards?

NHTSA estimates that the final and augural 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 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 IV–73 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.[1284] Additional details on technology cost estimates can be found in Chapter V of NHTSA's FRIA and Chapter 3 of the Joint TSD.

TABLE IV–73—NHTSA ESTIMATED NET (ACCUMULATED) TECHNOLOGY COSTS, MIDSIZE PC

Final technology (as compared to baseline vehicle prior to technology application)		MY Baseline	2012	2017	2021	2025
Stoichiometric Gasoline Direct Injection (GDI).	SGDIc	2008	$75–	$67–	$58–	$55–
		2010	$75	$67	$58	$55
Turbocharging and Downsizing—Level 1 (18 bar BMEP).	TRBDS1	2008	$542–	$494–	$420–	$398–
		2010	$542	$494	$420	$398
Turbocharging and Downsizing—Level 2 (24 bar BMEP).	TRBDS2	2008	$18–	$26–	$20–	$5–
		2010	$18	$26	$20	$5
Cooled Exhaust Gas Recirculation (EGR)—Level 1 (24 bar BMEP).	CEGR1	2008	$336–	$302–	$285–	$247–
		2010	$336	$302	$285	$247
Cooled Exhaust Gas Recirculation (EGR)—Level 2 (27 bar BMEP).	CEGR2	2008	$583–	$525–	$495–	$428–
		2010	$583	$525	$495	$428
Advanced Diesel	ADSL	2008	$1,031–	$889–	$911–	$702–
		2010	$1,031	$889	$911	$702
6-speed DCT	DCT	2008	($94)–	($75)–	($79)–	($70)–
		2010	($94)	($75)	($79)	($70)
8-Speed Trans (Auto or DCT)	8SPD	2008	$286–	$257–	$223–	$210–
		2010	$286	$257	$223	$210
Shift Optimizer	SHFTOPT	2008	$2–	$2–	$2–	$1–
		2010	$2	$2	$2	$1
12V Micro-Hybrid (Stop-Start)	MHEV	2008	$561–	$385–	$325–	$296–
		2010	$561	$385	$325	$296
Strong Hybrid—Level 2	SHEV2	2008	$2,619–	$2,290–	$1,830–	$1,669–
		2010	$2,671	$2,334	$1,867	$1,702
Plug-in Hybrid—30 mi range	PHEV1	2008	$17,415–	$13,060–	$9,727–	$7,772–
		2010	$17,915	$13,449	$10,019	$8,015
Electric Vehicle (Early Adopter)—75 mile range.	EV1	2008	$6,089–	$3,577–	$2,655–	$1,188–
		2010	$6,280	$3,711	$2,779	$1,254
Electric Vehicle (Broad Market)—150 mile range.	EV4	2008	$14,970–	$10,526–	$7,682–	$5,640–
		2010	$15,145	$10,648	$7,771	$5,705

In order to pay for this additional technology (and, for some manufacturers, civil penalties), NHTSA estimates that the cost of an average passenger car will increase relative to levels resulting from compliance with baseline (MY 2016) standards by between $244 and $364 in MY to between $1,577 and $1,826 in MY 2025. Similarly, light truck prices are estimated to rise from between $77 and $147 in MY 2017 to between $1,185 and $1,228 in MY 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):

TABLE IV–74—NHTSA ESTIMATED AVERAGE PASSENGER CAR INCREMENTAL COST INCREASES ($) UNDER FINAL STANDARDS—MYS 2017–2021

Manufacturer	MY baseline	2017	2018	2019	2020	2021
Industry Average	2008	244–	454–	630–	929–	1,141–
	2010	364	483	659	857	991
Aston Martin	2008	79–	156–	244–	337–	447–
	2010	73	150	227	321	420
BMW	2008	96–	149–	209–	297–	492–
	2010	88	255	325	407	501
Daimler	2008	97–	175–	244–	585–	687–
	2010	79	158	225	308	387
Fiat	2008	278–	644–	628–	1,088–	1,114–
	2010	338	372	579	811	1,077
Ford	2008	390–	443–	755–	1,515–	1,854–
	2010	309	326	438	945	993
Geely	2008	69–	361–	700–	727–	848–
	2010	66	146	504	555	640
General Motors	2008	144–	526–	630–	1,015–	1,185–
	2010	225	462	486	758	868
Honda	2008	228–	484–	510–	513–	1,100–
	2010	632	805	825	816	1,009
Hyundai	2008	510–	549–	844–	920–	969–

[1284] 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–74—NHTSA ESTIMATED AVERAGE PASSENGER CAR INCREMENTAL COST INCREASES ($) UNDER FINAL STANDARDS—MYS 2017–2021—Continued

	2010	605	591	898	913	1,060
KIA	2008	13–	94–	339–	780–	915–
	2010	353	414	759	988	1,081
Lotus	2008	90–	178–	255–	354–	469–
	2010	242	322	1,228	1,306	1,396
Mazda	2008	337–	447–	423–	767–	758–
	2010	737	845	773	1,086	1,073
Mitsubishi	2008	500–	1,015–	988–	1,299–	1,737–
	2010	575	634	603	1,722	2,022
Nissan	2008	409–	645–	1,054–	1,100–	1,125–
	2010	565	653	864	926	953
Porsche	2008	86–	286–	382–	474–	572–
	2010	64	95	190	286	397
Spyker	2008	79–	222–	325–	408–	529–
	2010	0	0	0	0	0
Subaru	2008	173–	257–	542–	1,191–	1,161–
	2010	50	126	895	1,407	1,367
Suzuki	2008	13–	20–	1,420–	1,555–	1,666–
	2010	84	109	825	1,080	1,426
Tata	2008	95–	434–	431–	527–	582–
	2010	66	133	217	261	378
Tesla	2008	2–	2–	2–	2–	2–
	2010	0	0	0	0	0
Toyota	2008	220–	507–	657–	852–	1,082–
	2010	322	460	840	957	1,189
Volkswagen	2008	78–	162–	248–	639–	789–
	2010	84	397	484	686	851

TABLE IV–75—NHTSA ESTIMATED AVERAGE PASSENGER CAR INCREMENTAL COST INCREASES ($) UNDER AUGURAL STANDARDS—MYS 2022–2025

Manufacturer	MY Baseline	2022	2023	2024	2025
Industry Average	2008	1,271–	1,391–	1,748–	1,826–
	2010	1,090	1,219	1,480	1,577
Aston Martin	2008	568–	695–	827–	964–
	2010	541	662	783	915
BMW	2008	651–	789–	1,293–	1,367–
	2010	750	882	1,357	1,427
Daimler	2008	951–	1,177–	1,288–	1,608–
	2010	627	957	1,088	1,499
Fiat	2008	1,349–	1,692–	1,770–	2,045–
	2010	1,103	1,530	1,692	1,910
Ford	2008	2,075–	2,076–	3,345–	2,961–
	2010	1,172	1,184	1,651	1,780
Geely	2008	944–	1,203–	1,365–	1,446–
	2010	757	945	1,164	1,360
General Motors	2008	1,189–	1,475–	1,739–	2,010–
	2010	879	1,062	1,220	1,531
Honda	2008	1,132–	1,309–	1,310–	1,284–
	2010	1,009	1,249	1,254	1,229
Hyundai	2008	1,126–	1,133–	1,585–	1,501–
	2010	1,226	1,259	1,408	1,419
KIA	2008	999–	1,154–	1,163–	1,447–
	2010	1,330	1,316	1,302	1,497
Lotus	2008	601–	739–	882–	1,036–
	2010	1,503	758	894	1,025
Mazda	2008	1,676–	1,784–	1,875–	2,070–
	2010	1,481	1,589	1,589	1,782
Mitsubishi	2008	1,686–	1,734–	2,080–	3,757–
	2010	2,001	1,982	1,962	2,051
Nissan	2008	1,368–	1,440–	1,851–	1,805–
	2010	1,080	1,191	1,555	1,531
Porsche	2008	609–	748–	867–	1,031–
	2010	649	839	991	1,094
Spyker	2008	700–	983–	1,274–	1,355–
	2010	0	0	0	0
Subaru	2008	1,235–	1,331–	2,144–	3,356–
	2010	1,337	1,389	3,963	3,231
Suzuki	2008	1,687–	1,689–	1,820–	2,283–
	2010	1,435	1,426	1,462	1,630
Tata	2008	833–	1,090–	1,199–	1,323–

TABLE IV–75—NHTSA ESTIMATED AVERAGE PASSENGER CAR INCREMENTAL COST INCREASES ($) UNDER AUGURAL STANDARDS—MYS 2022–2025—Continued

Manufacturer	MY Baseline	2022	2023	2024	2025
	2010	483	848	961	1,192
Tesla	2008	2–	2–	2–	2–
	2010	0	0	0	0
Toyota	2008	1,125–	1,115–	1,276–	1,265–
	2010	1,247	1,248	1,493	1,433
Volkswagen	2008	932–	1,110–	1,267–	1,639–
	2010	960	1,099	1,337	1,670

TABLE IV–76—NHTSA ESTIMATED AVERAGE LIGHT TRUCK INCREMENTAL COST INCREASES ($) UNDER FINAL STANDARDS—MYS 2017–2021

Manufacturer	MY Baseline	2017	2018	2019	2020	2021
Industry Average	2008	77–	193–	424–	623–	858–
	2010	147	197	398	631	912
Aston Martin	2008	0–	0–	0–	0–	0–
	2010	0	0	0	0	0
BMW	2008	416–	489–	495–	513–	654–
	2010	321	378	394	428	661
Daimler	2008	438–	453–	446–	491–	510–
	2010	187	335	338	361	406
Fiat	2008	100–	108–	173–	939–	1,013–
	2010	469	468	538	1,199	1,316
Ford	2008	7–	85–	97–	297–	1,089–
	2010	87	116	195	303	1,150
Geely	2008	128–	404–	502–	494–	496–
	2010	34	499	474	470	524
General Motors	2008	1–	162–	656–	993–	957–
	2010	1	40	471	921	905
Honda	2008	196–	199–	345–	395–	688–
	2010	210	252	310	336	741
Hyundai	2008	288–	301–	423–	418–	408–
	2010	272	282	911	949	932
KIA	2008	49–	103–	229–	342–	833–
	2010	316	324	369	365	825
Mazda	2008	4–	561–	509–	532–	502–
	2010	15	762	686	690	669
Mitsubishi	2008	284–	319–	269–	269–	2,092–
	2010	276	283	275	254	1,509
Nissan	2008	237–	252–	481–	609–	993–
	2010	178	201	414	608	682
Porsche	2008	−2–	27–	481–	459–	513–
	2010	−0	48	928	912	927
Spyker	2008	52–	93–	101–	104–	497–
	2010	0	0	0	0	0
Subaru	2008	−49–	102–	685–	644–	615–
	2010	810	854	1,238	1,218	1,200
Suzuki	2008	1–	13–	594–	585–	745–
	2010	252	251	231	228	1,719
Tata	2008	18–	75–	96–	143–	768–
	2010	10	79	108	179	550
Toyota	2008	13–	234–	402–	479–	749–
	2010	6	88	313	327	650
Volkswagen	2008	10–	131–	669–	684–	742–
	2010	52	184	341	587	590

TABLE IV—77 NHTSA ESTIMATED AVERAGE LIGHT TRUCK INCREMENTAL COST INCREASES ($) UNDER AUGURAL STANDARDS—MYS 2022–2025

Manufacturer	MY Baseline	2022	2023	2024	2025
Industry Average	2008	954–	1,001–	1,086–	1,185–
	2008	949	1,061	1,151	1,228
Aston Martin	2008	0–	0–	0–	0–
	2010	0	0	0	0
BMW	2008	1,407–	1,413–	1,472–	1,416–
	2010	887	909	935	962
Daimler	2008	1,366–	1,381–	1,389–	1,339–

TABLE IV—77 NHTSA ESTIMATED AVERAGE LIGHT TRUCK INCREMENTAL COST INCREASES ($) UNDER AUGURAL STANDARDS—MYS 2022–2025—Continued

Manufacturer	MY Baseline	2022	2023	2024	2025
	2010	866	925	940	944
Fiat	2008	992–	1,286–	1,324–	1,611–
	2010	1,314	1,747	1,726	1,816
Ford	2008	1,166–	1,187–	1,198–	1,389–
	2010	1,126	1,118	1,120	1,209
Geely	2008	765–	1,090–	1,114–	1,131–
	2010	727	1,334	1,340	1,306
General Motors	2008	940–	928–	974–	1,233–
	2010	887	894	972	1,169
Honda	2008	911–	978–	959–	945–
	2010	878	897	1,025	1,002
Hyundai	2008	901–	865–	1,288–	1,254–
	2010	1,174	1,175	1,413	1,369
KIA	2008	818–	934–	919–	936–
	2010	780	1,089	1,060	1,016
Mazda	2008	488–	739–	811–	793–
	2010	661	901	1,051	1,008
Mitsubishi	2008	2,020–	1,986–	1,958–	1,824–
	2010	1,462	1,441	1,421	1,337
Nissan	2008	1,221–	1,172–	1,256–	1,415–
	2010	791	786	1,007	997
Porsche	2008	611–	1,296–	1,321–	1,297–
	2010	972	1,276	1,322	1,311
Spyker	2008	481–	559–	659–	738–
	2010	0	0	0	0
Subaru	2008	674–	734–	1,351–	1,245–
	2010	1,225	1,233	1,501	1,464
Suzuki	2008	712–	702–	712–	1,015–
	2010	1,668	1,643	1,618	1,504
Tata	2008	806–	889–	990–	1,039–
	2010	704	801	898	984
Toyota	2008	776–	817–	938–	895–
	2010	674	887	1,086	1,095
Volkswagen	2008	760–	1,022–	1,487–	1,367–
	2010	640	824	1,135	1,411

TABLE IV–78—NHTSA ESTIMATED AVERAGE INCREMENTAL COST INCREASES ($) BY MANUFACTURER UNDER FINAL STANDARDS—MYS 2017–2021

Manufacturer	MY Baseline	2017	2018	2019	2020	2021
Industry Average	2008	183–	360–	557–	823–	1,043–
	2010	287	382	567	779	964
Aston Martin	2008	79–	156–	244–	337–	447–
	2010	73	150	227	321	420
BMW	2008	194–	248–	288–	354–	535–
	2010	146	285	342	412	538
Daimler	2008	177–	240–	292–	563–	643–
	2010	110	213	259	324	393
Fiat	2008	192–	385–	412–	1,020–	1,069–
	2010	405	420	559	999	1,191
Ford	2008	248–	313–	525–	1,098–	1,596–
	2010	212	235	333	672	1,059
Geely	2008	88–	375–	637–	654–	739–
	2010	54	273	493	526	601
General Motors	2008	78–	355–	642–	1,004–	1,077–
	2010	130	282	480	828	884
Honda	2008	217–	392–	458–	477–	972–
	2010	496	631	662	669	928
Hyundai	2008	465–	497–	755–	817–	855–
	2010	561	551	900	917	1,045
KIA	2008	22–	96–	313–	680–	897–
	2010	348	404	715	920	1,054
Lotus	2008	90–	178–	255–	354–	469–
	2010	242	322	1,228	1,306	1,396
Mazda	2008	260–	475–	443–	710–	693–
	2010	600	829	757	1,016	1,002
Mitsubishi	2008	446–	842–	813–	1,052–	1,822–
	2010	520	566	540	1,442	1,925
Nissan	2008	351–	517–	872–	948–	1,084–

TABLE IV–78—NHTSA ESTIMATED AVERAGE INCREMENTAL COST INCREASES ($) BY MANUFACTURER UNDER FINAL STANDARDS—MYS 2017–2021—Continued

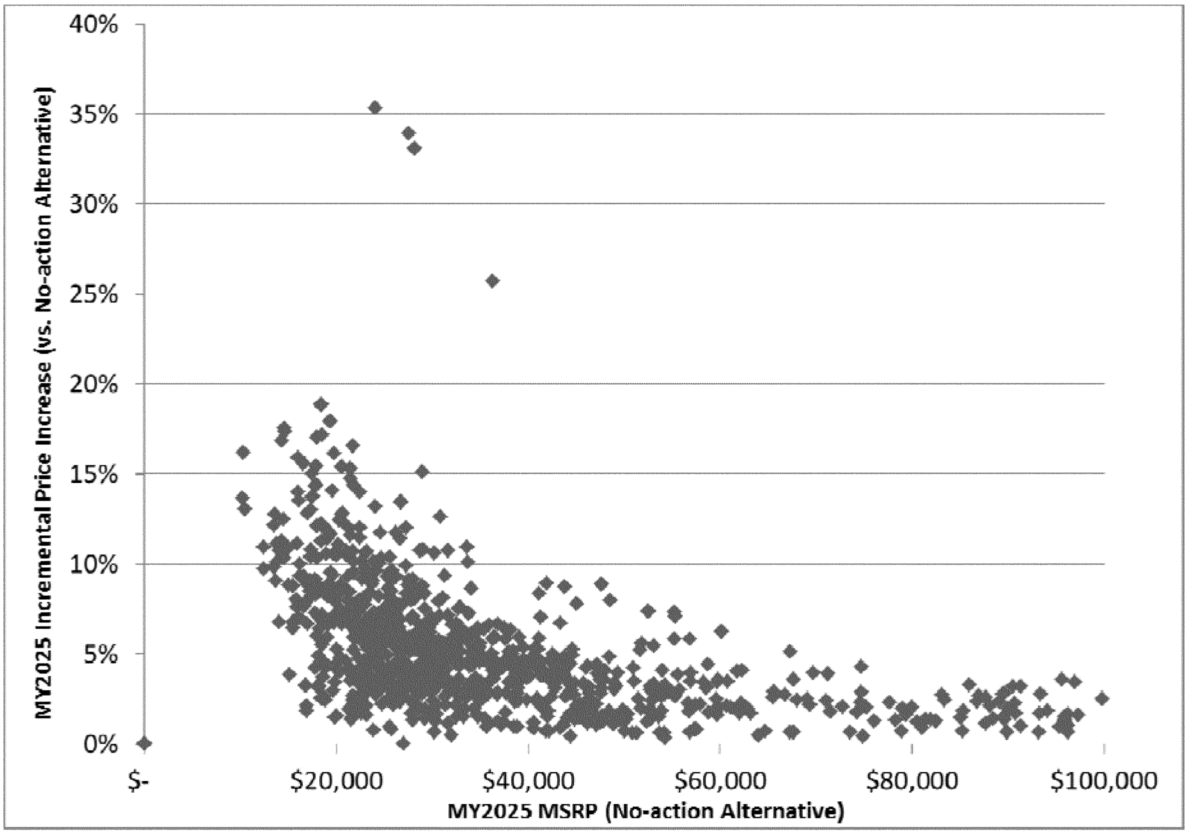
Manufacturer	MY Baseline	2017	2018	2019	2020	2021
	2010	466	535	746	843	884
Porsche	2008	62–	221–	406–	471–	558–
	2010	30	70	582	615	673
Spyker	2008	75–	202–	289–	364–	524–
	2010	0	0	0	0	0
Subaru	2008	116–	217–	578–	1,057–	1,030–
	2010	291	355	1,001	1,349	1,316
Suzuki	2008	11–	19–	1,266–	1,380–	1,502–
	2010	96	119	778	1,015	1,449
Tata	2008	56–	254–	263–	338–	675–
	2010	30	97	146	208	488
Tesla	2008	2–	2–	2–	2–	2–
	2010	0	0	0	0	0
Toyota	2008	134–	398–	559–	710–	952–
	2010	200	315	636	717	985
Volkswagen	2008	65–	156–	338–	649–	779–
	2010	78	359	458	668	804

TABLE IV—79 NHTSA ESTIMATED AVERAGE INCREMENTAL COST INCREASES ($) BY MANUFACTURER UNDER AUGURAL STANDARDS—MYS 2022–2025

Manufacturer	MY Baseline	2022	2023	2024	2025
Industry Average	2008	1,162–	1,259–	1,528–	1,616–
	2010	1,042	1,165	1,370	1,461
Aston Martin	2008	568–	695–	827–	964–
	2010	541	662	783	915
BMW	2008	851–	952–	1,342–	1,380–
	2010	782	888	1,264	1,326
Daimler	2008	1,055–	1,229–	1,313–	1,546–
	2010	701	947	1,042	1,325
Fiat	2008	1,188–	1,509–	1,575–	1,861–
	2010	1,202	1,630	1,707	1,868
Ford	2008	1,770–	1,790–	2,671–	2,478–
	2010	1,153	1,157	1,433	1,547
Geely	2008	889–	1,169–	1,290–	1,353–
	2010	747	1,073	1,222	1,343
General Motors	2008	1,072–	1,222–	1,389–	1,655–
	2010	883	990	1,114	1,377
Honda	2008	1,065–	1,210–	1,208–	1,185–
	2010	970	1,146	1,189	1,166
Hyundai	2008	1,081–	1,079–	1,525–	1,452–
	2010	1,220	1,250	1,408	1,413
KIA	2008	959–	1,106–	1,110–	1,338–
	2010	1,273	1,293	1,278	1,450
Lotus	2008	601–	739–	882–	1,036–
	2010	1,503	758	894	1,025
Mazda	2008	1,372–	1,518–	1,610–	1,761–
	2010	1,339	1,472	1,497	1,652
Mitsubishi	2008	1,765–	1,793–	2,052–	3,319–
	2010	1,899	1,880	1,862	1,918
Nissan	2008	1,323–	1,358–	1,672–	1,690–
	2010	1,006	1,088	1,416	1,396
Porsche	2008	610–	876–	969–	1,088–
	2010	817	1,065	1,163	1,207
Spyker	2008	670–	926–	1,193–	1,274–
	2010	0	0	0	0
Subaru	2008	1,104–	1,192–	1,962–	2,880–
	2010	1,303	1,342	3,214	2,691
Suzuki	2008	1,516–	1,518–	1,628–	2,066–
	2010	1,454	1,442	1,474	1,620
Tata	2008	820–	991–	1,099–	1,191–
	2010	623	819	922	1,063
Tesla	2008	2–	2–	2–	2–
	2010	0	0	0	0
Toyota	2008	991–	1,003–	1,152–	1,130–
	2010	1,033	1,115	1,344	1,311
Volkswagen	2008	898–	1,092–	1,312–	1,586–
	2010	902	1,050	1,301	1,623

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–4 shows the trend for MY 2025, for vehicles with estimated baseline prices up to $100,000:

Figure IV-4 NHTSA 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 final standards, but nevertheless believes that this issue is worth monitoring in the market going forward. NHTSA continues to seek 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 final and augural 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 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 final and augural 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 standards is negative.

TABLE IV–80—NHTSA ESTIMATED INCREMENTAL APPLICATION OF TECHNOLOGIES TO PASSENGER CAR FLEET UNDER FINAL AND AUGURAL STANDARDS—MYS 2017–2025

Technology	Baseline MY	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)	2025 (%)
LUB1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
EFR1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	4	5	6	6	6	6	6	6	6
LUB2_EFR2	2008	8–	13–	19–	27–	37–	45–	48–	52–	54–
	2010	0	0	1	4	8	9	11	19	24
CCPS	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
DVVLS	2008	0–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–
	2010	0	0	0	0	0	0	0	0	0
DEACS	2008	(1)–	(1)–	(1)–	(1)–	(2)–	(2)–	(2)–	(2)–	(2)–
	2010	(1)	(1)	(2)	(2)	(2)	(2)	(2)	(2)	(3)
ICP	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
DCP	2008	12–	13–	13–	12–	12–	12–	12–	12–	12–
	2010	10	10	10	10	10	10	10	10	10
DVVLD	2008	11–	13–	13–	13–	14–	14–	14–	14–	14–
	2010	8	9	9	9	9	9	9	10	9
CVVL	2008	4–	4–	4–	6–	6–	6–	6–	6–	6–
	2010	7	7	9	9	9	9	9	9	9
DEACD	2008	(1)–	(1)–	(1)–	(2)–	(2)–	(2)–	(3)–	(5)–	(5)–
	2010	(2)	(2)	(4)	(6)	(8)	(8)	(8)	(9)	(9)
SGDI	2008	12–	16–	23–	28–	37–	41–	45–	50–	50–
	2010	31	38	49	52	57	59	60	61	62
DEACO	2008	0–	(1)–	(2)–	(4)–	(5)–	(4)–	(4)–	(4)–	(4)–
	2010	0	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
VVA	2008	0–	0–	1–	1–	1–	1–	1–	1–	1–
	2010	0	0	0	0	0	0	0	0	0
SGDIO	2008	0–	2–	2–	4–	5–	4–	4–	4–	4–
	2010	0	2	2	2	3	2	2	3	3
TRBDS1_SD	2008	6–	6–	5–	4–	10–	7–	8–	0–	(6)–
	2010	29	29	32	32	32	28	22	15	9
TRBDS1_MD	2008	2–	5–	7–	10–	8–	6–	5–	0–	(3)–
	2010	4	8	11	14	16	16	15	13	8
TRBDS1_LD	2008	0–	1–	1–	1–	0–	0–	(1)–	(1)–	(1)–
	2010	0	1	1	1	1	1	1	(0)	(0)
TRBDS2_SD	2008	(0)–	1–	4–	4–	5–	6–	5–	8–	9–
	2010	0	1	3	3	6	6	11	11	12
TRBDS2_MD	2008	0–	1–	1–	1–	0–	2–	3–	5–	6–
	2010	2	2	2	2	0	1	2	3	3
TRBDS2_LD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
CEGR1_SD	2008	2–	3–	6–	11–	13–	18–	21–	26–	29–
	2010	0	2	4	8	8	13	14	20	25
CEGR1_MD	2008	0–	1–	1–	2–	2–	4–	6–	10–	10–
	2010	(0)	0	0	0	3	3	3	5	9
CEGR1_LD	2008	0–	0–	0–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–
	2010	0	0	0	0	0	(0)	0	0	0
CEGR2_SD	2008	0–	0–	0–	0–	0–	0–	0–	0–	1–
	2010	0	0	0	0	0	0	1	1	1
CEGR2_MD	2008	0–	0–	0–	0–	2–	3–	3–	3–	3–
	2010	0	0	0	0	0	0	0	0	1
CEGR2_LD	2008	0–	0–	1–	2–	2–	2–	3–	3–	2–
	2010	0	0	0	1	1	2	3	3	2
ADSL_SD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
ADSL_MD	2008	0–	0–	0–	1–	1–	1–	1–	1–	1–
	2010	0	(0)	0	0	0	0	0	0	0
ADSL_LD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
6MAN	2008	0–	0–	(0)–	(1)–	(1)–	(1)–	(1)–	(1)–	(1)–
	2010	0	0	0	(0)	(0)	(0)	(1)	(1)	(1)
HETRANSM	2008	1–	2–	3–	5–	6–	7–	7–	7–	7–
	2010	0	0	0	2	2	3	4	4	4
IATC	2008	3–	3–	(0)–	(0)–	(1)–	(1)–	(1)–	(1)–	(1)–
	2010	0	0	0	0	0	(0)	(0)	(0)	(0)
NAUTO	2008	5–	2–	2–	(0)–	(1)–	(2)–	(2)–	(2)–	(2)–
	2010	1	4	5	4	4	4	(1)	(1)	(1)
DCT	2008	0–	(6)–	(14)–	(22)–	(30)–	(31)–	(32)–	(31)–	(32)–
	2010	(1)	1	3	(7)	(8)	(12)	(18)	(26)	(27)

TABLE IV–80—NHTSA ESTIMATED INCREMENTAL APPLICATION OF TECHNOLOGIES TO PASSENGER CAR FLEET UNDER FINAL AND AUGURAL STANDARDS—MYS 2017–2025—Continued

Technology	Baseline MY	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)	2025 (%)
8SPD	2008	4–	4–	3–	(2)–	(7)–	(9)–	(10)–	(11)–	(13)–
	2010	3	6	10	12	10	9	5	2	1
HETRANS	2008	9–	22–	35–	47–	59–	65–	68–	65–	64–
	2010	0	2	10	23	29	39	47	56	54
SHFTOPT	2008	9–	22–	35–	49–	66–	71–	76–	73–	69–
	2010	0	0	12	23	36	44	58	59	60
EPS	2008	4–	9–	9–	9–	13–	13–	13–	13–	13–
	2010	8	14	24	24	24	24	25	27	28
IACC1	2008	9–	12–	17–	21–	36–	39–	44–	45–	45–
	2010	6	9	17	18	28	29	34	38	45
IACC2	2008	7–	12–	20–	31–	38–	53–	64–	67–	69–
	2010	3	7	17	27	37	41	50	59	63
MHEV	2008	1–	0–	2–	7–	10–	11–	12–	13–	10–
	2010	0	0	0	2	3	3	4	5	5
ISG	2008	0–	1–	3–	6–	7–	11–	15–	19–	26–
	2010	1	1	2	4	5	6	8	12	17
SHEV1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
SHEV1_2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	1	1	1	1
SHEV2	2008	0–	0–	0–	0–	0–	0–	0–	3–	6–
	2010	0	0	0	0	0	0	0	2	5
PHEV1	2008	0–	0–	0–	0–	0–	0–	0–	2–	2–
	2010	0	0	0	0	0	0	0	1	1
PHEV2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV3	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV4	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
FCV	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
MR1	2008	5–	6–	5–	5–	5–	5–	6–	6–	5–
	2010	10	13	19	20	21	20	21	20	21
MR2	2008	8–	17–	25–	29–	29–	29–	30–	30–	29–
	2010	2	10	25	28	32	33	38	41	42
MR3	2008	3–	5–	6–	9–	9–	9–	11–	11–	11–
	2010	1	2	5	6	7	6	9	10	11
MR4	2008	2–	3–	3–	3–	3–	3–	4–	5–	8–
	2010	1	2	3	3	3	3	4	4	7
MR5	2008	1–	2–	2–	4–	5–	5–	6–	7–	10–
	2010	0	0	1	3	4	4	4	6	7
ROLL1	2008	0–	2–	3–	4–	4–	4–	4–	4–	4–
	2010	1	2	2	3	3	3	3	3	3
ROLL2	2008	0–	16–	33–	42–	50–	59–	62–	63–	63–
	2010	0	0	21	35	44	55	71	81	87
ROLL3	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
LDB	2008	0–	1–	1–	1–	1–	1–	1–	1–	1–
	2010	0	1	1	1	2	2	2	2	2
SAX	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
AERO1	2008	0–	3–	4–	4–	4–	4–	4–	4–	4–
	2010	0	5	5	5	5	5	5	5	5
AERO2	2008	2–	13–	23–	29–	32–	33–	34–	34–	33–
	2010	8	21	31	40	44	47	48	49	51

TABLE IV–81—NHTSA ESTIMATED INCREMENTAL APPLICATION OF TECHNOLOGIES TO LIGHT TRUCK FLEET UNDER FINAL AND AUGURAL STANDARDS—MYS 2017–2025

Technology	Baseline MY	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)	2025 (%)
LUB1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0

TABLE IV–81—NHTSA ESTIMATED INCREMENTAL APPLICATION OF TECHNOLOGIES TO LIGHT TRUCK FLEET UNDER FINAL AND AUGURAL STANDARDS—MYS 2017–2025—Continued

Technology	Baseline MY	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)	2025 (%)
EFR1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	2	2	2	4	4	4	4	4	4
LUB2_EFR2	2008	1–	14–	31–	40–	56–	66–	73–	84–	86–
	2010	0	0	11	24	41	44	48	56	63
CCPS	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	2	1	1	1	1	1	1	2	2
DVVLS	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	1	1	1	1	1	1	1	1	1
DEACS	2008	(1)–	(1)–	(3)–	(3)–	(11)–	(12)–	(12)–	(12)–	(12)–
	2010	(1)	(2)	(3)	(2)	(11)	(11)	(13)	(12)	(13)
ICP	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
DCP	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	1	1	1	1	1	1	1	1	1
DVVLD	2008	0–	0–	0–	0–	0–	0–	0–	1–	1–
	2010	0	0	0	0	0	1	1	1	1
CVVL	2008	0–	1–	1–	1–	1–	1–	1–	1–	1–
	2010	1	1	1	1	1	1	1	1	1
DEACD	2008	(4)–	(6)–	(7)–	(9)–	(14)–	(15)–	(15)–	(22)–	(22)–
	2010	(0)	(1)	(3)	(3)	(5)	(6)	(7)	(8)	(8)
SGDI	2008	4–	5–	8–	11–	25–	26–	27–	34–	34–
	2010	5	8	12	12	24	25	26	28	28
DEACO	2008	(0)–	(1)–	(2)–	(4)–	(4)–	(4)–	(5)–	(5)–	(6)–
	2010	0	(0)	(5)	(10)	(10)	(10)	(10)	(9)	(9)
VVA	2008	0–	0–	2–	3–	2–	2–	2–	2–	2–
	2010	0	0	0	0	0	0	0	0	0
SGDIO	2008	0–	1–	5–	12–	11–	11–	11–	11–	14–
	2010	0	0	5	8	9	9	11	11	11
TRBDS1_SD	2008	0–	0–	0–	0–	0–	(3)–	(3)–	(4)–	(6)–
	2010	2	2	3	3	2	2	2	1	(4)
TRBDS1_MD	2008	4–	7–	9–	17–	21–	18–	14–	15–	(1)–
	2010	3	5	6	6	8	8	7	2	(7)
TRBDS1_LD	2008	2–	2–	6–	8–	13–	12–	12–	11–	14–
	2010	1	1	7	12	22	22	25	25	23
TRBDS2_SD	2008	0–	0–	0–	0–	0–	2–	2–	3–	4–
	2010	0	0	0	0	0	0	0	1	6
TRBDS2_MD	2008	(0)–	(0)–	1–	1–	2–	3–	7–	10–	24–
	2010	0	0	0	0	0	0	1	8	16
TRBDS2_LD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	2
CEGR1_SD	2008	0–	0–	0–	0–	0–	1–	1–	1–	3–
	2010	0	0	0	0	0	0	0	0	0
CEGR1_MD	2008	0–	0–	1–	1–	5–	7–	8–	11–	13–
	2010	0	0	0	0	0	0	1	1	2
CEGR1_LD	2008	0–	0–	0–	0–	(0)–	(0)–	(0)–	(0)–	(0)–
	2010	0	0	0	0	0	0	0	0	0
CEGR2_SD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
CEGR2_MD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
CEGR2_LD	2008	0–	0–	0–	0–	1–	2–	2–	3–	3–
	2010	0	0	0	0	0	1	1	1	1
ADSL_SD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
ADSL_MD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	1	1	1	1	1	1
ADSL_LD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
6MAN	2008	0–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–
	2010	0	0	(0)	(0)	(0)	(0)	(0)	(0)	(0)
HETRANSM	2008	0–	0–	1–	1–	1–	2–	2–	2–	2–
	2010	0	0	1	1	1	1	1	1	1
IATC	2008	(6)–	(7)–	(15)–	(16)–	(22)–	(22)–	(22)–	(22)–	(23)–
	2010	0	(0)	(1)	(1)	(4)	(3)	(5)	(5)	(5)
NAUTO	2008	2–	(1)–	(11)–	(12)–	(14)–	(17)–	(17)–	(16)–	(16)–
	2010	(1)	(2)	(2)	(6)	(9)	(9)	(13)	(18)	(18)
DCT	2008	1–	0–	(1)–	(5)–	(5)–	(5)–	(5)–	(6)–	(6)–
	2010	0	2	1	(3)	(4)	(4)	(4)	(6)	(6)
8SPD	2008	3–	3–	(1)–	(6)–	(17)–	(19)–	(22)–	(23)–	(23)–
	2010	1	3	7	10	7	7	6	0	(6)

TABLE IV–81—NHTSA ESTIMATED INCREMENTAL APPLICATION OF TECHNOLOGIES TO LIGHT TRUCK FLEET UNDER FINAL AND AUGURAL STANDARDS—MYS 2017–2025—Continued

Technology	Baseline MY	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)	2025 (%)
HETRANS	2008	4–	16–	36–	52–	69–	78–	82–	83–	83–
	2010	1	1	12	24	43	47	58	69	73
SHFTOPT	2008	3–	10–	31–	46–	62–	70–	84–	87–	90–
	2010	0	0	15	27	31	35	43	62	70
EPS	2008	6–	7–	10–	12–	16–	19–	23–	23–	24–
	2010	(0)	1	5	6	15	15	14	16	16
IACC1	2008	2–	2–	7–	9–	23–	25–	28–	31–	33–
	2010	7	11	18	22	29	31	31	31	32
IACC2	2008	3–	4–	17–	22–	25–	27–	38–	49–	54–
	2010	4	10	21	27	37	41	43	52	55
MHEV	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	4	4	4	8	8	8	8	8	7
ISG	2008	0–	0–	0–	0–	0–	0–	0–	0–	1–
	2010	3	3	3	4	4	4	4	4	5
SHEV1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
SHEV1_2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
SHEV2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
PHEV1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
PHEV2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV3	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV4	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
FCV	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
MR1	2008	2–	2–	5–	8–	9–	9–	9–	9–	9–
	2010	4	5	9	18	27	27	28	32	32
MR2	2008	10–	17–	23–	31–	35–	34–	34–	35–	40–
	2010	4	11	19	24	35	36	38	45	58
MR3	2008	(0)–	(0)–	3–	7–	11–	20–	25–	30–	33–
	2010	1	1	2	4	22	26	30	36	55
MR4	2008	(0)–	(0)–	(0)–	1–	5–	11–	12–	20–	25–
	2010	1	2	2	2	9	10	15	17	22
MR5	2008	(0)–	(0)–	(0)–	(0)–	5–	7–	8–	12–	18–
	2010	0	0	0	0	1	2	5	5	8
ROLL1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	2	3	3	3	3	3
ROLL2	2008	1–	15–	33–	47–	59–	74–	76–	83–	84–
	2010	0	0	14	29	47	52	66	81	91
ROLL3	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
LDB	2008	2–	2–	3–	4–	5–	6–	9–	9–	9–
	2010	1	2	3	3	6	6	6	6	6
SAX	2008	0–	2–	7–	9–	14–	17–	18–	18–	18–
	2010	5	7	10	10	10	12	12	12	12
AERO1	2008	0–	2–	2–	2–	3–	3–	3–	3–	3–
	2010	0	2	4	4	4	4	4	4	4
AERO2	2008	2–	6–	15–	25–	31–	35–	36–	36–	36–
	2010	0	2	11	22	24	28	31	33	41

TABLE IV–82—NHTSA ESTIMATED INCREMENTAL APPLICATION OF TECHNOLOGIES TO OVERALL FLEET UNDER FINAL AND AUGURAL STANDARDS—MYS 2017–2025

Technology	Baseline MY	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)	2025 (%)
LUB1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
EFR1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	3	4	4	5	5	5	5	5	5

TABLE IV–82—NHTSA ESTIMATED INCREMENTAL APPLICATION OF TECHNOLOGIES TO OVERALL FLEET UNDER FINAL AND AUGURAL STANDARDS—MYS 2017–2025—Continued

Technology	Baseline MY	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)	2025 (%)
LUB2_EFR2	2008	6–	14–	23–	31–	44–	52–	57–	62–	65–
	2010	0	0	5	11	20	21	23	32	37
CCPS	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	1	1	1	0	0	0	0	0	0
DVVLS	2008	0–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–
	2010	0	0	1	1	1	1	1	1	1
DEACS	2008	(1)–	(1)–	(1)–	(2)–	(5)–	(5)–	(5)–	(5)–	(5)–
	2010	(1)	(1)	(2)	(2)	(5)	(5)	(6)	(6)	(6)
ICP	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
DCP	2008	8–	8–	8–	8–	8–	8–	8–	8–	8–
	2010	7	6	6	6	6	6	6	7	7
DVVLD	2008	7–	8–	8–	9–	9–	9–	9–	9–	9–
	2010	5	6	6	6	6	6	6	7	6
CVVL	2008	2–	2–	3–	4–	4–	4–	4–	4–	4–
	2010	5	5	6	6	6	6	7	7	7
DEACD	2008	(2)–	(3)–	(3)–	(5)–	(6)–	(6)–	(7)–	(10)–	(11)–
	2010	(1)	(2)	(3)	(5)	(7)	(8)	(8)	(9)	(9)
SGDI	2008	9–	12–	18–	22–	33–	36–	39–	45–	45–
	2010	22	27	36	38	46	48	49	50	50
DEACO	2008	(0)–	(1)–	(2)–	(4)–	(4)–	(4)–	(5)–	(4)–	(5)–
	2010	0	(1)	(3)	(5)	(5)	(5)	(5)	(5)	(5)
VVA	2008	0–	0–	1–	2–	2–	2–	2–	2–	2–
	2010	0	0	0	0	0	0	0	0	0
SGDIO	2008	0–	1–	3–	7–	7–	7–	7–	6–	7–
	2010	0	1	3	4	5	5	5	5	5
TRBDS1_SD	2008	4–	4–	3–	3–	6–	3–	4–	(1)–	(6)–
	2010	19	19	22	22	22	20	15	10	5
TRBDS1_MD	2008	3–	5–	8–	12–	12–	10–	8–	5–	(2)–
	2010	4	7	9	11	13	13	13	9	3
TRBDS1_LD	2008	1–	1–	3–	3–	5–	4–	4–	3–	4–
	2010	1	1	3	5	8	8	9	8	8
TRBDS2_SD	2008	(0)–	1–	3–	3–	3–	5–	4–	6–	7–
	2010	0	0	2	2	4	4	7	8	10
TRBDS2_MD	2008	(0)–	0–	1–	1–	1–	2–	4–	6–	12–
	2010	1	1	1	1	0	1	1	4	7
TRBDS2_LD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	1
CEGR1_SD	2008	2–	2–	4–	7–	9–	12–	14–	18–	20–
	2010	0	1	3	5	5	9	10	13	17
CEGR1_MD	2008	0–	1–	1–	2–	3–	5–	7–	10–	11–
	2010	(0)	0	0	0	2	2	2	3	7
CEGR1_LD	2008	0–	0–	0–	(0)–	(0)–	(0)–	(0)–	(0)–	(0)–
	2010	0	0	0	0	0	(0)	0	0	0
CEGR2_SD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	1	1	1
CEGR2_MD	2008	0–	0–	0–	0–	2–	2–	2–	2–	2–
	2010	0	0	0	0	0	0	0	0	0
CEGR2_LD	2008	0–	0–	0–	1–	2–	2–	3–	3–	2–
	2010	0	0	0	1	1	2	2	2	2
ADSL_SD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
ADSL_MD	2008	0–	0–	0–	1–	1–	1–	1–	1–	1–
	2010	0	(0)	0	1	1	1	1	0	0
ADSL_LD	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
6MAN	2008	0–	(0)–	(0)–	(1)–	(1)–	(1)–	(1)–	(1)–	(1)–
	2010	0	0	0	(0)	(0)	(0)	(0)	(0)	(0)
HETRANSM	2008	0–	1–	2–	3–	5–	5–	5–	5–	5–
	2010	0	0	1	1	2	2	3	3	3
IATC	2008	0–	(0)–	(5)–	(6)–	(8)–	(8)–	(8)–	(8)–	(8)–
	2010	0	0	(0)	(0)	(1)	(1)	(2)	(2)	(2)
NAUTO	2008	4–	1–	(3)–	(4)–	(5)–	(7)–	(7)–	(7)–	(7)–
	2010	0	2	2	1	(0)	(1)	(5)	(7)	(7)
DCT	2008	0–	(4)–	(9)–	(16)–	(21)–	(22)–	(23)–	(23)–	(23)–
	2010	(1)	1	2	(6)	(6)	(9)	(13)	(19)	(20)
8SPD	2008	4–	4–	2–	(4)–	(11)–	(13)–	(14)–	(15)–	(16)–
	2010	3	5	9	11	9	8	6	2	(1)
HETRANS	2008	7–	20–	35–	49–	62–	70–	73–	71–	70–
	2010	0	2	11	23	34	42	51	60	61

TABLE IV–82—NHTSA ESTIMATED INCREMENTAL APPLICATION OF TECHNOLOGIES TO OVERALL FLEET UNDER FINAL AND AUGURAL STANDARDS—MYS 2017–2025—Continued

Technology	Baseline MY	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)	2025 (%)
SHFTOPT	2008	7–	18–	34–	48–	65–	71–	79–	77–	76–
	2010	0	0	13	25	34	41	53	60	63
EPS	2008	5–	8–	9–	10–	14–	15–	16–	16–	16–
	2010	5	9	17	18	21	21	21	23	24
IACC1	2008	6–	8–	13–	17–	32–	34–	39–	40–	41–
	2010	6	10	17	19	28	30	33	36	41
IACC2	2008	6–	9–	19–	28–	34–	44–	55–	61–	64–
	2010	4	8	19	27	37	41	48	57	60
MHEV	2008	0–	0–	2–	5–	7–	7–	8–	8–	7–
	2010	2	2	2	4	4	5	5	6	6
ISG	2008	0–	1–	2–	4–	5–	7–	10–	13–	18–
	2010	1	2	2	4	5	5	7	9	13
SHEV1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
SHEV1_2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	1	1
SHEV2	2008	0–	0–	0–	0–	0–	0–	0–	2–	4–
	2010	0	0	0	0	0	0	0	2	3
PHEV1	2008	0–	0–	0–	0–	0–	0–	0–	1–	1–
	2010	0	0	0	0	0	0	0	0	0
PHEV2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV1	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV2	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV3	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
EV4	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
FCV	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
MR1	2008	4–	4–	5–	6–	7–	7–	7–	7–	7–
	2010	8	10	15	19	23	23	23	24	24
MR2	2008	8–	17–	24–	30–	31–	31–	31–	31–	33–
	2010	3	10	23	26	33	34	38	42	47
MR3	2008	2–	3–	5–	8–	10–	13–	15–	17–	19–
	2010	1	2	4	5	12	13	16	19	26
MR4	2008	1–	2–	2–	2–	4–	6–	7–	10–	14–
	2010	1	2	3	3	5	6	7	9	12
MR5	2008	1–	1–	1–	3–	5–	6–	6–	9–	12–
	2010	0	0	1	2	3	3	5	6	7
ROLL1	2008	0–	1–	2–	2–	2–	2–	2–	2–	2–
	2010	0	1	1	2	3	3	3	3	3
ROLL2	2008	0–	16–	33–	44–	53–	64–	67–	69–	70–
	2010	0	0	19	33	45	54	69	81	88
ROLL3	2008	0–	0–	0–	0–	0–	0–	0–	0–	0–
	2010	0	0	0	0	0	0	0	0	0
LDB	2008	1–	1–	2–	2–	2–	3–	4–	3–	4–
	2010	1	1	2	2	3	3	3	3	3
SAX	2008	0–	1–	2–	3–	5–	6–	6–	6–	6–
	2010	2	2	4	4	4	4	4	4	4
AERO1	2008	0–	3–	3–	4–	4–	4–	4–	4–	4–
	2010	0	4	4	5	5	5	4	4	4
AERO2	2008	2–	11–	20–	28–	32–	34–	35–	35–	34–
	2010	5	14	24	34	37	41	42	44	48

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 between $134 billion and $140 billion in incremental outlays during MYs 2017–2025 (and model years leading up to MY 2017) for additional technology attributable to the final and augural standards:

TABLE IV–83—NHTSA ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS ($M) UNDER FINAL STANDARDS—MYS 2017–2021

Manufacturer	MY Baseline	Earlier	2017	2018	2019	2020	2021
Industry Average	2008	4.0–	2.8–	5.4–	8.4–	12.8–	16.5–
	2010	8.7	4.4	5.8	8.7	11.9	14.9
Aston Martin	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
BMW	2008	0.0–	0.1–	0.1–	0.1–	0.1–	0.1–
	2010	0.0	0.0	0.1	0.1	0.1	0.1
Daimler	2008	0.0–	0.0–	0.0–	0.0–	0.2–	0.2–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
Fiat	2008	0.3–	0.2–	0.3–	0.3–	0.8–	0.8–
	2010	1.2	0.6	0.6	0.8	1.5	1.8
Ford	2008	0.8–	0.5–	0.6–	1.1–	2.3–	3.4–
	2010	0.7	0.5	0.6	0.8	1.6	2.5
Geely	2008	0.0–	0.0–	0.0–	0.1–	0.1–	0.1–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
General Motors	2008	0.5–	0.2–	1.0–	1.9–	3.1–	3.3–
	2010	1.2	0.4	0.8	1.4	2.3	2.5
Honda	2008	0.1–	0.4–	0.7–	0.8–	0.8–	1.7–
	2010	1.8	0.8	1.1	1.1	1.1	1.6
Hyundai	2008	0.4–	0.3–	0.4–	0.6–	0.6–	0.7–
	2010	0.6	0.6	0.5	0.9	0.9	1.0
KIA	2008	–0.0–	0.0–	0.0–	0.1–	0.3–	0.4–
	2010	0.2	0.1	0.2	0.3	0.3	0.4
Lotus	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
Mazda	2008	0.2–	0.1–	0.2–	0.1–	0.2–	0.2–
	2010	0.4	0.2	0.3	0.2	0.3	0.3
Mitsubishi	2008	0.2–	0.0–	0.1–	0.1–	0.1–	0.2–
	2010	0.1	0.0	0.0	0.0	0.1	0.1
Nissan	2008	0.2–	0.5–	0.7–	1.1–	1.2–	1.4–
	2010	1.0	0.6	0.6	0.9	1.0	1.0
Porsche	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	–0.0	–0.0	0.0	0.0	0.0
Spyker	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
Subaru	2008	0.1–	0.0–	0.0–	0.1–	0.3–	0.3–
	2010	0.2	0.1	0.1	0.3	0.4	0.4
Suzuki	2008	0.0–	0.0–	0.0–	0.1–	0.2–	0.2–
	2010	0.0	0.0	0.0	0.0	0.0	0.1
Tata	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.1–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
Tesla	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
Toyota	2008	1.3–	0.4–	1.2–	1.7–	2.2–	3.0–
	2010	1.3	0.5	0.8	1.6	1.8	2.4
Volkswagen	2008	0.0–	0.0–	0.0–	0.1–	0.4–	0.4–
	2010	0.0	0.0	0.2	0.2	0.3	0.4
Passenger Car	2008	3.9–	2.3–	4.3–	6.1–	9.4–	11.7–
	2010	7.7	3.6	4.8	6.5	8.5	9.9
Light Truck	2008	0.1–	0.4–	1.1–	2.3–	3.4–	4.8–
	2010	1.1	0.8	1.1	2.2	3.4	4.9
Total	2008	4.0–	2.8–	5.4–	8.4–	12.8–	16.5–
	2010	8.7	4.4	5.8	8.7	11.9	14.9

TABLE IV–84—NHTSA ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS ($M) UNDER AUGURAL STANDARDS—MYS 2022–2025 (AND TOTAL THROUGH MY 2025)

Manufacturer	MY Baseline	2022	2023	2024	2025	Total
Industry Average	2008	18.5–	20.2–	24.9–	26.8–	140.3–
	2010	16.1	18.1	21.7	23.3	133.7
Aston Martin	2008	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0
BMW	2008	0.3–	0.3–	0.5–	0.5–	1.9–
	2010	0.2	0.2	0.4	0.3	1.5
Daimler	2008	0.3–	0.4–	0.4–	0.5–	2.1–
	2010	0.1	0.2	0.2	0.3	1.1
Fiat	2008	0.9–	1.2–	1.2–	1.4–	7.6–
	2010	1.9	2.6	2.7	3.0	16.8
Ford	2008	3.8–	3.9–	5.9–	5.5–	27.7–

TABLE IV–84—NHTSA ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS ($M) UNDER AUGURAL STANDARDS—MYS 2022–2025 (AND TOTAL THROUGH MY 2025)—Continued

Manufacturer	MY Baseline	2022	2023	2024	2025	Total
	2010	2.7	2.8	3.5	3.8	19.4
Geely	2008	0.1–	0.1–	0.1–	0.1–	0.8–
	2010	0.1	0.1	0.1	0.1	0.5
General Motors	2008	3.3–	3.8–	4.3–	5.3–	26.9–
	2010	2.5	2.9	3.3	4.1	21.3
Honda	2008	1.9–	2.2–	2.2–	2.2–	12.9–
	2010	1.7	2.0	2.1	2.1	15.3
Hyundai	2008	0.8–	0.9–	1.3–	1.2–	7.1–
	2010	1.2	1.3	1.5	1.5	10.0
KIA	2008	0.4–	0.5–	0.5–	0.6–	2.8–
	2010	0.5	0.5	0.5	0.6	3.5
Lotus	2008	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0
Mazda	2008	0.5–	0.5–	0.6–	0.6–	3.3–
	2010	0.4	0.5	0.5	0.5	3.5
Mitsubishi	2008	0.2–	0.2–	0.2–	0.4–	1.6–
	2010	0.1	0.1	0.2	0.2	1.1
Nissan	2008	1.8–	1.9–	2.3–	2.4–	13.4–
	2010	1.2	1.3	1.7	1.7	11.0
Porsche	2008	0.0–	0.0–	0.0–	0.0–	0.1–
	2010	0.0	0.0	0.0	0.0	0.2
Spyker	2008	0.0–	0.0–	0.0–	0.0–	0.1–
	2010	0.0	0.0	0.0	0.0	0.0
Subaru	2008	0.3–	0.3–	0.6–	0.9–	3.0–
	2010	0.4	0.4	1.0	0.8	4.1
Suzuki	2008	0.2–	0.2–	0.2–	0.3–	1.3–
	2010	0.1	0.1	0.1	0.1	0.5
Tata	2008	0.1–	0.1–	0.1–	0.1–	0.5–
	3020	0.0	0.0	0.0	0.0	0.1
Tesla	2008	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0[1285]
Toyota	2008	3.2–	3.3–	3.8–	3.8–	23.8–
	2010	2.6	2.8	3.4	3.3	10.4
Volkswagen	2008	0.5–	0.6–	0.6–	0.8–	3.4–
	2010	0.4	0.5	0.6	0.8	3.4
Passenger Car	2008	13.1–	14.6–	18.8–	20.2–	104.4–
	2010	11.0	12.4	15.5	16.7	96.6
Light Truck	2008	5.4–	5.6–	6.1–	6.6–	35.9–
	2010	5.1	5.7	6.2	6.6	37.1
Total	2008	18.5–	20.2–	24.9–	26.8–	140.3–
	2010	16.1	18.1	21.7	23.3	133.7

NHTSA notes that these estimates of the economic costs for meeting higher CAFE standards omit certain potentially important categories of costs, and may also reflect underestimation (or possibly overestimation) of some costs that are included. For example, although the agency's analysis is intended—with very limited exceptions[1286]—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 final and augural 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 final rule, it is possible that the agency may have underestimated or overestimated manufacturers' direct costs for applying some fuel economy technologies, or the increases in manufacturer's indirect costs associated with higher vehicle manufacturing costs. In either case, the technology outlays reported here will not correctly represent the costs of meeting higher CAFE standards.

Since the NPRM, NHTSA has revised its analysis to incorporate the social cost associated with the incremental cost of maintaining more technologically advanced vehicles. Table IV–85 below summarizes these incremental costs by regulatory class, and illustrates that increased maintenance costs contribute about another $10 billion to the cost of the rule.

[1285] Tesla is not included in the agencies 2010 baseline fleet.

[1286] 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–85—NHTSA ESTIMATED INCREMENTAL MAINTENANCE COSTS ASSOCIATED WITH TECHNOLOGY APPLIED TO MEET CAFE STANDARDS, MY 2017–2025

	MY baseline	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Passenger cars	2008	0–	0.2–	0.5–	0.7–	0.8–	0.9–	1.0–	1.0–	1.1–	6.2–
	2010	0.0	0.0	0.3	0.5	0.6	0.8	1.1	1.2	1.3	5.9
Light trucks	2008	0.0–	0.1–	0.3–	0.4–	0.5–	0.6–	0.6–	0.7–	0.7–	3.8–
	2010	0.0	0.0	0.1	0.3	0.4	0.4	0.5	0.7	0.8	3.2
Combined	2008	0.0–	0.3–	0.7–	1.0–	1.3–	1.5–	1.6–	1.7–	1.8–	10.0–
	2010	0.0	0.0	0.4	0.8	1.0	1.2	1.6	1.9	2.1	9.0

Similarly, NHTSA's estimates of increased costs of congestion, accidents, and noise associated with added vehicle use are drawn from a 1997 study, and the correct magnitude of these values may have changed since they were developed. If this is the case, the costs of increased vehicle use associated with the fuel economy rebound effect will differ from the agency's estimates in this analysis. Thus, like the agency's estimates of economic benefits, estimates of total compliance costs reported here may underestimate or overestimate the true economic costs of the final standards.

However, offsetting these costs, the achieved increases in fuel economy will also produce significant benefits to society. 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 the AEO 2012 Early Release. 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 FRIA accompanying today's final rule presents a detailed analysis of the rule's specific benefits.

As Tables IV–86 and IV–87 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 final and augural 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 in a range from $671 billion to $688 billion.

TABLE IV–86—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($b) UNDER FINAL STANDARDS USING 3 PERCENT DISCOUNT RATE—MYS 2017–2021[1287]

	MY Baseline	Earlier	2017	2018	2019	2020	2021[1287]
Passenger cars	2008	19.2–	10.4–	19.6–	28.6–	40.2–	48.4–
	2010	27.5	13.2	19.3	30.5	40.1	48.5
Light trucks	2008	1.9–	3.7–	8.9–	17.3–	24.8–	34.4–
	2010	3.3	2.8	5.3	13.1	19.9	29.4
Combined	2008	21.1–	14.1–	28.5–	45.9–	65.0–	82.8–
	2010	30.8	16	24.5	43.6	60	77.9

TABLE IV–87—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($b) UNDER AUGURAL STANDARDS USING 3 PERCENT DISCOUNT RATE—MYS 2022–2025 (AND TOTAL THROUGH MY 2025)

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	54.2–	60.1–	68.6–	75.9–	425.3–
	2010	54	61.6	70.1	77	441.9
Light trucks	2008	38.1–	40.7–	44.5–	48.3–	262.6–
	2010	32.4	36.7	41.3	45.6	229.9
Combined	2008	92.3–	100.7–	113.1–	124.2–	687.5–
	2010	86.4	98.3	111.3	122.5	671.4

The tables below report that the present value of total benefits from requiring cars and light trucks to achieve the fuel economy levels specified in the final and augural CAFE standards for MYs 2017–25 will range from $536 billion to $549 billion when discounted at the 7 percent rate also required by OMB guidance. Thus the present value of fuel savings and other benefits over the lifetimes of the vehicles covered by the final and augural standards is about 20 percent lower when discounted at a 7 percent annual rate than when discounted using the 3 percent annual rate.[1288]

[1287] 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 deemed central by in the interagency guidance on the social cost of carbon.

[1288] 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–88—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($b) UNDER FINAL STANDARDS USING 7 PERCENT DISCOUNT RATE—MYS 2017–2021

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	15.3–	8.3–	15.7–	22.9–	32.2–	38.8–
	2010	22	10.6	15.5	24.5	32.1	38.9
Light trucks	2008	1.5–	2.9–	7.0–	13.7–	19.7–	27.3–
	2010	2.6	2.2	4.2	10.4	15.8	23.4
Combined	2008	16.8–	11.2–	22.7–	36.6–	51.9–	66.0–
	2010	24.7	12.8	19.6	34.8	47.9	62.2

TABLE IV–89—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($b) UNDER AUGURAL STANDARDS USING 7 PERCENT DISCOUNT RATE—MYS 2022–2025 (AND TOTAL THROUGH MY2025)

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	43.4–	48.2–	55.0–	60.8–	340.7–
	2010	43.3	49.4	56.2	61.7	354.1
Light trucks	2008	30.2–	32.3–	35.3–	38.3–	208.2–
	2010	25.7	29.1	32.8	36.1	182.3
Combined	2008	73.6–	80.4–	90.3–	99.1–	548.6–
	2010	69	78.4	88.8	97.8	536

For both the passenger car and light truck fleets, NHTSA estimates that the benefits of today's 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 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 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–90 and IV–91 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 standards are discounted at a 3 percent rate, they will exceed the costs of the final and augural standards by between $498 billion and $507 billion:

TABLE IV–90—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($b) UNDER FINAL STANDARDS USING 3 PERCENT DISCOUNT RATE—MYS 2017–2021

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	14–	8–	14–	21–	28–	34–
	2010	18	9	14	22	29	35
Light trucks	2008	2–	3–	7–	14–	20–	28–
	2010	2	2	4	10	16	23
Combined	2008	16–	11–	21–	35–	48–	61–
	2010	21	11	18	32	45	59

TABLE IV–91—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($b) UNDER AUGURAL STANDARDS USING 3 PERCENT DISCOUNT RATE—MYS 2022–2025 (AND TOTAL THROUGH MY 2025)

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	37–	42–	45–	51–	293–
	2010	40	45	50	55	317
Light trucks	2008	31–	33–	36–	39–	213–
	2010	26	29	33	36	181
Combined	2008	68–	74–	82–	90–	507–
	2010	65	74	83	92	498

As indicated previously, when fuel savings and other future benefits resulting from the standards are discounted at the 7 percent rate prescribed in OMB guidance, they are about 20% lower than when the 3 percent discount rate is applied. Nevertheless, Tables IV–92 and IV–93 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 $372–377 billion over MYs 2017–25. Net benefits are thus about a quarter lower when future benefits are discounted at a 7 percent annual rate than at a 3 percent rate.

TABLE IV–92—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($b) UNDER FINAL STANDARDS USING 7 PERCENT DISCOUNT RATE—MYS 2017–2021

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	11–	6–	10–	15–	21–	25–
	2010	13	6	10	17	22	27
Light trucks	2008	1–	2–	6–	11–	15–	21–
	2010	1	1	3	8	12	17
Combined	2008	12–	8–	16–	26–	36–	46–
	2010	15	8	13	24	33	44

TABLE IV–93—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($b) UNDER AUGURAL STANDARDS USING 7 PERCENT DISCOUNT RATE—MYS 2022–2025 (AND TOTAL THROUGH MY 2025)

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	27–	30–	33–	37–	215–
	2010	30	34	37	41	236
Light trucks	2008	23–	25–	27–	30–	162–
	2010	19	22	25	28	136
Combined	2008	51–	55–	60–	67–	377–
	2010	49	56	62	69	372

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 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 2012, Early Release. 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 2012 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 the standards would produce. If the AEO 2012 Early Release projections of fuel prices prove 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.[1289] 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

[1289] *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.

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 standards and for all model years combined, using both discount rates prescribed by OMB regulatory guidance. Tables IV–94 and IV–95 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.)

TABLE IV–94—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($B) UNDER FINAL STANDARDS USING 3 PERCENT DISCOUNT RATE—MYS 2017–2021

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Technology costs	2008	4.0–	2.8–	5.4–	8.4–	12.8–	16.5–
	2010	8.7	4.4	5.8	8.4	11.9	14.9
Additional cost of maintaining more advanced vehicles	2008	0.0–	0.0–	0.3–	0.7–	1.0–	1.3–
	2010	0.0	0.0	0.0	0.4	0.8	1.0
Savings in lifetime fuel expenditures	2008	15.8–	10.7–	21.7–	35.0–	49.6–	63.3–
	2010	23.3	12.2	18.7	33.4	46.0	59.6
Consumer surplus from additional driving	2008	1.6–	1.0–	2.0–	3.2–	4.6–	5.7–
	2010	2.3	1.2	1.8	3.1	4.2	5.5
Value of savings in refueling time	2008	0.7–	0.4–	0.8–	1.2–	1.6–	2.0–
	2010	0.9	0.4	0.6	1.1	1.3	1.7
Reduction in petroleum market externalities	2008	0.9–	0.6–	1.2–	1.9–	2.7–	3.4–
	2010	1.3	0.7	1.0	1.8	2.4	3.1
Reduction in climate-related damages from lower CO_2 emissions	2008	1.5–	1.0–	2.1–	3.4–	4.9–	6.3–
	2010	2.2	1.2	1.8	3.3	4.6	6.0
Value of reduced highway fatalities from changes in vehicle mass	2008	(0.1)–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	−0.1	0.0	0.1
Reduction in health damage costs from lower emissions of criteria air pollutants							
CO	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
VOC	2008	0.0–	0.0–	0.0–	0.0–	0.1–	0.1–
	2010	0.0	0.0	0.0	0.0	0.1	0.1
NO_X	2008	0.0–	0.0–	0.1–	0.1–	0.1–	0.1–
	2010	0.1	0.0	0.0	0.1	0.1	0.1
PM	2008	0.2–	0.2–	0.3–	0.5–	0.8–	1.0–
	2010	0.4	0.2	0.3	0.5	0.7	0.9
SO_X	2008	0.2–	0.1–	0.3–	0.5–	0.6–	0.8–
	2010	0.3	0.2	0.2	0.4	0.6	0.8
Dis-benefits from increased driving							
Congestion costs	2008	0.7–	0.4–	0.9–	1.4–	1.9–	2.4–
	2010	1.0	0.5	0.8	1.3	1.8	2.3
Noise costs	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
Crash costs	2008	0.3–	0.2–	0.4–	0.6–	0.9–	1.1–
	2010	0.5	0.2	0.4	0.6	0.8	1.1
Total benefits	2008	21.1–	14.1–	28.5–	45.9–	65.0–	82.8–
	2010	30.8	16	24.5	43.6	60	77.9
Net benefits	2008	15.9–	10.6–	21.4–	34.7–	48.3–	61.4–
	2010	20.6	10.8	17.6	32.5	44.6	58.5

TABLE IV–95—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($B) UNDER AUGURAL STANDARDS USING 3 PERCENT DISCOUNT RATE—MYS 2022–2025 AND TOTAL FOR ALL MYS

	MY Baseline	2022	2023	2024	2025	Total
Technology costs	2008	18.5–	20.2–	24.9–	26.8–	140.3–
	2010	16.1	18.1	21.7	23.3	133.7
Additional cost of maintaining more advanced vehicles	2008	1.5–	1.6–	1.7–	1.8–	10.0–
	2010	1.2	1.6	1.9	2.1	9.0
Savings in lifetime fuel expenditures	2008	70.5–	76.9–	86.5–	94.9–	524.9–
	2010	66.0	75.1	85.1	93.6	512.9
Consumer surplus from additional driving	2008	6.4–	7.0–	7.8–	8.5–	47.8–
	2010	6.1	7.0	7.8	8.6	47.5
Value of savings in refueling time	2008	2.3–	2.5–	2.8–	3.1–	17.3–
	2010	1.9	2.2	2.5	2.7	15.5
Reduction in petroleum market externalities	2008	3.7–	4.0–	4.5–	4.9–	27.7–
	2010	3.4	3.9	4.4	4.7	26.7
Reduction in climate-related damages from lower CO_2 emissions	2008	7.2–	7.9–	8.9–	9.9–	53.2–

TABLE IV–95—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($B) UNDER AUGURAL STANDARDS USING 3 PERCENT DISCOUNT RATE—MYS 2022–2025 AND TOTAL FOR ALL MYS—Continued

	MY Baseline	2022	2023	2024	2025	Total
	2010	6.7	7.8	8.9	9.9	52.2
Value of reduced highway fatalities from changes in vehicle mass	2008	0.0–	0.0–	0.1–	0.2–	0.3–
	2010	0.1	0.1	0.1	0.2	0.4
Reduction in health damage costs from lower emissions of criteria air pollutants						
CO	2008	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0
VOC	2008	0.1–	0.1–	0.1–	0.1–	0.7–
	2010	0.1	0.1	0.1	0.1	0.6
NO_X	2008	0.2–	0.2–	0.2–	0.2–	1.2–
	2010	0.2	0.2	0.2	0.2	1.2
PM	2008	1.1–	1.2–	1.3–	1.4–	8.0–
	2010	1.0	1.1	1.3	1.4	7.7
SO_X	2008	0.9–	1.0–	0.9–	0.9–	6.2–
	2010	0.9	1.0	1.0	1.1	6.5
Dis-benefits from increased driving						
Congestion costs	2008	2.7–	3.0–	3.3–	3.7–	20.3–
	2010	2.6	2.9	3.3	3.6	20.2
Noise costs	2008	0.1–	0.1–	0.1–	0.1–	0.4–
	2010	0.0	0.1	0.1	0.1	0.4
Crash costs	2008	1.3–	1.4–	1.6–	1.7–	9.6–
	2010	1.2	1.4	1.6	1.7	9.4
Total benefits	2008	92.3–	100.7–	113.1–	124.2–	687.5–
	2010	86.4	98.3	111.3	122.5	671.4
Net benefits	2008	68.2–	74.5–	81.6–	90.2–	507.0–
	2010	65.2	74.2	82.8	91.7	498.0

Similarly, Tables IV–96 and IV–97 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.)

TABLE IV–96—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($B) UNDER FINAL STANDARDS USING 7 PERCENT DISCOUNT RATE—MYS 2017–2021

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Technology costs	2008	4.0–	2.8–	5.4–	8.4–	12.8–	16.5–
	2010	8.7	4.4	5.8	8.4	11.9	14.9
Additional cost of maintaining more advanced vehicles	2008	0.0–	0.0–	0.3–	0.7–	1.0–	1.3–
	2010	0.0	0.0	0.0	0.4	0.8	1.0
Savings in lifetime fuel expenditures	2008	12.4–	8.4–	16.9–	27.3–	38.7–	49.3–
	2010	18.3	9.5	14.6	26.1	35.9	46.5
Consumer surplus from additional driving	2008	1.3–	0.8–	1.6–	2.5–	3.6–	4.5–
	2010	1.8	0.9	1.4	2.4	3.3	4.3
Value of savings in refueling time	2008	0.5–	0.3–	0.6–	0.9–	1.3–	1.6–
	2010	0.7	0.4	0.5	0.8	1.1	1.4
Reduction in petroleum market externalities	2008	0.7–	0.5–	0.9–	1.5–	2.1–	2.6–
	2010	1.0	0.5	0.8	1.4	1.9	2.5
Reduction in climate-related damages from lower CO_2 emissions	2008	1.5–	1.0–	2.1–	3.4–	4.9–	6.3–
	2010	2.2	1.2	1.8	3.3	4.6	6.0
Value of reduced highway fatalities from changes in vehicle mass	2008	−0.1–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.1
Reduction in health damage costs from lower emissions of criteria air pollutants							
CO	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
VOC	2008	0.0–	0.0–	0.0–	0.0–	0.1–	0.1–
	2010	0.0	0.0	0.0	0.0	0.0	0.1
NO_X	2008	0.0–	0.0–	0.0–	0.1–	0.1–	0.1–
	2010	0.1	0.0	0.0	0.1	0.1	0.1
PM	2008	0.2–	0.1–	0.3–	0.4–	0.6–	0.8–
	2010	0.3	0.1	0.2	0.4	0.6	0.7
SO_X	2008	0.2–	0.1–	0.2–	0.4–	0.5–	0.6–

TABLE IV–96—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($B) UNDER FINAL STANDARDS USING 7 PERCENT DISCOUNT RATE—MYS 2017–2021—Continued

	MY Baseline	Earlier	2017	2018	2019	2020	2021
	2010	0.3	0.1	0.2	0.3	0.5	0.6
Dis-benefits from increased driving							
Congestion costs	2008	0.6–	0.3–	0.7–	1.1–	1.5–	1.9–
	2010	(0.8)	0.4	0.6	1.1	1.4	1.8
Noise costs	2008	0.0–	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0	0.0
Crash costs	2008	0.2–	0.2–	0.3–	0.5–	0.7–	0.9–
	2010	0.4	0.2	0.3	0.5	0.7	0.9
Total benefits	2008	16.8–	11.2–	22.7–	36.6–	51.9–	66.0–
	2010	24.7	12.8	19.6	34.8	47.9	62.2
Net benefits	2008	11.9–	7.9–	16.1–	26.1–	36.0–	45.8–
	2010	14.7	7.8	12.9	24.2	33.3	43.8

TABLE IV–97—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($B) UNDER AUGURAL STANDARDS USING 7 PERCENT DISCOUNT RATE—MYS 2022–2025 AND TOTAL FOR ALL MYS

	MY Baseline	2022	2023	2024	2025	Total
Technology costs	2008	18.5–	20.2–	24.9–	26.8–	140.3–
	2010	16.1	18.1	21.7	23.3	133.7
Additional cost of maintaining more advanced vehicles.	2008	1.5–	1.6–	1.7–	1.8–	10.0–
	2010	1.2	1.6	1.9	2.1	9.0
Savings in lifetime fuel expenditures	2008	55.0–	60.0–	67.4–	74.0–	409.5–
	2010	51.5	58.6	66.3	72.9	400.3
Consumer surplus from additional driving	2008	5.0–	5.4–	6.1–	6.6–	37.3–
	2010	4.8	5.4	6.1	6.7	37.1
Value of savings in refueling time	2008	1.8–	2.0–	2.2–	2.4–	13.6–
	2010	1.5	1.7	2.0	2.2	12.2
Reduction in petroleum market externalities	2008	2.9–	3.2–	3.6–	3.9–	21.9–
	2010	2.7	3.1	3.4	3.7	21.1
Reduction in climate-related damages from lower CO_2 emissions.	2008	7.2–	7.9–	8.9–	9.9–	53.2–
	2010	6.7	7.8	8.9	9.9	52.2
Value of reduced highway fatalities from changes in vehicle mass.	2008	0.0–	0.0–	0.1–	0.2–	0.2–
	2010	0.1	0.0	0.1	0.2	0.3
Reduction in health damage costs from lower emissions of criteria air pollutants.						
CO	2008	0.0–	0.0–	0.0–	0.0–	0.0–
	2010	0.0	0.0	0.0	0.0	0.0
VOC	2008	0.1–	0.1–	0.1–	0.1–	0.5–
	2010	0.1	0.1	0.1	0.1	0.5
NO_X	2008	0.1–	0.1–	0.2–	0.2–	1.0–
	2010	0.1	0.1	0.2	0.2	1.0
PM	2008	0.9–	0.9–	1.0–	1.1–	6.4–
	2010	0.8	0.9	1.0	1.1	6.2
SO_X	2008	0.7–	0.8–	0.7–	0.7–	4.9–
	2010	0.7	0.8	0.8	0.9	5.1
Dis-benefits from increased driving:.						
Congestion costs	2008	2.1–	2.3–	2.6–	2.9–	16.0–
	2010	2.0	2.3	2.6	2.9	15.9
Noise costs	2008	0.0–	0.0–	0.0–	0.1–	0.3–
	2010	0.0	0.0	0.0	0.1	0.3
Crash costs	2008	1.0–	1.1–	1.2–	1.4–	7.5–
	2010	1.0	1.1	1.2	1.3	7.4
Total benefits	2008	73.6–	80.4–	90.3–	99.1–	548.6–
	2010	69	78.4	88.8	97.8	536
Net benefits	2008	50.8–	55.5–	60.2–	66.7–	376.9–
	2010	48.9	55.7	61.9	68.6	371.8

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 standards to a meaningful extent.

As discussed in the FRIA, 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 1.4–2.1 mpg lower than when these provisions are not considered:

TABLE IV–98—NHTSA ESTIMATED AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER FINAL STANDARDS—MYS 2017–2021

[With EPCA AFV and credit provisions]

	MY Baseline	2017	2018	2019	2020	2021
Passenger cars	2008	39.5–	41.5–	43.8–	46.3–	47.9–
	2010	39.4–	41.1–	43.3–	45.1–	47.1–
Light trucks	2008	29.3–	30.3–	31.9–	33.3–	35.2–
	2010	28.8–	29.3–	31.3–	32.8–	34.9–
Combined	2008	35.0–	36.6–	38.7–	40.8–	42.6–
	2010	34.8–	36.0–	38.2–	39.9–	42.0–

TABLE IV–99—NHTSA ESTIMATED AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER AUGURAL STANDARDS—MYS 2022–2025

[With EPCA AFV and credit provisions]

	MY Baseline	2022	2023	2024	2025
Passenger cars	2008	49.3–	50.0–	51.5–	52.9–
	2010	48.1	49.6	51.3	52.1
Light trucks	2008	36.1–	36.8–	37.9–	39.0–
	2010	35.5	36.5	37.4	37.6
Combined	2008	43.8–	44.6–	46.0–	47.4–
	2010	42.9	44.2	45.6	46.2

As a result, NHTSA estimates that, when EPCA AFV and credit provisions are taken into account, fuel savings will total about 170 billion gallons, as compared to the 180–184 billion gallons estimated when these flexibilities are not considered:

TABLE IV–100—NHTSA ESTIMATED FUEL SAVED (BILLION GALLONS) UNDER FINAL STANDARDS—MYS 2017–2021

[With EPCA AFV and credit provisions]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	6–	3–	5–	8–	10–	12–
	2010	6	4	5	8	10	12
Light trucks	2008	1–	1–	2–	4–	6–	8–
	2010	2	1	2	4	6	8
Combined	2008	6–	4–	7–	12–	16–	20–
	2010	8	5	7	12	15	20

TABLE IV–101—NHTSA ESTIMATED FUEL SAVED (BILLION GALLONS) UNDER AUGURAL STANDARDS—MYS 2022–2025

[With EPCA AFV and credit provisions]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	14–	15–	17–	19–	107–
	2010	13	15	17	18	108
Light trucks	2008	9–	10–	11–	12–	63–
	2010	8	9	10	11	62
Combined	2008	23–	25–	28–	31–	170–
	2010	22	24	28	29	169

The agency similarly estimates CO_2 emissions reductions will total 1,832–1,843 million metric tons (mmt), as compared to the 1,953–1,987 mmt estimated when these EPCA provisions are not considered:[1290]

[1290] 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–102—NHTSA ESTIMATED AVOIDED CARBON DIOXIDE EMISSIONS (MMT) UNDER FINAL STANDARDS—MYS 2017–2021

[With EPCA AFV and credit provisions]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	60–	32–	55–	82–	112–	131–
	2010	66	39	56	85	105	130
Light trucks	2008	8–	10–	24–	44–	64–	86–
	2010	22	13	18	46	60	82
Combined	2008	68–	43–	79–	126–	176–	217–
	2010	89	52	73	131	166	213

TABLE IV–103—NHTSA ESTIMATED AVOIDED CARBON DIOXIDE EMISSIONS (MMT) UNDER AUGURAL STANDARDS—MYS 2022–2025

[With EPCA AFV and credit provisions]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	149–	161–	181–	197–	1,158–
	2010	144	163	185	197	1,171
Light trucks	2008	98–	105–	116–	128–	684–
	2010	91	102	112	115	662
Combined	2008	247–	266–	297–	325–	1,843–
	2010	234	265	298	312	1,832

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–104 and IV–105 below show that, total technology costs are estimated to decline to about $120 billion as a result of manufacturers' use of these provisions, as compared to the $134–140 billion estimated when excluding these flexibilities:

TABLE IV–104—NHTSA ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS ($ BILLION) UNDER FINAL STANDARDS—MYS 2017–2021

[With EPCA AFV and credit provisions]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	3–	2–	4–	6–	8–	11–
	2010	5	3	4	6	8	9
Light trucks	2008	0–	1–	1–	2–	3–	4–
	2010	2	1	1	2	3	5
Combined	2008	4–	2–	5–	7–	11–	14–
	2010	6	4	5	8	11	14

TABLE IV–105—NHTSA ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS ($ BILLION) UNDER AUGURAL STANDARDS—MYS 2022–2025

[With EPCA AFV and credit provisions]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	12–	13–	16–	17–	92–
	2010	10	11	14	14	85
Light trucks	2008	4–	5–	5–	6–	30–
	2010	5	5	6	6	35
Combined	2008	16–	18–	21–	23–	121–
	2010	15	17	20	20	120

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 is $629–639 billion when discounted at a 3 percent annual rate, as Tables IV–106 and IV–107 below report. This estimate of total benefits is lower than the $671–688 billion reported previously for the analysis that excluded these provisions:

TABLE IV–106—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($ BILLION) UNDER FINAL STANDARDS USING A 3 PERCENT DISCOUNT RATE— MYS 2017–2021

[With EPCA AFV and credit provisions]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	19.7–	10.8–	18.7–	27.8–	38.4–	45.2–
	2010	21.8	12.9	18.7	28.9	36	44.9
Light trucks	2008	2.7–	3.4–	8.0–	14.8–	21.5–	29.2–
	2010	7.2	4.4	5.9	15	19.9	27.6
Combined	2008	22.4–	14.2–	26.6–	42.5–	59.8–	74.4–
	2010	29	17.3	24.6	43.8	55.8	72.4

TABLE IV–107—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($ BILLION) UNDER AUGURAL STANDARDS USING A 3 PERCENT DISCOUNT RATE— MYS 2022–2025

[With EPCA AFV and credit provisions]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	51.9–	56.8–	64.4–	71.1–	404.8–
	2010	49.9	57	65.4	70.2	405.6
Light trucks	2008	33.4–	36.0–	40.3–	44.8–	234.2–
	2010	30.6	34.7	38.7	40.2	224.1
Combined	2008	85.2–	92.7–	104.6–	115.9–	638.5–
	2010	80.3	91.6	104	110.2	629.1

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–108 and IV–109 report that the present value of benefits from requiring higher fuel economy for MY 2017–25 cars and light trucks will total $502–510 billion when discounted using a 7 percent rate, as compared to the previous $536–549 billion estimate of total benefits when FFV credits were not permitted:

TABLE IV–108—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($ BILLION) UNDER FINAL STANDARDS USING A 7 PERCENT DISCOUNT RATE— MYS 2017–2021

[With EPCA AFV and credit provisions]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	15.8–	8.7–	15.0–	22.3–	30.8–	36.2–
	2010	17.4	10.3	15	23.1	28.8	36
Light trucks	2008	2.1–	2.7–	6.3–	11.8–	17.1–	23.2–
	2010	5.7	3.5	4.7	11.9	15.8	21.9
Combined	2008	17.9–	11.4–	21.3–	34.0–	47.8–	59.4–
	2010	23.2	13.8	19.6	35	44.6	57.8

TABLE IV–109—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($ BILLION) UNDER AUGURAL STANDARDS USING A 7 PERCENT DISCOUNT RATE—MYS 2022–2025

[With EPCA AFV and credit provisions]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	41.6–	45.5–	51.6–	57.0–	324.3–
	2010	40	45.7	52.5	56.2	325
Light trucks	2008	26.5–	28.6–	32.0–	35.5–	185.7–
	2010	24.3	27.5	30.7	31.8	177.7
Combined	2008	68.0–	74.0–	83.5–	92.5–	509.7–
	2010	64.1	73.1	83	88	502.2

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–110 and IV–111 show, the agency estimates that these will reduce net benefits from the CAFE standards to $475–483 billion from the previously-reported estimate of $498–507 billion without those credits.

TABLE IV–110—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($ BILLION) UNDER FINAL STANDARDS USING A 3 PERCENT DISCOUNT RATE—MYS 2017–2021

[With EPCA AFV and credit provisions]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	15 –	8 –	14 –	20 –	28 –	32 –
	2010	16	9	14	21	26	33
Light trucks	2008	2 –	3 –	7 –	12 –	18 –	24 –
	2010	5	3	5	12	16	22
Combined	2008	18 –	11 –	21 –	33 –	45 –	56 –
	2010	21	13	18	33	42	55

TABLE IV–111—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($ BILLION) UNDER AUGURAL STANDARDS USING A 3 PERCENT DISCOUNT RATE—MYS 2022–2025

[With EPCA AFV and credit provisions]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	37 –	40 –	45 –	50 –	289 –
	2010	36	42	47	51	296
Light trucks	2008	28 –	30 –	34 –	37 –	194 –
	2010	24	28	31	33	179
Combined	2008	64 –	70 –	79 –	87 –	483 –
	2010	61	70	78	84	475

Similarly, Tables IV–112 and IV–113 below show that NHTSA estimates manufacturers' use of EPCA AFV and credit provisions will reduce net benefits from requiring higher fuel economy for MY 2017–25 cars and light trucks—to $356–362 billion—if a 7 percent discount rate is applied to future benefits. This estimate is approximately 4% less than the previously-reported $372–377 billion estimate of net benefits without the availability of EPCA AFV and credit provisions using that same discount rate.

TABLE IV–112—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($ BILLION) UNDER FINAL STANDARDS USING A 7 PERCENT DISCOUNT RATE—MYS 2017–2021

[With EPCA AFV and credit provisions]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	12–	6–	11–	15–	20–	24–
	2010	12	7	10	16	20	24
Light trucks	2008	2–	2–	5–	9–	14–	19–
	2010	4	2	3	9	12	16
Combined	2008	13–	8–	16–	25–	34–	42–
	2010	16	9	13	25	32	41

TABLE IV–113—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($ BILLION) UNDER AUGURAL STANDARDS USING A 7 PERCENT DISCOUNT RATE—MYS 2022–2025

[With EPCA AFV and credit provisions]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	27–	30–	33–	36–	214–
	2010	27	31	35	38	221
Light trucks	2008	21–	23–	26–	28–	148–
	2010	18	21	23	25	135
Combined	2008	48–	52–	59–	65–	362–
	2010	46	52	59	63	356

For this final rule, NHTSA has included an analysis that accounts for the cumulative costs and benefits of the final fuel economy standards that affect MY 2011–2021 vehicles and the augural standards that affect MY 2022–2025 vehicles. This analysis enables the agency to assess the cumulative effects of previously adopted CAFE standards for MY 2011 and MY 2012–2016, as well as the final standards for MY 2017–2021 and augural standards for MY 2022–2025 that this final rule presents. The table below shows the total fuel savings, reductions in carbon dioxide emissions, and social costs and benefits resulting from the sequence of CAFE standards established for MYs 2011–21, as well as program totals with the inclusion of the augural standards for MY 2022–2025. Each of these impacts is measured against a baseline that assumes the CAFE standards for MY 2010 would have been extended to apply to MYs 2011–25 if the agency had not developed standards for those model years.

As is the case elsewhere in this preamble, the table below represents the estimated impact of the CAFE rules based on required fuel economy levels, excluding consideration of credit banking, transfers and trading, dedicated alternative fuel vehicles, and dual fuel vehicles operating on alternative fuels, as required under EPCA/EISA. The technology costs reported in the table represent the costs of technologies used by manufacturers to increase fuel economy to the levels required by the higher standards. (These cost estimates are the same whether we use a 3 percent or 7 percent discount rate to discount future benefits or costs, because they occur at the time the vehicle is purchased, so no discounting is involved.) The discounted social costs include the technology costs associated with the sequence of standards, as well monetized social costs associated with any increases in traffic congestion, noise, accidents and fatalities that occur in response to the increases in fuel economy resulting from compliance with the standards.

Instead of using the estimated impacts from previous regulatory analyses accompanying the standards for MY 2011 and MYs 2012–16, the costs and benefits provided in this analysis are estimated using the current version of the CAFE model. Thus, they are based on the agency's most up-to-date estimates of the costs of technologies that are available to improve fuel economy. All costs from previous years are adjusted to 2010 dollars using the implicit price deflator for gross domestic product (GDP).

Table IV–114 illustrates that the combined effects of the previously established CAFE standards for MY 2011 and MY 2012–2016, together with the final CAFE standards for MY 2017–2021 and augural CAFE standards for MY 2022–2025 presented in this final rule, would be to save 450–520 billion gallons of fuel, reduce CO_2 emissions by 4.9–5.7 billion metric tons, and provide net economic benefits in excess of $1 trillion.

TABLE IV–114—NHTSA SUMMARY OF ESTIMATED IMPACTS FROM ALL FINAL AND AUGURAL STANDARDS FOR MY 2011–2025 LIGHT DUTY VEHICLES

[Compared to Continuation of MY 2010 Standards]

	MY baseline	2011–2016			2011–2021			2011–2025		
		PC	LT	Combined	PC	LT	Combined	PC	LT	Combined
Fuel saved (b gallons)	2008	59–	41–	100–	176–	118–	294–	313–	208–	520–
	2010	42	33	75	144	102	246	266	183	449
Oil saved (billion barrels)	2008	1.4–	1.0–	2.4–	4.2–	2.8–	7.0–	7.5–	5.0–	12.4–
	2010	1.0	0.8	1.8	3.4	2.4	5.9	6.3	4.4	10.7
Retail fuel savings, discounted at 3% ($B).	2008	177–	121–	298–	541–	358–	899–	980–	642–	1,622–
	2010	126	96	222	444	305	749	835	562	1,397
CO2 saved (mmt)	2008	645–	447–	1,092–	1,914–	1,286–	3,200–	3,399–	2,260–	5,659–
	2010	458	353	811	1,568	1,095	2,663	2,894	1,979	4,873
Discounted social benefits, 3% ($B)	2008	212–	144–	355–	648–	426–	1,072–	1,176–	765–	1,939–
	2010	149	114	263	527	362	889	996	668	1,662
Technology costs ($B)	2008	33–	20–	53–	106–	57–	163–	204–	99–	303–
	2010	27	18	44	92	56	147	172	98	270
Discounted social costs, 3% ($B)	2008	44–	26–	70–	233–	140–	372–	393–	236–	627–
	2010	34	23	57	187	123	309	318	207	522
Discounted net benefits, 3%	2008	168–	118–	285–	415–	286–	700–	783–	529–	1,312–
	2010	115	91	206	340	239	580	678	461	1,140

The agency performed a number of sensitivity analyses to examine important assumptions. All sensitivity analyses were based on the ''standard setting'' output of the CAFE model, and are based solely upon the 2010 baseline fleet. We examine sensitivity with respect to the following economic parameters:

- The price of gasoline: The main analysis uses the Reference Case AEO 2012 Early Release estimate for the price of gasoline. As the AEO 2012 Early Release does not contain Low and High Price Cases, ranges derived from the Low and High Price Cases from the AEO 2011 were utilized in conjunction with the Reference Case AEO 2012 Early Release to study the effect of the Low and High Price Cases on the model results.
- 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.
- 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 $0.199 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 valuations of approximately $5, $36, and $68 per ton, at discount rates of 5 percent (model average), 2.5 percent (model average) and 3 percent (95th percentile), respectively, with regard to the benefits of reducing CO_2 emissions.[1291] These are the 2010 values, which increase over time. These values can be translated into cents per gallon by multiplying by 0.0089,[1292] giving the following values:
  - ($4.91 per ton CO_2) x 0.0089 = $0.044 per gallon discounted at 5%
  - ($22.22 per ton CO_2) x 0.0089 = $0.198 per gallon discounted at 3%

[1291] The low, high, and very high valuations of $5, $36, and $67 are rounded for brevity. 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.

[1292] 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.

(used in the main analysis)
- ($36.49 per ton CO_2) x 0.0089 = $0.325 per gallon discounted at 2.5%
- And a 95th percentile estimate of
- ($67.55 per ton CO_2) × 0.0089 = $0.601 per gallon discounted at 3%

- Global Warming Potential (non-CO_2 GHG benefits): The main analysis does not monetize benefits associated with the reduction of non-CO_2 GHGs (methane, nitrous oxide, HFC–134a). This sensitivity analysis uses a GWP approach to convert non-CO_2 gases to CO_2-equivalence to monetize these benefits using the same methods with which the benefits of CO_2 reductions are valued.
- 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.
- 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, respectively, of the main analysis estimates.
- Post-warranty repair costs: The main analysis includes repair costs during the warranty period; post-warranty repair costs are addressed in a sensitivity analysis. The warranty period is assumed to be 5 years for the powertrain and 3 years for the rest of the vehicle. This sensitivity analysis scales the frequency of repair by vehicle survival rates, assumes that per-vehicle repair costs during the post-warranty period are the same as in the in-warranty period, and that repair costs are proportional to incremental direct costs (therefore vehicles with additional components will have increased repair costs).
- Battery cost: The agency conducted a sensitivity analysis of battery costs for HEV, PHEV and EV technologies. The ranges for battery costs are based on the recommendations from the technical experts in the field of battery energy storage technologies at Department of Energy (DOE) and Argonne National Laboratory (ANL). These ranges of battery costs are developed using the Battery Performance and Cost (BatPaC) model developed by ANL and funded by DOE.[1293] The values for these ranges are shown in Table IV–115 and are calculated with 95% confidence interval after analyzing the confidence bound using the BatPaC model.

In the NPRM central analysis, EPA developed direct manufacturing costs (DMC) for battery systems using ANL's BatPaC model. For this sensitivity analysis, NHTSA scaled these central battery system costs by the percentages shown in Table IV–115, per guidance from DOE and ANL experts on reasonable ranges for these costs.

TABLE IV–115—NHTSA 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

Figures IV–4 to IV–8 show these battery system DMCs in terms of $/kW for HEV and $/kWh for 20-mile range PHEV (PHEV20), 40-mile range PHEV (PHEV40), 75-mile range EV (EV75), 100-mile range EV (EV100) and 150-mile range EV (EV150). We note that battery system cost varies with vehicle subclasses and driving range. Smaller batteries tend to be relatively more expensive per kWh because the cost for the battery management system, disconnect units and baseline thermal management system is the same from vehicle to vehicle for each type of electrification system, such as HEV, PHEV and EV (but varies between different electrification systems) and this cost is spread over fewer kWh for smaller vehicle. For example, the battery system cost for EVs ranges from $221/kWh for subcompact cars for EV75, to $160/kWh for large trucks for EV150 in MY 2021. Note: the agencies do not apply PHEV or EV technology to large MPVs/minivans or large trucks; however, the estimated costs of such a system are shown here for completeness.

[1293] Section 3.4.3.9 in TSD Chapter 3 has detailed descriptions of the history of the BatPac model and how the agencies used the BatPac model in this analysis.

Figure IV-5 Battery System Direct Manufacture Cost (DMC) for P2 HEV

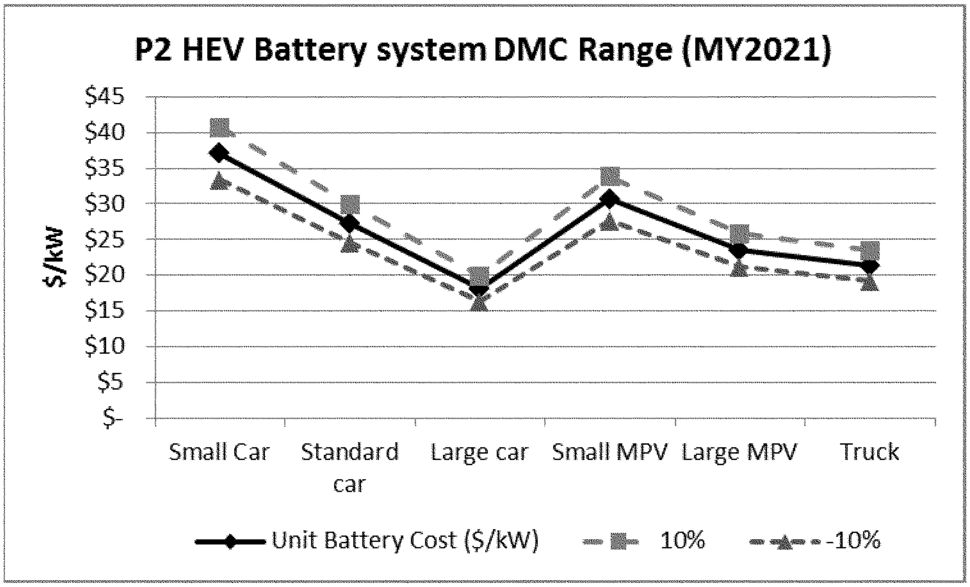


Figure IV-6 Battery System Direct Manufacture Cost (DMC) for PHEV20

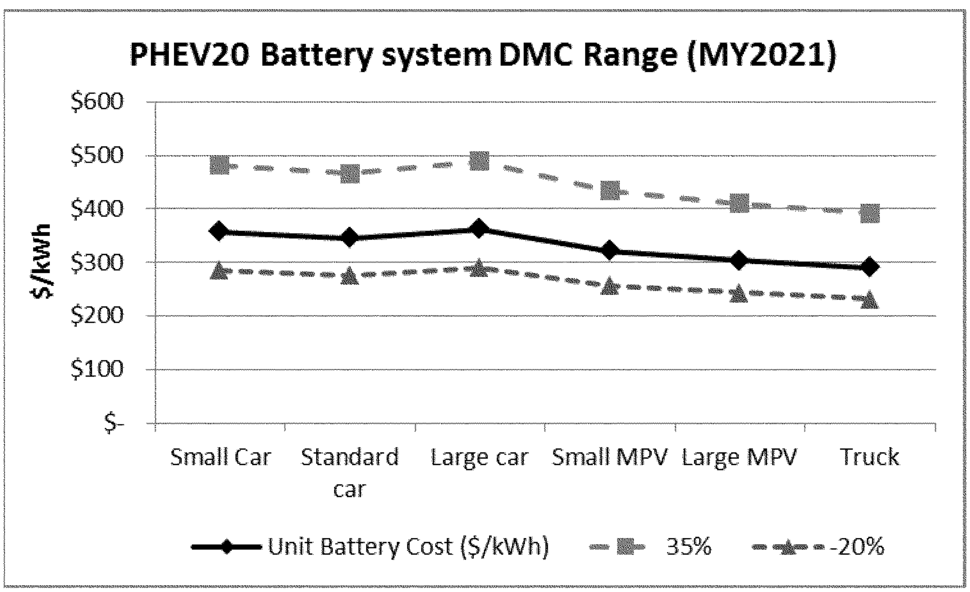


Figure IV-7 Battery System Direct Manufacture Cost (DMC) for PHEV40

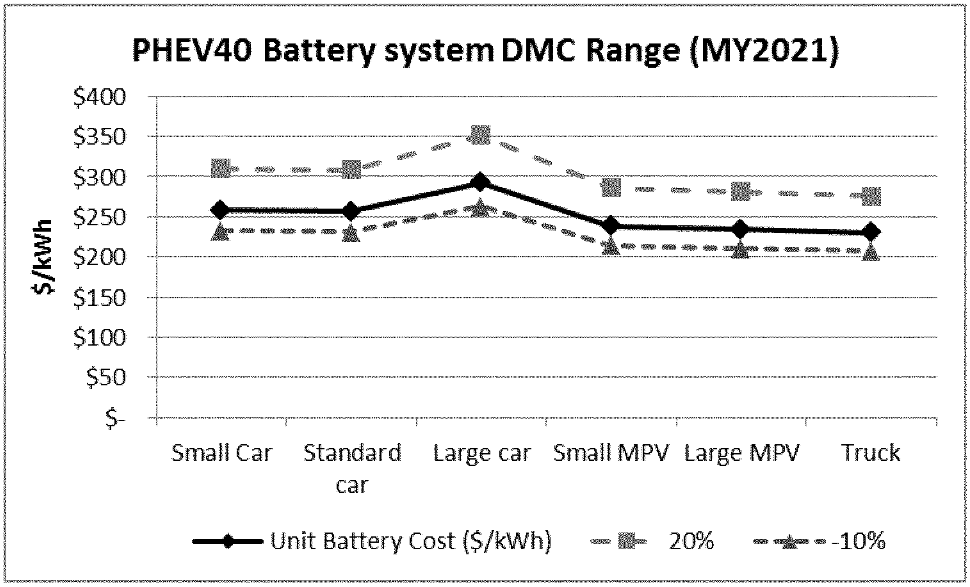


Figure IV-8 Battery System Direct Manufacture Cost (DMC) for EV75

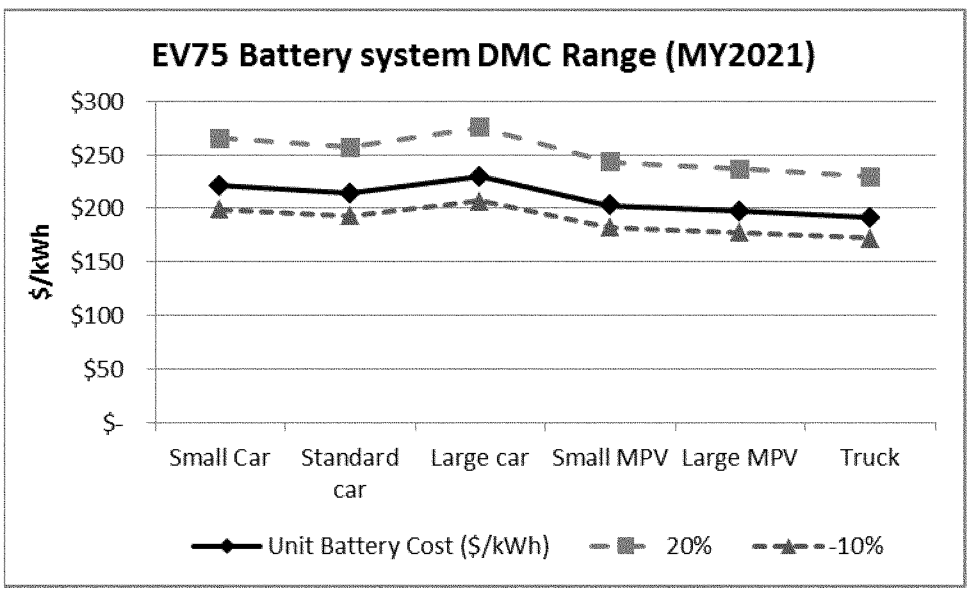
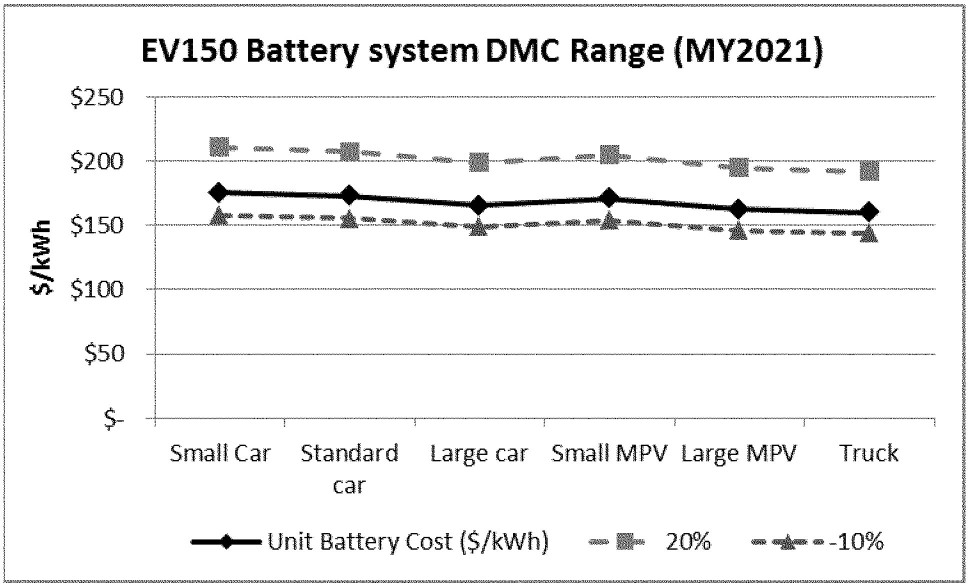


Figure IV-9 Battery System Direct Manufacture Cost (DMC) for EV150



For the reader's reference, this sensitivity was conducted using what the agency refers to as ''standard setting'' analytical runs, in which the agency restricts the operation of the model consistent with statutory requirements related to how the agency may determine maximum feasible CAFE standards (for example, the standard setting runs do not include EVs, because NHTSA may not consider the fuel economy of EVs when setting maximum feasible CAFE standards, nor do they consider PHEVs prior to MY 2020, for the same reason), as compared to the ''real-world'' analysis, in which the agency attempts to model how manufacturers might respond to the standards (and regulatory alternatives) taking account of all available technologies and compliance flexibilities. NHTSA used the ''standard setting'' runs for this sensitivity analysis to show the regulatory impact of the battery cost. In the ''standard setting'' runs, NHTSA included 30-mile range PHEV (PHEV30) only after MY 2019 to represent all PHEVs, the cost of which is the average cost of PHEV20 and PHEV40. NHTSA did not apply any EVs in this analysis.

• Mass reduction cost: Due to the wide range of mass reduction cost as stated in TSD Chapter 3, 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 Figure IV–10. The slope of this line used for NPRM central analysis is $4.36 (2010$) 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 values for the range of mass reduction cost are shown in Table IV–116.

TABLE IV–116—NHTSA BOUNDS FOR MASS REDUCTION DIRECT MANUFACTURING COST

[2010$]

Sensitivity bound	Slope of mass reduction line [$/(lb − %MR)]	Example unit direct manufacture cost [1] [$/lb]	Example total direct manufacture cost [2] [$/lb]
Lower Bound	$2.61	$0.39	$235
NPRM Central Analysis	4.36	0.65	392
Upper Bound	6.10	0.92	549

Notes

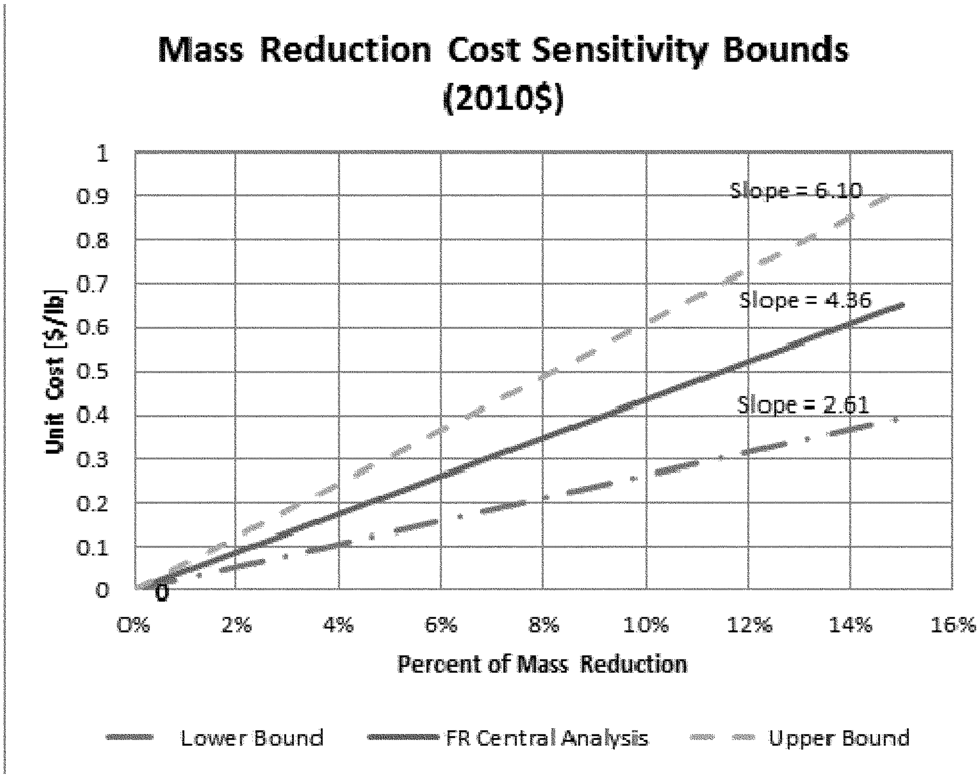
[1] Example is based on 15% mass reduction.

Unit direct manufacturing cost [$/lb] = Slope × Percent of Mass Reduction.

[2] Example is based on 15% mass reduction for a 4000-lb vehicle.

Total direct manufacturing cost $[] = Unit Direct Manufacturing Cost × Amount of Mass Reduction.

Figure IV-10 Direct Manufacturing Cost for Mass Reduction (2010$)



• 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 baseline 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 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-drive response' analysis assumes 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 costs, effects, and benefits would actually be smaller with a market-driven response; rather it means 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.

• Transmission shift optimization technology disabled: As part of the simulation work for the final rule, ANL attempted to replicate the shift optimizer technology but was not able to identify any significant fuel consumption reductions. For this reason a sensitivity case analysis was conducted with the transmission shift optimizer technology disabled.

Varying each of the above 10 parameters in isolation results in a variety of economic scenarios. These are listed in Table IV–117 below along with the preferred alternative.

TABLE IV–117—LIST OF NHTSA ECONOMIC SENSITIVITY ANALYSES

Name	Fuel price	Discount rate (%)	Rebound effect (%)	SCC ($)	Military security (¢/gal)
Reference	Reference	3	10	22	0
High Fuel Price	High	3	10	22	0
Low Fuel Price	Low	3	10	22	0
5% Rebound Effect	Reference	3	5	22	0
15% Rebound Effect	Reference	3	15	22	0
20% Rebound Effect	Reference	3	20	22	0
12¢/gal Military Security Value	Reference	3	10	22	12
$5/ton CO_2 Value	Reference	3	10	5	0
$36/ton CO_2 Value	Reference	3	10	36	0
$68/ton CO_2 Value	Reference	3	10	68	0
Global Warming Potential	Reference	3	10	22	0
50% Consumer Benefit	Reference	3	10	22	0
75% Consumer Benefit	Reference	3	10	22	0
Post-Warranty Repair Costs	Reference	3	10	22	0
Low Battery Cost	Reference	3	10	22	0
High Battery Cost	Reference	3	10	22	0
Low Cost Mass Reduction	Reference	3	10	22	0
High Cost Mass Reduction	Reference	3	10	22	0
Market-Driven Response	Reference	3	10	22	0
No Shift Optimization	Reference	3	10	22	0

The basic results of these sensitivity analyses are contained in Chapter X of the FRIA, but several selected findings are as follows:

- Varying the economic assumptions has almost no impact on achieved mpg. The mass reduction cost sensitivities, battery cost reduction sensitivities, market-based baseline sensitivity, and no shift optimization sensitivity cases are the only instances in which achieved mpg differs from the reference case of the Preferred Alternative. None of these alter the outcome by more than 0.3 mpg for either fleet.
- Varying the economic assumptions has, at most, a small impact on per-vehicle costs, with only the no shift optimization variation affecting the per-vehicle cost by more than 10 percent from the central analysis level. Similarly, fuel saved and CO_2 emissions reductions vary only slightly across the sensitivity cases, where the only substantial impact results from the market-driven baseline sensitivity in which voluntary overcompliance reduces the number of gallons of fuel saved as well as the quantity of CO_2 emissions by just under 28 percent.
- 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 38 percent or to increase them by about 32 percent relative to those of the Preferred Alternative. Other large impacts on net benefits occurred with the $68/ton CO_2 valuation, in which net benefits increased by nearly 22 percent, the market-driven baseline, which reduces net benefits by close to 32 percent, and (as expected) the 50 and 75 percent consumer fuel savings valuation cases, which decrease net benefits by approximately 52 and 26 percent, respectively.
- Even if consumers value the benefits achieved at 50% of the main analysis assumptions, total benefits still exceed costs, with net benefits greater than $135 billion.

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–118 through IV–120. 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 results 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.[2] 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 a 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) of 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 which are applicable to recent or near-term future model years. As noted above, the cost learning factors used for the sensitivity case are different than 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–118—NHTSA ESTIMATED 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	54.07	53.92	0.16
Max Net Benefits	56.52	56.42	0.10
Light trucks			
Preferred Alternative	39.29	39.14	0.15
Max Net Benefits	43.66	43.56	0.10

TABLE IV–119—NHTSA ESTIMATED 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	54.07	52.78	1.29
Max Net Benefits	56.52	55.32	1.20
Light trucks			
Preferred Alternative	39.29	37.71	1.58
Max Net Benefits	43.66	43.27	0.39

TABLE IV–120—NHTSA SENSITIVITY ANALYSES

[Estimated Achieved mpg, per-vehicle cost, net benefits, fuel saved, and 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 millions of $	MY 2017–2025 fuel saved, in millions of gallons	MY 2017–2025 CO_2 Emissions reduced, in mmT
Passenger Cars					
ICM w/Main Analysis Costs	54.07	$1,578	$293,062	109,852	2,384
RPE w/Main Analysis Costs	53.92	1,943	273,307	107,200	2,325
ICM w/NAS Costs	52.78	2,103	242,912	100,496	2,155
Light trucks					
ICM w/Main Analysis Costs	39.29	1,226	175,793	61,984	1,333
RPE w/Main Analysis Costs	39.14	1,491	181,243	65,083	1,397
ICM w/NAS Costs	37.71	1,375	154,597	56,337	1,217

For today's rulemaking analysis, as for the NPRM, 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 introduced this analysis for the NPRM because some stakeholders commenting on the recently-promulgated standards for medium- and heavy-duty vehicles had 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 agreed 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 uncertainties discussed below regarding the *degree* to which manufacturers will do so, the agency judged it appropriate to conduct its central rulemaking analysis without attempting to simulate these effects. Nonetheless, the agency considered voluntary overcompliance sufficiently plausible to warrant corresponding sensitivity analysis.

In the NPRM, NHTSA invited comment on this sensitivity analysis, in particular regarding the reasonableness of the assumption that manufacturers might consider further fuel economy improvements, depending on technology costs and fuel prices; the reasonableness of the agency's approach (comparing technology costs to the present value of fuel savings over some payback period) to simulating such decisions; and what payback period (or periods) would most likely to reflect manufacturers' decisions regarding technology application through MY2025.

Several environmental organizations submitted comments on NHTSA's analysis. The Center for Biological Diversity (CBD) commented that the agency's baseline ''suggests a much lower fuel efficiency increase driven solely by market forces than actual experience demonstrates occurs.'' [1294] The Natural Resources Defense Council (NRDC) commented that manufacturers might add more technology than required by standards, but that such decisions are too uncertain to be included in NHTSA's baseline projection. The Environmental Defense Fund (EDF) commented that, given relatively stable future fuel prices, and given provisions allowing credit transfers between manufacturers, manufacturers will not likely overcomply with MY2016 standards, on average, after MY2016. The American Council for an Energy-Efficient Economy (ACEEE) commented that the historical record contains little evidence of sustained fuel economy increases absent sustained increases in fuel economy standards. ACEEE also commented that an alternative ''non-flat'' baseline would reduce NHTSA's estimates of the benefits (and costs) of the new standards, the net effect being a reduction in the cost-effectiveness of the standards, because the most cost-effective technologies are the ones that will appear in the alternative baseline scenario, leaving the more expensive technologies for the rule to bring into the market.

In addition, several stakeholders on the ''payback period'' NHTSA should apply in its analysis. EDF indicated that any payback period shorter than five years would not accurately reflect the current and forecasted buying trends of consumers. The Sierra Club also submitted comments suggesting a five-year payback period. Volkswagen commented that buyers' preferences will suggest payback periods of less than four years. The International Council on Clean Transportation (ICCT) commented that analysis in 2010 by David Greene supported an average payback period of three years.[1295] NADA commented that analysis based on a payback period oversimplifies the calculation of consumer benefits, but did not comment on the payback period as basis to estimate the potential that manufacturers might add technology beyond that required by regulation.

NHTSA recognizes the uncertainty inherent in forecasting whether and to what extent the average fuel economy level of light-duty vehicles will continue to increase beyond the level necessary to meet regulatory standards. However, because market forces could independently result in changes to the future light-duty vehicle fleet even in the absence of agency action, to the extent they can be estimated, those changes should be incorporated into the baseline. As a result, today's final rule continues to present impacts in terms of two sets of analyses: one assuming that the average fleetwide fuel economy for light-duty vehicles will not exceed the minimum level necessary to comply with CAFE standards, and one assuming continued improvement in average fleetwide fuel economy for light-duty vehicles due to higher market demand for fuel-efficient vehicles.

From a market-driven perspective, there is considerable historical evidence that manufacturers have an economic incentive to improve the fuel economy of their fleets beyond the level of the CAFE standards when they are able to do so. Although there was an historical period of stagnation in average fuel economy starting in the 1990s, when manufacturers allocated efficiency improvements to weight and power, it was accompanied by a prolonged period of historically low gasoline prices, where real prices remained below $1.50 per gallon for nearly 15 years. Even during that period, passenger car fuel economy exceeded CAFE standards every year and light-truck fuel economy exceeded standards in most years. This trend supports the proposition that consumers have historically recognized the benefits that accrue from operating vehicles with greater fuel efficiency even in an environment of low fuel prices.

In recent years, overcompliance with standards has increased, likely in response to higher fuel prices, with the market shifting toward more fuel-efficient models and toward passenger cars rather than trucks, even in the absence of regulatory pressure. This suggests that, at the fuel prices that have been prevalent in recent years, consumers are placing a greater value on fuel economy than the longer term historical average. Consumers appear to be recognizing 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. The fuel economy of the combined car and light-truck fleet has increased since 2005, with the largest increase in 2009. NHTSA also expects the new fuel economy labels will increase awareness of the consumer savings that result from purchasing a vehicle with higher fuel economy and will impact consumer demand for more fuel-efficient vehicles. NHTSA discusses how consumers value fuel savings in Chapter VIII of the FRIA accompanying today's notice.

Consumer demand for fuel-efficient vehicles is expected to continue in the future. Increasing uncertainty about future fuel prices and growing concern for the energy security and environmental impacts of petroleum use are likely to have an increasing impact on the vehicle market. In response, a number of manufacturers have announced plans to introduce technology beyond what is necessary to meet the MY 2016 standards. This evidence aligns with the AEO 2012 Early Release, which shows continued fuel economy improvements in the Reference Case through 2035 in the absence of the MY 2017–2025 standards.

NHTSA performed today's analysis by simulating potential overcompliance under the no-action alternative, the

[1294] CBD, p. 6.

[1295] Greene, David 2010. ''Uncertainty, loss aversion, and markets for energy efficiency'', Energy Economics.

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 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 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 standards, the agency has applied the 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–121—NHTSA ESTIMATED AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER BASELINE STANDARDS—MYS 2017–2021

[Including voluntary overcompliance]

	MY Baseline	2017	2018	2019	2020	2021
Passenger cars	2008	39.0–	39.5–	40.0–	40.2–	40.5–
	2010	38.6–	39.1–	39.4–	39.8–	40.3–
Light trucks	2008	30.4–	31.0–	31.7–	32.0–	32.3–
	2010	29.4–	29.6–	30.4–	31.0–	31.5–
Combined	2008	35.3–	35.9–	36.6–	36.9–	37.2–
	2010	34.7–	35.1–	35.7–	36.2–	36.8–

TABLE IV–122—NHTSA ESTIMATED AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER BASELINE STANDARDS—MYS 2022–2025

[Including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025
Passenger cars	2008	40.8–	40.9–	41.0–	41.1–
	2010	40.5	40.6	40.7	40.9
Light trucks	2008	32.5–	32.7–	32.9–	33.1–
	2010	31.8	32.0	32.2	32.4
Combined	2008	37.5–	37.7–	37.9–	38.1–
	2010	37.0	37.2	37.4	37.6

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 nearly 3 mpg by MY 2025. In other words, without simulating voluntary overcompliance, the agency estimated that combined average achieved fuel economy would reach 34.7–35.4 mpg in MY 2025, whereas the agency estimates that it would reach 37.6–38.1 mpg in that year if voluntary overcompliance occurred.

In contrast, the effect on achieved fuel economy levels of allowing voluntary overcompliance with the standards was minimal. Allowing manufacturers to overcomply with the 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–123—NHTSA ESTIMATED AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER FINAL STANDARDS—MYS 2017–2021

[Including voluntary overcompliance]

	MY Baseline	2017	2018	2019	2020	2021
Passenger cars	2008	40.8–	43.0–	45.1–	47.2–	48.9–
	2010	40.5–	42.2–	44.3–	46.4–	48.6–
Light trucks	2008	30.9–	32.0–	33.9–	35.3–	36.7–
	2010	29.9–	30.5–	32.2–	33.6–	35.6–
Combined	2008	36.5–	38.3–	40.4–	42.2–	43.9–
	2010	36.0–	37.1–	39.1–	41.0–	43.2–

TABLE IV–124—NHTSA ESTIMATED AVERAGE ACHIEVED FUEL ECONOMY (MPG) UNDER AUGURAL STANDARDS—MYS 2022–2025

[Including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025
Passenger cars	2008	50.2–	51.2–	53.1–	54.3–
	2010	49.6	51.1	53.0	54.4
Light trucks	2008	37.6–	38.3–	39.4–	40.2–
	2010	36.3	37.5	38.4	39.3
Combined	2008	45.0–	46.0–	47.6–	48.7–
	2010	44.1	45.5	47.0	48.2

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 131–133 billion gallons, as compared to the 180–184 billion gallons estimated when potential voluntary overcompliance is not taken into account:

TABLE IV–125—NHTSA ESTIMATED FUEL SAVED (BILLION GALLONS) UNDER FINAL STANDARDS—MYS 2017–2021

[Including voluntary overcompliance]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	4–	3–	5–	7–	9–	10–
	2010	5	3	4	7	8	10
Light trucks	2008	0–	1–	1–	3–	4–	5–
	2010	1	1	1	2	3	5
Combined	2008	5–	3–	6–	9–	13–	16–
	2010	6	4	5	9	12	15

TABLE IV–126—NHTSA ESTIMATED FUEL SAVED (BILLION GALLONS) UNDER AUGURAL STANDARDS—MYS 2022–2025

[Including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	11–	13–	15–	16–	92–
	2010	11	13	15	16	92
Light trucks	2008	6–	6–	7–	8–	41–
	2010	5	6	7	7	39
Combined	2008	17–	19–	22–	24–	133–
	2010	16	19	21	23	131

The agency is not projecting, however, that fuel consumption will be greater when voluntary overcompliance is taken into account. Rather, under today's final and augural standards, the agency's analysis shows *lower* fuel consumption (by 0.7–1.1 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 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 final and augural standards.

The agency further estimates CO_2 emissions reductions attributable to today's final and augural standards will total 1,432–1,414 million metric tons (mmt), versus the 1,953–1,987 mmt estimated when potential voluntary overcompliance is not taken into account:[1296]

TABLE IV–127—NHTSA ESTIMATED AVOIDED CARBON DIOXIDE EMISSIONS (MMT) UNDER FINAL STANDARDS—MYS 2017–2021

[Including voluntary overcompliance]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	46–	29–	51–	71–	95–	110–
	2010	54	31	46	71	92	111
Light trucks	2008	5–	8–	15–	28–	42–	56–
	2010	12	8	13	26	36	52
Combined	2008	52–	36–	65–	99–	136–	166–
	2010	66	39	58	98	127	162

TABLE IV–128—NHTSA ESTIMATED AVOIDED CARBON DIOXIDE EMISSIONS (MMT) UNDER AUGURAL STANDARDS—MYS 2022–2025

[Including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	123–	135–	155–	171–	985–
	2010	121	137	158	172	993
Light trucks	2008	64–	68–	77–	84–	447–
	2010	56	66	73	80	421
Combined	2008	187–	203–	232–	255–	1,432–

[1296] 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–128—NHTSA ESTIMATED AVOIDED CARBON DIOXIDE EMISSIONS (MMT) UNDER AUGURAL STANDARDS—MYS 2022–2025—Continued

[Including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025	Total
	2010	177	203	231	252	1,414

This analysis further indicates smaller or similar incremental outlays for additional technology under the standards when potential voluntary overcompliance is taken into account. Table IV–129 and Table IV–130 below show that total incremental technology costs attributable to today's standards are estimated at $127–140 billion, as compared to the $134–140 billion estimated when potential voluntary overcompliance was not taken into account:

TABLE IV–129—NHTSA ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS ($ BILLION) UNDER FINAL STANDARDS—MYS 2017–2021

[Including voluntary overcompliance]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	5–	3–	5–	7–	9–	12–
	2010	5	3	4	6	9	11
Light trucks	2008	0–	0–	1–	2–	3–	4–
	2010	1	1	1	2	3	4
Combined	2008	5–	3–	5–	8–	12–	16–
	2010	7	4	5	8	11	14

TABLE IV–130—NHTSA ESTIMATED INCREMENTAL TECHNOLOGY OUTLAYS ($ BILLION) UNDER AUGURAL STANDARDS—MYS 2022–2025

[Including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	14–	15–	19–	20–	109–
	2010	12	13	16	17	97
Light trucks	2008	5–	5–	6–	6–	31–
	2010	4	5	5	5	30
Combined	2008	18–	20–	25–	26–	140–
	2010	16	18	21	22	127

Because NHTSA's analysis indicated that voluntary overcompliance with baseline standards will reduce the share of fuel savings attributable to today's standards, the agency's estimate of the present value of total benefits will be $484–495 billion when discounted at a 3 percent annual rate, as Tables IV–131 and IV–132 following report. This estimate of total benefits is lower than the $671–687 billion reported previously for the analysis in which potential voluntary overcompliance was not taken into account:

TABLE IV–131—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($ BILLION) UNDER FINAL STANDARDS USING A 3 PERCENT DISCOUNT RATE—MYS 2017–2021

[Including voluntary overcompliance]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	15.2–	9.5–	17.1–	24.1–	32.4–	38.0–
	2010	17.7	10.3	15.3	24.1	31.2	38
Light trucks	2008	1.7–	2.5–	4.8–	9.2–	13.8–	18.8–
	2010	3.9	2.5	4.2	8.5	11.7	17.2
Combined	2008	17.0–	12.1–	21.9–	33.3–	46.3–	56.9–
	2010	21.5	12.8	19.4	32.6	42.9	55.1

TABLE IV–132—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($ BILLION) UNDER AUGURAL STANDARDS USING A 3 PERCENT DISCOUNT RATE—MYS 2022–2025

[including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	42.7–	47.3–	55.3–	61.4–	343.1–

TABLE IV–132—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($ BILLION) UNDER AUGURAL STANDARDS USING A 3 PERCENT DISCOUNT RATE—MYS 2022–2025—Continued

[including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025	Total
	2010	41.9	47.9	55.5	61.1	343.1
Light trucks	2008	21.6–	23.2–	26.6–	29.2–	151.6–
	2010	18.9	22.3	25	27.5	141.6
Combined	2008	64.3–	70.5–	81.9–	90.6–	494.6–
	2010	60.7	70.1	80.6	88.7	484.4

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–133 and IV–134 report that the present value of benefits from requiring higher fuel economy for MY 2017–25 cars and light trucks will total $387–395 billion when discounted using a 7 percent rate, as compared to the previous $525–536 billion estimate of total benefits when potential voluntary overcompliance is not taken into account:

TABLE IV–133—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($ BILLION) UNDER FINAL STANDARDS USING A 7 PERCENT DISCOUNT RATE—MYS 2017–2021

[Including voluntary overcompliance]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	12.2–	7.6–	13.7–	19.4–	26.0–	30.5–
	2010	14.1	8.3	12.3	19.3	25	30.4
Light trucks	2008	1.4–	2.0–	3.8–	7.3–	11.0–	14.9–
	2010	3.1	2	3.3	6.7	9.3	13.6
Combined	2008	13.5–	9.7–	17.5–	26.6–	37.0–	45.4–
	2010	17.2	10.3	15.5	26	34.3	44

TABLE IV–134—NHTSA ESTIMATED PRESENT VALUE OF BENEFITS ($ BILLION) UNDER AUGURAL STANDARDS USING A 7 PERCENT DISCOUNT RATE—MYS 2022–2025

[Including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	34.2–	37.9–	44.3–	49.2–	275.0–
	2010	33.6	38.4	44.5	49	275
Light trucks	2008	17.2–	18.4–	21.1–	23.2–	120.2–
	2010	15	17.6	19.8	21.8	112.3
Combined	2008	51.3–	56.3–	65.4–	72.4–	395.1–
	2010	48.5	56	64.4	70.8	387

The agency estimates, as shown in Tables IV–135 and IV–136, that net benefits from the CAFE standards will be $329–335 billion. This is compared to the previously-reported estimate of $498–507 billion which did not incorporate the potential for voluntary overcompliance and is based primarily on the reduction of benefits attributable to the standards when voluntary overcompliance is taken into account.

TABLE IV–135—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($ BILLION) UNDER FINAL STANDARDS USING A 3 PERCENT DISCOUNT RATE—MYS 2017–2021

[Including voluntary overcompliance]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	10–	6–	11–	16–	21–	24–
	2010	11	7	10	16	21	25
Light trucks	2008	1–	2–	4–	7–	11–	14–
	2010	2	2	3	6	9	13
Combined	2008	11–	8–	15–	23–	31–	38–
	2010	14	8	13	23	29	38

TABLE IV–136—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($ BILLION) UNDER AUGURAL STANDARDS USING A 3 PERCENT DISCOUNT RATE—MYS 2022–2025

[Including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	26–	29–	33–	38–	214–
	2010	28	32	37	41	228
Light trucks	2008	16–	17–	20–	22–	115–
	2010	14	17	19	21	106
Combined	2008	43–	47–	53–	60–	329–
	2010	42	49	56	62	335

Similarly, Tables IV–137 and IV–138 below show that NHTSA estimates voluntary overcompliance could reduce net benefits attributable to today's standards to $235–242 billion if a 7 percent discount rate is applied to future benefits. This estimate is lower than the previously-reported $372–377 billion estimate of net benefits when potential voluntary overcompliance is not taken into account, using that same discount rate.

TABLE IV–137—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($ BILLION) UNDER FINAL STANDARDS USING A 7 PERCENT DISCOUNT RATE—MYS 2017–2021

[Including voluntary overcompliance]

	MY Baseline	Earlier	2017	2018	2019	2020	2021
Passenger cars	2008	7–	4–	8–	12–	15–	17–
	2010	8	5	7	12	15	18
Light trucks	2008	1–	2–	3–	5–	8–	10–
	2010	2	1	2	5	6	9
Combined	2008	8–	6–	11–	17–	23–	27–
	2010	10	6	9	16	21	28

TABLE IV–138—NHTSA ESTIMATED PRESENT VALUE OF NET BENEFITS ($ BILLION) UNDER AUGURAL STANDARDS USING A 7 PERCENT DISCOUNT RATE—MYS 2022–2025

[Including voluntary overcompliance]

	MY Baseline	2022	2023	2024	2025	Total
Passenger cars	2008	18–	21–	23–	26–	150–
	2010	20	23	26	30	164
Light trucks	2008	12–	13–	15–	16–	85–
	2010	11	12	14	16	78
Combined	2008	31–	33–	37–	43–	235–
	2010	31	36	40	45	242

As discussed above, these reductions in fuel savings and avoided CO_2 emissions (and correspondingly, in total and net benefits) attributable to today's 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 CAFE standards.

For more detailed information regarding NHTSA's sensitivity analyses for this final rule, please see Chapter X of NHTSA's FRIA.

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 FRIA. *Results of the uncertainty analysis are summarized below for the model year 2017–2025 standards, combining the passenger car and light truck fleets:*

- *Total Benefits at 7% discount rate: Societal benefits will total $7.5 billion to $721 billion, with a mean estimate of $373 billion.*
- *Total Benefits at 3% discount rate: Societal benefits will total $9 billion to $912 billion, with a mean estimate of $467 billion.*
- *Total Costs at 7% discount rate: Costs will total between $429 million and $247 billion, with a mean estimate of $125 billion.*
- *Total Costs at 3% discount rate: Costs will total between $421 million and $250 billion, with a mean estimate of $126 billion*

5. How would these final standards impact vehicle sales and employment?

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 the operating costs of those models. While the initial purchase price of those vehicles will increase, the overall cost of owning them—including their operating costs—will decrease, because their fuel consumption will decline significantly. The net effect on sales will depend on the extent to which consumers are willing to pay for higher fuel economy and the resulting savings in operating costs, versus their sensitivity to changes in vehicles' initial purchase prices, and is thus challenging to evaluate.

The agency anticipates that consumers will place some value on improved fuel economy, both because it reduces the operating cost of the vehicles, and because recently promulgated EPA and DOT regulations require vehicles sold during 2017 through 2025 to display labels that more clearly communicate to potential buyers the fuel savings, economic, and environmental benefits of owning more fuel-efficient vehicles. We recognize that the magnitude of this effect cannot be predicted at this time, and that how consumers value fuel economy is a subject of ongoing debate. We also expect that consumers may consider other factors besides direct purchase price increases that affect the costs they pay for new vehicles, and have included these factors in the analysis.

There is a broad consensus in the economic literature that the price elasticity of demand for automobiles is approximately −1.0,[1297,1298,1299,1300] meaning that every one percent increase in the price of the vehicle would reduce sales by one percent (assuming no change in fuel economy, quality, or other attributes of vehicles). NHTSA typically assumes that manufacturers will be able to pass all of their costs to improve fuel economy on to consumers in the form of higher sales prices for models offering higher fuel economy. The subsequent discussion of consumer welfare, however, suggests that by itself, a net decrease in overall operating costs may not necessarily produce a net increase in sales. Many consumers are more sensitive to vehicles' initial purchase prices than to their subsequent operating costs, and thus may not be willing to purchase vehicles with higher fuel economy even when it appears that doing so would reduce their overall costs to own a vehicle.

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) and the extent to which this final rule could affect consumer behavior. In addition, consumers' valuation of fuel economy improvements depends upon the price of gasoline, which has recently been very volatile. On balance, the effect of this final rule on vehicle sales will depend upon whether the value that potential buyers place on the increased fuel economy that this rule requires is greater or less than the increase in vehicle prices that results from the rule, as well as on how automakers interpret buyers' likely responses to higher prices and increased fuel economy. Additional data would enhance the accuracy of predictions on these issues. In addition, it would be helpful to assess important emerging trends, such as the degree that longer financing terms affect consumers' decisionmaking as they weigh operating costs versus upfront costs, and the degree to which extreme and continued volatility itself in gas prices affects assumptions about likely returns on upfront technology investments.

a. How do consumers value fuel economy?

The first question to evaluate is how consumers value fuel economy, or more accurately, how they value fuel savings attributable to increased fuel economy. Two interrelated economic concepts are commonly used to summarize how consumers appear to value future fuel savings that result from higher fuel economy. The first relates to the length of time that consumers consider when valuing fuel savings, or ''payback period,'' while the second relates to the discount rate that consumers apply to future savings. Although either of these two concepts can be used by itself to indicate how buyers value future fuel savings, our analysis uses a combination of the two to characterize consumers' valuation of future fuel savings.

The length of time that consumers consider when valuing future fuel savings can significantly affect their comparisons of fuel savings to the increased cost of purchasing a vehicle that offers higher fuel economy. For example, there will be a significant difference in aggregate fuel savings if consumers consider 1 year, 3 years, 5 years, 10 years, or the lifetime of the vehicle as the relevant payback period. The discount rate that consumers use to discount future fuel savings to their present value can also have a significant impact; higher discount rates will reduce the importance of future fuel savings relative to a vehicle's initial purchase price. If consumers value fuel savings over a short payback period, such as 1 to 2 years, then the discount rate will be less important, but if consumers consider fuel savings over a longer period, then the discount rate will become important.

The payback period and discount rate are conceptual proxy measures for consumer decisions that may often be made without any explicit quantitative analysis. For example, some buyers choosing among a set of vehicles may know what they have been paying recently for fuel, what they are likely to pay to buy each of the vehicles considered, and some attributes—including labeled fuel economies—of those vehicles. However, these 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; 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 by considering an

[1297] Kleit, A.N. (1990). ''The Effect of Annual Changes in Automobile Fuel Economy Standards,'' *Journal of Regulatory Economics,* vol. 2, pp 151–172. Available at *http://www.springerlink.com/content/m04787480k056018/* (last accessed August 1, 2012) or Docket No. NHTSA–2010–0131.

[1298] Bordley, R. (1994). ''An Overlapping Choice Set Model of Automotive Price Elasticities,'' *Transportation Research B,* vol 28B, no 6, pp 401–408. Available at *http://www.sciencedirect.com/science/article/B6V99–466M3VD–1/2/3ecfe61bac45f1afb8d9b370330e3f0c* (last accessed August 1, 2012).

[1299] 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. Available at *http://econpapers.repec.org/article/tprrestat/v_3a78_3ay_3a1996_3ai_3a3_3ap_3a543–47.htm* (last accessed August 1, 2012) or Docket No. NHTSA–2010–0131.

[1300] 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. *See., e.g.,* Hymans, Saul H., ''Consumer Durable Spending: Explanation and Prediction,'' Brookings Papers on Economic Activity 1 (1970), which 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 (pp. 173–206). Available at: *http://www.brookings.edu/about/projects/bpea/editions/~/media/Projects/BPEA/1970%202/1970b_bpea_hymans_ackley_juster.PDF* or Docket No. NHTSA–2010–0131 (last accessed August 1, 2012).

explicit 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.

Information regarding the number of years that consumers value fuel savings comes from several sources. In past analyses, NHTSA has used five years as representing the average payback period, because this is the average length of time of a financing agreement.[1301] We conducted a 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 should be revised. A recent paper by David Greene[6] 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,'' although the author states that ''manufacturers have repeatedly stated that consumers will pay, in increased vehicle price, for only 2–4 years in fuel savings'' based on manufacturers' own market research. The National Research Council[1302] also used a 3 year payback period as one way to compare consumer valuation of benefits to a full lifetime value. A survey conducted for the Department of Energy in 2004, 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[1303] 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 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 examined and compiled many of these analyses and found: ''Implicit consumer discount rates were estimated by Greene (1983) based on eight early multinomial 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.''

This is an extremely broad range. 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 chose for purposes of this analysis to utilize the standard 3 and 7 percent social discount rates recommended by OMB guidance to evaluate the costs and benefits of regulation. To the extent that some consumers appear to apply higher discount rates, the analysis of likely sales consequences would be different. This review leads us to conclude that consumer valuation of future fuel savings is highly uncertain, leading to different potential scenarios for vehicle sales. A negative impact on sales is possible if consumers don't value the fuel savings or desire very short payback periods, because the final rule will lead to an increase in the perceived ownership cost of vehicles. In addition, sales decreases are possible if gasoline prices are lower than projected by manufacturers and the agencies or technology costs are higher than projected. A positive impact on sales is also possible, because the final 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. Whether a change in sales will result from this final rule, or will result from other factors that affect the way drivers consider fuel economy in their purchasing decisions, is subject to uncertainty.

b. How do manufacturers believe consumers value fuel savings attributable to higher fuel economy?

Although some manufacturers have indicated in public remarks or confidential statements to NHTSA that their plans to apply fuel-saving technology depend on fuel prices and consumers' willingness to pay for fuel economy improvements, the agency does not have specific and robust information regarding how manufacturers interpret consumers' valuation of fuel savings. Based on our review of the literature and available evidence, it is not clear how accurately manufacturers are accounting for consumer valuation of fuel economy in making their pricing decisions, nor how that accuracy will be affected in the future as manufacturers' costs to produce vehicles rise in response to the final standards. In standard economic theory, if manufacturers believe that consumers value the fuel savings at a higher dollar level than the technology costs, then manufacturers' profit motives would lead them to voluntarily add the cost-effective technologies to their vehicles in the absence of government mandates, in the belief that their sales and profits would increase.

This concept ties into the basic question of whether manufacturers are providing the amount of fuel economy that consumers wish to purchase—whether there is matching between consumers' demand for fuel economy and the firms' supply of fuel economy. It is possible that the light-duty vehicle market is currently operating according to standard economic assumptions, and manufacturers are providing approximately the amount of fuel economy that consumers wish to purchase, because they correctly interpret consumers' valuation of fuel economy. On the other hand, it is possible that manufacturers are providing more or less fuel economy than consumers wish to purchase, because they do not correctly understand consumers' valuation of fuel economy. Because NHTSA does not know which scenario is correct today, and cannot predict which will apply in the future, we evaluate the response of sales under both scenarios in the following sections in order to assess the range of potential impacts that could be attributable to this final rule.

As discussed above, it is very difficult to determine how consumers will react to fuel economy improvements, and manufacturers presumably face this same challenge. Consumer consideration of fuel economy appears to evolve based on a variety of factors (fuel price, recessions, marketing), and consumers can react quickly to changes in these factors, sometimes more rapidly than the industry is able to change its product offerings. There have been examples of periods when demand for fuel efficient vehicles exceeded the available supply of highly efficient vehicles, and other periods where very efficient vehicle models were introduced into the market but sales stalled. If manufacturers did not

[1301] 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%.

[1302] National Research Council (2002), ''Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards'', National Academies Press, Washington DC.

[1303] Turrentine, T.S. and K.S. Kurani, 2007. ''Car Buyers and Fuel Economy,'' *Energy Policy,* vol. 35, pp. 1213–1223.

accurately forecast consumers' demand for fuel efficient vehicles, manufacturers' investment in vehicle technologies would not result in desired payoff. Manufacturers may be likely to be particularly risk averse with regard to future changes in fuel prices, in large part due to the substantial capital investments that are necessary to develop and market fuel-efficient models. If a manufacturer invests substantially in fuel efficient technologies expecting higher consumer demand than realized, then the manufacturer has incurred the costs of investment but not reaped the benefits of those investments. On the other hand, if a manufacturer does not invest in fuel efficient technologies, then the manufacturer may lose some market share in the short run if demand for fuel economy is higher than expected, but they still retain the option of investing in fuel efficient technologies. The predicted level of investment under uncertainty related to consumer demand for fuel efficient vehicles and irreversibility of investment for fuel efficient technologies would be less than the predicted level of investment under no uncertainty and complete reversibility.

In addition, there is reason to believe there may be risk aversion on the consumer side. The simultaneous investment by all companies may also encourage consumer confidence in the new technologies. If only one company adopted new technologies, early adopters might gravitate toward that company, but early adopters tend to be a relatively small portion of the public. More cautious buyers, who are likely to be more numerous, might wait for greater information before moving away from well-known technologies. If all companies adopt advanced technologies at the same time, though, potential buyers may perceive the new technologies as the new norm rather than as a risky innovation. They will then be more willing to move to the new technologies. As some commenters have pointed out, simultaneous action required by the rule may change buyers' expectations (their reference points) for fuel economy, and investing in more fuel economy may seem less risky than in the absence of the rule.[1304]

Further, the certainty of the regulations reduces the costs of meeting them, because there will be a) more economies of scale and more learning curve benefits due to greater cumulative production of fuel-efficient technologies and b) more incentive for automakers and suppliers to invest in R&D to create future fuel-efficient technologies.[1305] We note that this risk aversion by itself does not indicate a market failure; it is the fact that the risk aversion leads to under provision of social benefits (e.g., reduction in greenhouse gas emissions).

c. How did NHTSA attempt to calculate potential impacts of the final rule on vehicle sales under the different scenarios discussed above?

Given the considerable uncertainty associated with consumer valuation of fuel savings and manufacturers' understanding of that valuation, NHTSA sought to assess potential sales impacts under two possible basic scenarios: first, one in which the light-duty vehicle market is currently operating according to standard theoretical economic principles, and manufacturers are providing *exactly* the amount of fuel economy that consumers wish to purchase, because they perfectly understand consumers' valuation of fuel economy; and second, one in which manufacturers are *not* providing the exact amount of fuel economy that consumers wish to purchase (either too much or too little), because they do not have perfect information regarding consumers' valuation of fuel economy. In the first scenario, manufacturers and consumers would behave as though they are assuming the same payback period (and/or discount rate) for fuel savings attributable to higher fuel economy; in the second, manufacturers and consumers would behave as though they are assuming different payback periods (and/or discount rates).

For years, consumers have been learning about the benefits that accrue to them from owning and operating vehicles with greater fuel efficiency. 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 market driven baseline.

The 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.[1306] These positive externalities may lead to benefits for manufacturers as a whole. We emphasize that this discussion has been tentative and qualified. Social learning of related kinds has been

[1304] We note that this risk aversion by itself does not indicate a market failure; but that the risk aversion leads to under-provision of social benefits (e.g., reduction in greenhouse gas emissions).

[1305] The literature reviewed by Popp, Newell, and Jaffe (2010) shows that environmental regulation has played an important role in inducing innovation that reduces the cost of achieving environmental goals; Popp (2011) provides evidence that consumer pressure alone is rarely sufficient to achieve broad diffusion of environmentally friendly technologies.

[1306] 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.

identified in a number of contexts,[1307] and the agency expects that it will influence consumers' future valuation of fuel economy. Thus, while it is difficult to determine how consumers will react to fuel economy improvements attributable to the final rule, we believe that it is likely that consumers will learn more about and increasingly value fuel economy improvements in the future. If manufacturers assume that consumers value fuel economy less than consumers *actually* value fuel economy, there will be a demand pull for better fuel economy vehicles into the market, and by virtue of the final standards forcing manufacturers to increase better fuel economy product offerings; it is possible that sales could increase as a result.

d. How did NHTSA illustrate these scenarios analytically?

The agency examined a number of cases to illustrate these scenarios. Sales impacts were determined for 6 cases that are combinations of manufacturers' beliefs of how consumers value fuel savings and consumers' valuation of fuel savings. The first two cases assume a flat baseline (no voluntary improvement in fuel economy above the MY 2016 standards by manufacturers absent new regulations), consistent with the agency's main analysis in this rulemaking. In these first two cases we assume consumers value fuel savings for a 3 year period or a 5 year period (the average length of a loan), and we also determine the breakeven point of consumer valuation of fuel savings, where there would be no impact on sales, assuming all other factors remain constant. As can be seen in Table IV–140 below, with a flat baseline and assuming that consumers consider fuel economy benefits over a 3 or 5 year period, benefits exceed costs to the point that consumers will purchase more vehicles and sales will increase. NHTSA estimates a break-even point of 2.35 years for scenarios with a flat baseline; that is, if consumers value fuel savings over an average 2.35 years, neither an increase nor a decrease in sales is expected.

The next 4 cases assume that manufacturers will, absent new regulations, implement technologies in response to their belief that consumers have either a 1 year, 3 year, or 5 year payback period, and for 3 of these scenarios where the consumer also values fuel economy over the same payback periods assumed by manufacturers. For example, the agency also examined the impact on sales and employment under the sensitivity analysis assumption that the baseline fleet included the manufacturers voluntarily implementing any technology that had a 1 year or less payback period for consumers. In this analysis, the least expensive technologies relative to their effects on fuel economy improvement (those that had a consumer payback where fuel savings over the first year of use were higher than new vehicle price increases) were assumed to be voluntarily implemented by manufacturers, resulting in improved fuel economy in the baseline case which would have occurred without adoption of this rule. The same methodology was used in the cases where both manufacturers and consumers value fuel savings over either a 3 year period or a 5 year period. All three of these cases result in reductions in sales, with the impact decreasing as the manufacturer's baseline increases from 1 year to 3 year to 5 years. In a final case we assume that manufacturers voluntarily implement any technology that had a 1 year or less payback period for consumers, but that consumers value fuel savings over a 3 year period.

Under that case, the breakeven point for consumers is about 3.1 years—meaning that if consumers valued their fuel savings over 3.1 years in this scenario, there would be no impact on sales; in other words if the payback period of the fuel saving technologies was less than 3.1 years, then the vehicle sales would increase and vice versa.

For the reader's reference, Table IV–139 below shows the included combinations of payback periods assumed—for these different cases—to represent consumers' and manufacturers' decisions. The agency considered these different cases to represent an illustrative range of possible outcomes under the scenarios described above.

TABLE IV–139—SCENARIOS CONSIDERED FOR SALES IMPACT ANALYSIS

Payback period representing manufacturers' decisions	Payback period representing buyers' decisions		
	1 Year	3 Years	5 Years
0 Years (Flat)		Included	Included.
1 Year	Included	Included.	
3 Years		Included.	
5 Years			Included.

For the analysis for each of these cases, NHTSA makes several assumptions. For the fuel savings part of the equation, as shown in the table, we assumed that the average purchaser considers the fuel savings they would receive over a 1, 3, or 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 that included taxes, because this is what consumers must pay. Fuel savings were calculated over the first 1, 3, or 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 some of 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. As these costs are transfer payments, they are not included in the societal cost of the program, but they are included as one of the increased costs to the consumer for these standards. We took the most recent auto sales tax by state [1308] and

[1307] See Hunt Alcott, Social Norms and Energy Conservation, Journal of Public Economics (March 2011), available at *http://opower.com/uploads/library/file/1/allcott_2011_jpubec_-_social_norms_and_energy_conservation.pdf* (last accessed August 1, 2012); Christophe Chamley, Rational Herds: Economic Models of Social Learning (Cambridge, 2004), available at *http://bilder.buecher.de/zusatz/21/21995/21995098_lese_1.pdf* (last accessed August 1, 2012).

[1308] See *http://www.factorywarrantylist.com/car-tax-by-state.html* (last accessed August 1, 2012). Note that county, city, and other municipality-specific taxes were excluded from NHTSA's weighted average, as the variation in locality taxes within states, lack of accessible documentation of locality rates, and difficulty in obtaining reliable sets of weights to apply to locality taxes

Continued

weighted them by population by state to determine a national weighted-average sales tax of 5.46 percent (hereafter rounded to 5.5 percent in the discussion). NHTSA sought to weight sales taxes by new vehicle sales by state; however, such data were unavailable. NHTSA recognizes that for this purpose, new vehicle sales by state is a superior weighting mechanism to Census population; in an effort to approximate new vehicle sales by state NHTSA studied the change in new vehicle registrations (using R.L. Polk data) by state across recent years and developed a corresponding set of weights. The resulting national weighted-average sales tax rate was almost identical to that resulting from the use of Census population estimates as weights, just slightly above 5.5 percent. NHTSA opted to utilize Census population rather than the registration-based proxy of new vehicle sales as the basis for computing this weighted average, as the end results were negligibly different and the analytical approach involving new vehicle registrations had not been as thoroughly reviewed.

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. A recent study by Quality Planning [1309] provides the average value of collision plus comprehensive insurance for new vehicles, in 2010$, is $521 ($396 of which is collision and $125 of which is comprehensive). The average consumer expenditure for a new passenger car in 2011, according to the Bureau of Economic Analysis was $24,572 and the average price of a new light truck was $31,721 in $2010.[1310] Using sales volumes from the Bureau, we determined an average passenger car and an average light truck price was $27,953 in $2010 dollars.[1311] Average prices and estimated sales volumes are needed because price elasticity is an estimate of how a percent increase in price [1312] affects the percent decrease in sales. Dividing the cost to insure a new vehicle by the average price of a new vehicle gives the proportion of comprehensive plus collision insurance as 1.86 percent of the price of a vehicle. As vehicles' values decline with vehicle age, comprehensive and collision insurance premiums likewise decline. Data on the change in insurance premiums as a function of vehicle age are scarce; however, NHTSA utilized data from the aforementioned Quality Planning study that cite the cost to insure the average vehicle on the road today (average age 10.8 years)[1313] to enable a linear interpolation of the change in insurance premiums during the first 11 years of a typical vehicle's life. Using this interpolation, as a percentage of the base vehicle price of $27,953, the cost of collision and comprehensive insurance in each of the first five years of a vehicle's life is 1.86 percent, 1.82 percent, 1.75 percent, 1.64 percent, and 1.50 percent, respectively, or 8.57 percent in aggregate. 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 to finance their purchase.[1314] Using proprietary forecasts available from Global Insight, NHTSA developed an average of 48-month [1315] bank and auto finance company loan rates for years 2017 through 2025, which—when deflated by Global Insight's corresponding forecasts of the CPI—is 5.16 percent. In the construction of this estimate, NHTSA assumed an equal distribution of bank and auto finance company loans—an assumption necessitated by the lack of data on the distribution of the volume of loans between the differing types of creditors. NHTSA opted to adjust future loan rates using the CPI rather than the GDP deflator as this analysis is intended to facilitate further analysis from the perspective of the consumer, for which the CPI is the preferred deflation factor. At these terms the average person taking a loan will pay 13.7 percent more (undiscounted) for their vehicle over the 5 years than a consumer paying cash for the vehicle at the time of purchase. Discounting future loan payments at a 3 percent discount rate, a consumer financing a vehicle purchase pays 5.43 percent more as opposed to an all cash purchase. Taking into account to make the total baseline price for MY 2017 $25,443 ($24,572 + $871), for light trucks $1,090 was added to the average price of a MY 2011 light truck to make the total baseline price for MY 2017 $32,811 ($31,721 + $1,090). All of these values are in 2010 dollars. Assuming that only 70 percent of vehicle purchases are financed, the average consumer would pay 3.80 (=0.70 * 5.43 percent) percent more than the retail price of a vehicle.

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 percent [1316] 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 30.64 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

complicates the ability to perform this analysis. Localities with relatively high automobile sales taxes may have relatively fewer auto dealerships, as consumers would likely endeavor to purchase vehicles in areas with lower locality taxes.

1309 "During Recession, American Drivers Assumed More Risk to Reduce Auto Insurance Costs," Quality Planning, March 2011. See *https://www.qualityplanning.com/media/4312/110329%20tough%20times_f2.pdf* (last accessed August 1, 2012).

1310 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/itable/* (last accessed August 1, 2012)

1311 *http://www.bls.gov/cpi/cpid11av.pdf,* Table 1A. Consumer Price Index for All Urban Consumers (CPI–U): U.S. city average, by expenditure category and commodity and service group, for new vehicles. (Last accessed August 1, 2012)

1312 When estimating the sales impact, the price of the vehicle was increased from these MY 2011 prices based on the costs of estimated safety and MY 2011–2016 fuel economy rules. See the cumulative impact section for an estimate of those costs. For passenger cars $871 was added to the average price of a MY 2011 passenger car to make the total baseline price for MY 2017 $25,443 ($24,572 + $871), for light trucks $1,090 was added to the average price of a MY 2011 light truck to make the total baseline price for MY 2017 $32,811 ($31,721 + $1,090). All of these values are in 2010 dollars.

1313 See *https://www.polk.com/company/news/average_age_of_vehicles_reaches_record_high_according_to_polk* (last accessed August 1, 2012).

1314 Bird, Colin. "Should I Pay Cash, Lease or Finance My New Car?" *http://www.cars.com/go/advice/Story.jsp?section=fin&story=should-i-pay-cash&subject=loan-quick-start&referer=advice&aff=sacbee,* July 12, 2011, citing CNW Marketing Research. (Last accessed August 1, 2012)

1315 No projections were available for rates of loan terms of 60 months. NHTSA compared the historical difference of 48-month and 60-month loan rates and determined the 48-month rate to be a suitable proxy for the 60-month rate.

1316 Consumer Reports, August 2008, "What That Car Really Costs to Own," Available at *http://www.consumerreports.org/cro/cars/pricing/what-that-car-really-costs-to-own-4–08/overview/what-that-car-really-costs-to-own-ov.htm* (last accessed August 1, 2012).

rate, the consumer considers that he could get 30.64 percent back upon resale in 5 years, but will pay 5.5 percent more for taxes, 8.0 percent more in insurance, and 5.1 percent more for loans, resulting in an 12.0 percent return on the increase in price for fuel economy technology (=30.6 percent − 5.5 percent − 8.0 percent − 5.1 percent). Thus, the increase in price per vehicle would be multiplied by 0.88 (=1 − 0.12) 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. For ease of presentation, we combine the impact on passenger car and light truck sales for the Preferred Alternative only for the combined 9 year period of 2017–2025, and we compare the sales impact for both the MY 2010 baseline and for the MY 2008 baseline at the 3 percent and 7 percent discount rates. There is not a significant difference in sales impacts depending upon the baseline considered (2010 versus 2008) and the discount rate impact is predictable, with sales increasing to a lesser extent under a 7 percent discount rate than in the case of a 3 percent discount rate, since benefits are valued lower with a higher discount rate.

TABLE IV–140—POTENTIAL SALES IMPACT FOR PASSENGER CARS AND LIGHT TRUCKS

[Vehicles in thousands]

Years fuel valued by manufacturers	Years fuel valued by consumers	MYs 2017–2025 Sales impact in thousands and in percent of total sales (3% discount rate)		MYs 2017–2025 Sales impact in thousands and in percent of total sales (7% discount rate)	
		(000's)	(%)	(000's)	(%)
2008 Baseline					
0 Flat	3 yr.	911	0.6	757	0.5
0 Flat	5 yr.	3,784	2.7	3,232	2.3
1 yr. *	1 yr. *	–2,696	–1.9	–2,322	–1.6
1 yr.	3 yr.	–360	–0.3	–445	–0.3
3 yr. *	3 yr. *	–530	–0.4	–542	–0.4
5 yr. *	5 yr. *	–3	–0.0	–36	–0.0
2010 Baseline					
0 Flat	3 yr.	988	0.7	867	0.6
0 Flat	5 yr.	3,804	2.7	3,261	2.3
1 yr. *	1 yr. *	–2,405	–1.7	–2,611	–1.8
1 yr	3 yr.	–50	–0.0	–130	–0.1
3 yr. *	3 yr. *	–309	–0.2	–314	–0.2
5 yr. *	5 yr. *	124	0.1	94	0.1

* These scenarios are presented as theoretical cases. NHTSA believes it is unlikely that manufacturers and consumers would value improvements in fuel economy identically, and believes that on average, manufacturers will behave more conservatively in their assumptions of how consumers value fuel economy than how on average consumers will actually behave. NHTSA expects that in practice the number of years fuel is valued by manufacturers will be shorter than the number of years fuel is valued by consumers.

e. What have commenters and other sources said in terms of potential sales impacts attributable to the final rule?

A recent study on the effects on sales, attributable to NHTSA regulatory programs, including the fuel economy program was undertaken by the Center for Automotive Research (CAR).[1317] CAR examined the impacts of alternative fuel economy increases of 3%, 4%, 5%, and 6% per year on the outlook for the U.S. motor vehicle market, including the impacts of likely increases in costs for increased fuel economy (based on the NAS report, which estimates higher costs than NHTSA's current estimates) and required safety features. The CAR analysis also examined the technologies that would be used to achieve higher fuel economy, and how their production and use would affect the new vehicle market, production volumes, 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 evaluate the value of those safety mandates to consumers. Thus the CAR study cannot be compared to other studies, as it combines the cost of additional safety mandates along with costs for fuel economy improvements. The CAR study likely underestimates sales (that is, it overestimates the reduction in sales resulting from increased CAFE standards alone), as it assigns no value to consumers' perceived values of additional safety features. In any case, unlike other analyses discussed in this final rule, sales changes shown cannot be solely attributed to the rulemaking.

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 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

[1317] "The U.S. Automotive Market and Industry in 2025," Center for Automotive Research, June 2011, available at *http://www.cargroup.org/assets/files/ami.pdf* (last accessed August 1, 2012).

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.

TABLE IV–141—CENTER FOR AUTOMOTIVE RESEARCH (CAR) REPORT ESTIMATES OF SALES AND EMPLOYMENT IMPACTS IN 2025

	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
Gasoline at $3.50				
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 [1318] 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 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. Many commenters stated that they expected vehicle sales to increase as a result of the final rule, and cited an analysis conducted by Ceres and Citigroup Global Markets Inc.[1319] that 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 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. That analysis has subsequently been revised to predict a 4% increase from 15.8 million to 16.4 million.[1320] 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 [1321] 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).

The UAW, along with NRDC and the National Wildlife Foundation, also submitted reports indicating their assessment that the additional technology content needed to meet higher fuel economy standards would lead to considerable sales and employment growth. For example, the 2010 UAW/NRDC/Center for American Progress study, ''Driving Growth,'' concluded that if 75 percent of the

[1318] 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. *Available at http://www.cargroup.org/?module=Publications&event=View&pubID=16.* Docket No. NHTSA–2010–0131.

[1319] ''U.S. Autos, CAFE and GHG Emissions'', March 2011, Citi Ceres, UMTRI, Baum and Associates, Meszler Engineering Services, and the Natural Resources Defense Council, available at *http://www.ceres.org/resources/reports/fuel-economy-focus* (last accessed August 1, 2012).

[1320] ''U.S. Autos, CAFE and GHG Emissions'', March 2011, Citi Ceres, UMTRI, Baum and Associates, Meszler Engineering Services, and the Natural Resources Defense Council, available at *http://www.ceres.org/resources/reports/fuel-economy-focus* (last accessed August 1, 2012).

[1321] 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.

additional content needed for the vehicle fleet to reach an average 40 mpg by 2020 was produced in the U.S., as many as 150,000 jobs would be created.[1322] Similarly, the 2011 UAW/NRDC/NWF study, ''Supplying Ingenuity,'' found that 504 facilities across 43 states employing over 500,000 people are devoted to researching, developing, or producing clean-car technologies, and that 67 percent of these jobs are related to advanced conventional technologies such as better engines and transmissions and components like electric power steering and high strength steel.

f. Based on all of the above, what does NHTSA believe the likely impact on vehicle sales attributable to this final rule will be?

While NHTSA conducted and considered a variety of vehicle sales ''cases'' as presented above, we do not believe that we can state with certainty that any given case is ''correct'' for the rulemaking timeframe. Given that this final rule affects multiple years, many years in the future, and that during that time there will be a dynamic situation occurring with dramatically changing fuel economy levels and technology being added to vehicles, we anticipate that consumers' consideration of fuel economy will evolve over time. NHTSA believes that there is much uncertainty in how much consumers' consideration of fuel economy will change as a result of this final rule alone, as compared to other rules such as the MYs 2012–2016 CAFE and GHG emissions rules and the Fuel Economy Labeling rule, or manufacturers' marketing efforts. We anticipate that manufacturers will be tracking consumers' behavior and marketing their products to affect consumer behavior, as they always have. We have made several simplifying assumptions in order to estimate the potential impact on sales, but as discussed above, there are uncertainties in how this final rule will affect sales and employment. We note, as is likely evident in the table above, that the impact on sales in this analysis is heavily impacted by the difference between manufacturers' beliefs of how consumers value fuel savings and consumers' valuation of fuel savings.

This uncertainty, however, supports our conclusion in Section IV.F of the preamble that higher standards than the ones finalized in this rulemaking may not be economically practicable. The agency has tried to grapple with potential sales impacts as an important aspect of economic practicability, but reaching no definitive conclusion, believes that a conservative approach will be most likely to help us avoid setting standards that are beyond what would be economically practicable, and thus beyond the maximum feasible levels. NHTSA will monitor sales trends going forward, and anticipates that the intervening years between this final rule and the future rulemaking to develop and establish final standards for MYs 2022–2025 will provide significant additional insight into the questions of how consumers value fuel savings associated with increased fuel economy, how manufacturers believe consumers value that fuel savings, and corresponding effects on vehicle sales attributable to CAFE standards.

As discussed elsewhere in the preamble and FRIA, the literature provides mixed evidence that consumers consistently value future fuel savings consistent with shorter payback periods and/or higher discount rate than the full lifetime value of fuel savings over the useful life of vehicles discounted as the social discount rates. That also provides an explanation for one of the potential reasons that manufacturers do not voluntarily provide all of the fuel saving technologies that are cost-effective and available, on a societal basis considered over the lifetime of the vehicle. In the past, consumers have not been willing to pay the additional price for such fuel economy improvements. One question is whether consumers will place a greater value on fuel savings as a result of this rule, and only as a result of this rule. In the past, large spikes in gasoline prices and consistently high gasoline prices have spurred consumers to consider fuel economy more prevalent in their purchasing decisions. The agency believes that the new and improved fuel economy labels and the large increase in fuel economy required as a result of the MY 2012–2016 fuel economy standards, may all have an impact on consumer valuation of fuel savings. However, these effects are not due to this rule. This final rule with its very large increase in average fuel economy, as well as manufacturers marketing these increased fuel economy levels, should also have a significant effect on consumers' realization that fuel economy is changing rapidly and significantly. As a result, we believe consumers will pay more attention to fuel savings as a result of this final rule assuming that fuel prices do not decrease significantly, but there is uncertainty whether all sales impacts will be the result of this final rule alone. It is possible that consumers will not demand increased fuel economy even when such increases would reduce overall costs for them. 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, 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.

While it is difficult to determine how consumers will react to fuel economy improvements attributable to the final rule, we believe that it is likely that consumers will learn more about and increasingly value fuel economy improvements in the future, but we also believe that manufacturers and consumers are unlikely to place identical valuation on fuel economy benefits. We believe for the reasons discussed above that manufacturers will behave more conservatively in their assumptions of how consumers value fuel economy than how on average consumers will actually behave.

Some commenters stated that sales will increase as a result of the rule, as evidenced above in the above discussion of comments from Ceres and the UAW. Others, including NADA, expressed concern that sales may fall.

[1322] UAW/NRDC/Center for American Progress, ''Driving Growth: How Clean Cars and Climate Policy Can Create Jobs,'' March 2010. NHTSA–2010–0131.

g. How does NHTSA plan to address this issue in the future?

NHTSA is currently sponsoring work to develop a vehicle choice model for potential use in the agency's future rulemaking analyses—this work may help to better estimate the market's effective valuation of future fuel economy improvements. This rule did not rely on a vehicle choice model. With an integrated market share model, the CAFE model would 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 sought comment on the potential for this approach to help the agency estimate sales effects. Several commenters wanted the agency to either have the vehicle choice model go through a full peer review (the Alliance) or to be provided for public comment and review (NRDC) before being used. There was wide disparity in the comments on the concept of using a vehicle choice model to estimate the impacts on sales. The Alliance supported the use of a vehicle choice model. The American Fuel and Petrochemical Manufacturers [1323] stated that it was concerned that the analysis is not based on a model that considered consumer choices and the impacts on different industries and individuals that would be affected. The Natural Resources Defense Council (NRDC) [1324] and Union of Concerned Scientists (UCS) [1325] did not support the use of a consumer choice model and stated that the agencies should not rely on a highly uncertain and idealized consumer choice model.

NRDC stated that a consumer choice model could only rely on stated or revealed preferences based on existing vehicles in the market place and such a model is inappropriate for standards that drive the use of new technology. In response, NHTSA agrees that further work on the vehicle choice model is necessary, and is continuing to develop it. Section IV.C.4 of the preamble discusses the current progress with the choice model and next steps, and we refer the reader there for more information.

h. Potential Impact on Employment in the Automotive Industry in the Short Run

There are three potential areas of employment in the automotive industry that fuel economy standards could affect.[1326] We briefly outline those areas here.

- The first is the hiring of additional engineers by automobile companies and their suppliers to do research and development and testing on new technologies to determine their capabilities, durability, platform introduction, etc. The agency anticipates that there may be some level of additional job creation due to the added research and development, overall program management, and subsequent sales efforts required to market vehicles that have been redesigned for significant improvements in fuel economy, especially for revolutionary technologies such as hybrid and electric vehicles. In this respect, the final rule will likely have a positive effect on employment. At the same time, the levels of added employment are uncertain. In addition, it is not clear how much of this effort will be accomplished by added employment and how much by diverting existing employees to focus on CAFE instead of other company priorities such as improved acceleration performance, styling, marketing, new vehicle concepts, etc.
- The second area is the impact that new technologies would have on production employment, both at suppliers and at auto assemblers. Added parts, like turbochargers, or complexity of assembly could have a positive impact on employment. The use of more exotic steels, aluminum, or other materials to save weight could affect the number of welds or attachment methods. It is uncertain to what extent new CAFE technologies would require added steps in the assembly process that would necessitate new hiring, but generally when content is added, the number of employees in the supplier industry and on the assembly line goes up.
- The third area is the potential impact that sales gains or losses could have on production employment. This area is potentially much more sensitive to change than the first two areas discussed above, although for reasons discussed above its estimation is highly uncertain. An increase in sales, produced for example by consumer attention to overall costs and learning over time, would have a positive effect on employment. A decrease in sales, produced by increases in initial costs, would have a negative effect.

We received a number of comments (from the Defour Group and some private individuals) asserting that there will be decreases in employment as a result of the costs of the rule, and a number of comments (from the United Auto Workers, environmental organizations, sustainable business groups, some private individuals, and others) asserting increases in employment, based on the development of advanced technologies and the reduction in net costs due to fuel savings. An assessment by the Defour Group predicts a loss of 155,000 jobs in manufacturing and supply, plus another 50,000 in distribution.[1327] A study by Ceres predicts job gains of 43,000 in the auto industry and 484,000 economy-wide.[1328] Some comments cite a study by the Natural Resources Defense Council, National Wildlife Federation, and United Auto Workers that 150,000 auto workers already are working to supply clean, fuel-efficient technologies.[1329] The differences in results for quantitative employment impacts are mainly due to difference in the price impacts.

Estimates of decreases in employment commonly come from studies that use cost estimates higher than those estimated by the agencies, and sometimes lower benefits estimates, resulting in reductions in vehicle sales. For instance, some comments from individuals cite the National Automobile Dealers Association and Center for Automotive Research for cost estimates of $5,000 to $6,000 per vehicle, much higher than those

[1323] See EPA Docket EPA–HQ–OAR–2010–0799–9485.

[1324] See EPA Docket EPA–HQ–OAR–2010–0799–0284.

[1325] *Id.*

[1326] For a general analysis of the potentially complex employment effects of regulation, see Morgenstern, Richard D., William A. Pizer, and Jhih-Shyang Shih. ''Jobs Versus the Environment: An Industry-Level Perspective.'' *Journal of Environmental Economics and Management* 43 (2002): 412–436 (Docket EPA–HQ–OAR–2010–0799).

[1327] Walton, Thomas F., and Dean Drake, Defour Group LLC (February 13, 2012). ''Comments on the Notice of Proposed Rulemaking and Preliminary Regulatory Impact Analysis for MY 2017 to 2025 Fuel Economy Standards.'' Docket EPA–HQ–OAR–2010–0799–9319.

[1328] Management Information Services, Inc. (July 2011). ''More Jobs per Gallon: How Strong Fuel Economy/GHG Standards Will Fuel American Jobs.'' Boston, MA: Ceres. Docket EPA–HQ–OAR–2010–0799–0709.

[1329] Natural Resources Defense Council, National Wildlife Federation, and United Auto Workers (August 2011). ''Supplying Ingenuity: U.S. Suppliers of Clean, Fuel-Efficient Vehicle Technologies,'' available at *http://www.nrdc.org/transportation/autosuppliers/files/SupplierMappingReport.pdf* (last accessed August 1, 2012). (Docket EPA–HQ–OAR–2010–0799) estimated by the agencies. Those studies commonly look at the employment associated with vehicle sales, but not the employment associated with producing the technologies needed to comply with the standards, or changes in labor intensity of production. Analyses that find increases in employment commonly start with increased vehicle sales as a result of the rule. Many of these analyses also note that even without increased unit sales, employment is likely to rise due to the additional technology content of the vehicles sold.[1330] In both cases, ''multiplier'' effects, which extend employment impacts beyond the auto sector to impacts on suppliers, other sectors, and expenditure changes by workers, lead to large estimates, either positive or negative, of the employment effects of the rule. We received the suggestion to include in our analysis an alternative scenario where there is less than full employment; the implication of less than full employment is that multiplier effects are more likely. While we examined all of these different employment estimates, we decided to continue using our methodology from previous analyses, with some updates to our method of calculating the impacts.

In order to obtain an estimate of potential job increases per unit sales increase, we examined recent U.S. employment (original equipment manufacturers and suppliers) and U.S. production. Total employment in 2000 reached a peak in the Motor Vehicle and Parts Manufacturing sector of the economy averaging 1,313,500 workers (NAICS codes of 3361, 2, 3). Then there was a steady decline to 1,096,900 in 2006 and more rapid decreases in 2008, and 2009. Employment in 2009 averaged 664,000, employment in 2010 averaged 675,000 and employment in the first six months of 2011 has averaged 699,000. Table VII–19 shows how many vehicles are produced by the average worker in the industry. Averaging the information shown for the even years of 2000–2010, the average U.S. domestic employee produces 11.3 vehicles (the same number as in 2008 and 2010). Thus, assuming that a projected sales gain or loss divided by 11.3 would be one method of estimating the potential employment gain or loss in any one year. This provides a measurement in job years. This method underestimates the number of jobs per vehicle sold under the rule, because it does not take into account the additional employment associated with the additional fuel-saving technologies.

We also examined the employment impact for production and non-supervisory workers from the Bureau of Labor Statistics to see if there was a more direct link between their employment level and production than the white collar workers. There is a closer link between light vehicle production in the U.S. and the number of production and non-supervisory workers (for example, from 2002 to 2010, production fell by 44 percent; the number of production and non-supervisory workers in the industry fell by 44 percent and the number of white collar workers fell by 31 percent). However, in some years (2004 and 2006) the white-collar jobs had a higher percentage loss than the blue-collar jobs. In this analysis, the agency examines all jobs in the industry.

TABLE IV–142—U.S. LIGHT DUTY VEHICLE PRODUCTION AND EMPLOYMENT

Year	U.S. Light vehicle production	Motor vehicle and parts U.S. employment [1331]	Production per employee
2000	12,773,714	1,313,500	9.7
2002	13,568,385	1,151,300	11.8
2004	13,527,309	1,112,700	12.2
2006	12,855,845	1,069,800	11.7
2008	9,870,473	875,400	11.3
2010	7,597,147	674,600	11.3
Total/Average	70,192,873	6,197,300	11.3

The Administration projects that full employment will return in 2018.[1332] When the economy is at full employment, a fuel economy 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. 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 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. This program is expected to affect employment in the regulated sector (auto manufacturing) and other sectors directly affected by the final rule: 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). As discussed in the CAR and Ceres reports above, each of these sectors could potentially have ripple

[1330] UAW/NRDC/Center for American Progress, ''Driving Growth: How Clean Cars and Climate Policy Can Create Jobs,'' March 2010, p. 11.

[1331] U.S. employment data is from the Bureau of Labor Statistics, *available at http://data.bls.gov/timeseries/CES3133600101?data_tool=XGtable* (last accessed Aug. 10, 2012).

[1332] Based on the Congressional Budget Office January 2012 Report, ''The Budget and Economic Outlook, Fiscal Years 2012–2022,'' which predicted unemployment levels of 5.5% in 2018. See *http://www.cbo.gov/publication/42905* (last accessed Aug. 10, 2012).

effects throughout the rest of the economy. These ripple effects depend much more heavily on the state of the economy than do the direct effects. As noted above, though, 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. The Congressional Budget Office has predicted full employment by 2018.[1333] To the extent that full employment is achieved, increases in employment are not possible. 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.

Table IV–143 shows the potential cumulative impact on auto sector employment over the MY 2017–2025 period in job years, without considering or quantifying the ripple effect. This table takes the results from sales and divides by 11.3 to obtain the impact on auto sector employment. To estimate the proportion of domestic employment affected by the change in sales, we use data from Ward's Automotive Group for total car and truck production in the U.S. compared to total car and truck sales in the U.S. For the period 2001–2010, the proportion is 66.7 percent. We thus weight sales by this factor to get an estimate of the effect on U.S. employment in the motor vehicle manufacturing sector due to this rule. As in the sales analysis, the table shows the potential impact for the preferred alternative for both the MY 2010 baseline and for the MY 2008 baseline at the 3 percent and 7 percent discount rates for 6 different cases.

Since the impact of this final rule on sales is very difficult to predict, and sales have the largest potential effect on employment, the impact of this final rule on employment is also very difficult to predict. As with sales, the impact on employment is heavily affected by the difference between manufacturers' investments in fuel-saving technologies[1334] and consumers' valuation of fuel savings. However, since any negative impact of the rule on unit sales is partially offset by increased employment per vehicle sold, it is highly unlikely that the rule would lead to significant job losses in the short term in the automotive industry.

TABLE IV—143 ANALYSIS OF ALTERNATIVE SCENARIOS IN AUTOMOTIVE[1335] SECTOR EMPLOYMENT—IN THOUSANDS OF JOB YEARS

[Passenger cars and light trucks combined preferred alternative]

Years fuel valued by manufacturers	Years fuel valued by consumers	MYs 2017–2025 employment impact (3% discount rate) (000's)	MYs 2017–2025 employment impact (7% discount rate) (000's)
2008 Baseline			
0 Flat	3 yr	54	45
0 Flat	5 yr	223	191
*1 yr.	*1 yr	−160	−138
1 yr.	3 yr	−21	−26
*3 yr.	*3 yr	−31	−32
*5 yr.	*5 yr	0	−2
2010 Baseline			
0 Flat	3 yr	59	51
0 Flat	5 yr	225	193
*1 yr.	*1 yr	−143	−155
1 yr.	3 yr	−3	−8
*3 yr.	*3 yr	−18	−19
*5 yr.	*5 yr	7	6

[1335] The analysis does not reflect the likely positive impact in industry employment due to a change in vehicle content resulting from this rule.
*These scenarios are presented as theoretical cases. NHTSA believes it is unlikely that manufacturers and consumers would value improvements in fuel economy identically, and believes that on average, manufacturers will behave more conservatively in their assumptions of how consumers value fuel economy than how on average consumers will actually behave. NHTSA expects that in practice the number of years fuel is valued by manufacturers will be shorter than the number of years fuel is valued by consumers.

i. Scrappage Rates

The effect of this rule on the use and scrappage of older vehicles will be related to its effects on new vehicle prices, the fuel efficiency of new vehicle models, and the total sales of new vehicles. If the value of fuel savings resulting from improved fuel efficiency to the typical potential buyer of a new vehicle outweighs the average increase in new models' prices, sales of new vehicles will rise, while scrappage rates of used vehicles will increase slightly. This will cause the ''turnover'' of the vehicle fleet—that is, the retirement of used vehicles and their replacement by new models—to accelerate slightly, thus accentuating the anticipated effect of the

[1333] Based on the Congressional Budget Office January 2012 Report, ''The Budget and Economic Outlook, Fiscal Years 2012–2022,'' which predicted unemployment levels of 5.5% in 2018. See *http://www.cbo.gov/publication/42905* (last accessed Aug. 10, 2012).

[1334] As discussed above, these investments are affected both by manufacturers' beliefs about consumers' valuation of fuel economy, and by competitive dynamics, since the industry is composed of multiple firms, each of which considers the case where a competitor that doesn't invest ends up in a better position due to gas prices at the low end of the expected distribution.

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.

6. Social Benefits, Private Benefits, and Potential Unquantified Consumer Welfare Impacts of the 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. In order to appreciate how these viewpoints can diverge, it is important to distinguish between costs and benefits that are borne privately by those who would have purchased new vehicles in the absence of the rule, and costs and benefits that are distributed broadly throughout the economy. The agency's analysis of benefits and costs from requiring higher fuel efficiency, presented in detail above, includes several categories of benefits (identified as ''social benefits'') that are not limited to automobile buyers, and instead extend throughout the U.S. (and global) 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 climate change and local air pollution. In contrast, other categories of benefits—principally future fuel savings projected to result from higher fuel economy, but also, for example, the value of less frequent refueling—will be experienced exclusively by the initial purchasers and subsequent owners of vehicle models whose fuel economy manufacturers elect to improve (and are thus referred to as ''private benefits'').

While the economy-wide or social benefits from increased fuel economy represent a small but important share of the total economic benefits from raising CAFE standards, NHTSA estimates that benefits *to vehicle buyers themselves* will significantly exceed vehicle manufacturers' costs for complying with the stricter fuel economy standards this final rule establishes. The agency also assumes that the costs of new technologies manufacturers employ to improve fuel economy will ultimately be borne by vehicle buyers in the form of higher purchase prices. Thus NHTSA concludes that the benefits to vehicle buyers from requiring higher fuel efficiency will far outweigh the costs they will be required to pay to obtain it. As an illustration, Tables IV–144 and IV–145 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 consistent with the pre-tax prices used in its analysis of social costs and benefits. 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 between $3,800 and $4,300 for cars, and by more than $5,800 for light trucks.

TABLE IV–144—NHTSA ESTIMATED VALUE OF LIFETIME FUEL SAVINGS VS. VEHICLE PRICE INCREASES—MYS 2017–2021

Fleet	Measure	MY baseline	Model year				
			2017	2018	2019	2020	2021
Passenger Cars	Value of fuel savings	2008	$872–	$1,657–	$2,390–	$3,269–	$3,852–
		2010	$1,090	$1,609	$2,540	$3,311	$3,954
	Average price increase	2008	$233–	$434–	$602–	$904–	$1,105–
		2010	$364	$484	$659	$858	$994
	Difference	2008	$639–	$1,222–	$1,789–	$2,366–	$2,747–
		2010	$726	$1,125	$1,881	$2,453	$2,960
Light Trucks	Value of fuel savings	2008	$537–	$1,340–	$2,665–	$3,793–	$5,183–
		2010	$427	$817	$2,031	$3,142	$4,621
	Average price increase	2008	$78–	$191–	$422–	$620–	$853–
		2010	$147	$196	$396	$628	$907
	Difference	2008	$459–	$1,149–	$2,243–	$3,173–	$4,330–
		2010	$280	$621	$1,635	$2,514	$3,714

TABLE IV–145—NHTSA ESTIMATED VALUE OF LIFETIME FUEL SAVINGS VS. VEHICLE PRICE INCREASES—MYS 2022–2025

Fleet	Measure	MY baseline	Model year			
			2022	2023	2024	2025
Passenger Cars	Value of fuel savings	2008	$4,216–	$4,571–	$5,101–	$5,496–
		2010	$4,339	$4,880	$5,440	$5,881
	Average price increase	2008	$1,219–	$1,326–	$1,666–	$1,738–
		2010	$1,091	$1,221	$1,482	$1,578

TABLE IV–145—NHTSA ESTIMATED VALUE OF LIFETIME FUEL SAVINGS VS. VEHICLE PRICE INCREASES—MYS 2022–2025—Continued

Fleet	Measure	MY baseline	Model year 2022	2023	2024	2025
	Difference	2008 2010	$2,997– $3,248	$3,245– $3,659	$3,435– $3,958	$3,758– $4,303
Light Trucks	Value of fuel savings	2008 2010	$5,707– $5,068	$6,094– $5,747	$6,673– $6,431	$7,180– $7,017
	Average price increase	2008 2010	$949– $948	$994– $1,056	$1,076– $1,148	$1,171– $1,226
	Difference	2008 2010	$4,758– $4,126	$5,100– $4,694	$5,597– $5,289	$6,008– $5,804

The comparisons above immediately raise the question of why buyers would not purchase vehicles with the higher fuel economy levels the rule requires manufacturers to achieve in future model years even if NHTSA did not adopt it. 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–144 and IV–145 suggest that doing so would increase the prices that potential buyers would be willing to pay for many new vehicle models by far more than it would raise their manufacturers' costs of produce them. In other words, these comparisons suggest that increasing fuel economy would be an effective strategy for many manufacturers to expand their sales of new vehicles and increase 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 savings implied by the comparisons presented in Tables IV–144 and IV–145? 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 might arise is that the market for vehicle fuel economy does not appear to work perfectly, and that higher CAFE standards are necessary to require manufacturers to produce—and potential buyers to purchase—models with higher fuel economy. One source of such market imperfections might be limited availability of information to consumers about the savings from purchasing models that offer higher fuel economy. However, such information is increasingly available and has become easier to obtain, and new fuel economy labels will provide a wide range of information about the economic and environmental benefits of increased fuel economy.

While Tables IV–144 and IV–145 illustrate large net (discounted) savings from reduced fuel expenditures over the useful life of the vehicle, fuel expenditures are not the only relevant operating cost associated with vehicle ownership. By forcing manufacturers to add new fuel economy technologies to their vehicle offerings, this rule creates additional costs that will be borne by the purchasers of those vehicles. By model year 2025, buyers of new passenger cars and light trucks will face an average increase of $80 per vehicle in additional taxes and fees at the time of purchase and registration. Over the vehicle's useful life, buyers of MY 2025 new vehicles will spend an additional $225 in financing charges, $280 in the cost of insurance, and another $130 in vehicle maintenance costs. These costs combine to add over $700 (discounted) to the cost of ownership, and further erode the savings in fuel expenditures. However, Tables IV–144 and IV–145 suggest much larger net savings, even accounting for ancillary ownership costs.

Many commenters noted that recent poll results and changes in attitudes suggest that consumers are becoming more aware of the importance and value of fuel economy, and that this will increasingly be reflected in their future vehicle purchasing decisions. NRDC, the Sierra Club, Consumer Federation of America, and Consumers' Union each cited recent polls indicating that consumers are increasingly concerned about fuel prices and U.S. energy security, and are increasingly aware that purchasing vehicles with higher fuel economy can reduce both their gasoline costs and U.S. dependence on imported petroleum. Some of these commenters also noted that recent polls have shown growing support for higher CAFE standards as a strategy for increasing the range of vehicle models offering high fuel economy, and increased willingness of vehicle buyers to pay for improved fuel economy and advanced technologies such as electric vehicles.

The agency agrees that there appears to be growing awareness of fuel economy generally and increased interest in higher fuel economy among vehicle buyers, but notes that some of this may reflect the persistence of high fuel prices in recent years. Thus if fuel prices decline from recent high levels, some of this increased awareness and willingness to pay for higher fuel economy could erode. In addition, if significant failures in the market for fuel economy—such as those identified in the preceding discussion—exist, then increased consumer awareness of and interest in fuel economy may be inadequate by themselves to result in the levels of fuel economy that would be economically desirable. In this case, increased CAFE standards are still likely to be necessary to require manufacturers to supply—and buyers to demand—the higher fuel economy levels that can be economically justified on the basis of their benefits and costs.

Other potential sources of market failure include phenomena highlighted by the field of behavioral economics, including loss aversion, inadequate consumer attention to long-term effects of their decisions, or a lack of salience of benefits such as fuel savings to consumers at the time they make purchasing decisions. For example, some research suggest that many consumers are unwilling to make energy-efficiency investments that appear likely to pay off in the relatively short-term, in part because they are deterred by the prospect that those investments require immediate, known outlays but produce deferred and uncertain returns.[1336] As an illustration,

[1336] 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://apps.olin.wustl.edu/cres/*

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.[1337]Other research finds that consumers may undervalue benefits or costs that are less salient, difficult to isolate, or that they will realize only in the future.[1338]

Another possible explanation for manufacturers' unwillingness to offer models with improved fuel economy is that many consumers appear to undervalue potential savings in gasoline costs when purchasing vehicles. Fuel costs may be a ''shrouded'' attribute in consumers' decisions, because 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. It may also 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 from accompanying differences in more prominent features of new vehicles, such as passenger and cargo-carrying capacity, performance, or safety. Some recent research finds that because of these or other reasons, many buyers are unwilling to pay $1 more to purchase a vehicle that offers a $1 reduction in the discounted present value of its future gasoline costs.[1339]

Other research suggests that the manufacturers' hesitance to offer e 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 and fuel costs per mile driven or in a time period.[1340] The recently redesigned fuel economy label should help overcome this difficulty, because it draws attention to purely economic effects of fuel economy, although the vehicle's MPG itself 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 large increases in fuel economy.[1341] If the behavior identified in these studies is widespread, then the agency's estimates that the benefits to vehicle owners from requiring higher fuel economy significantly exceed the costs of providing it may indeed be consistent with the unwillingness of vehicle manufacturers to offer—and buyers to purchase—the levels of fuel economy this rule would require.

Another possible reconciliation of the large net benefits the agency projects for individual buyers and its assumption that producers would not offer the level of fuel economy this final rule requires is that many of the technologies projected by the agency to be available beginning in MY 2017 offer significantly improved efficiency per unit of cost, but are not available for application to new vehicles sold currently. Still another is that the actual value of future fuel savings resulting from the standards will vary widely among potential vehicle buyers. These differences primarily reflect variation in the amount they drive, but differences in their driving styles may also affect the fuel economy they expect to achieve, and buyers undoubtedly have varying expectations about future fuel prices. Thus while the agency's assertion that fuel savings for the *average* buyer will significantly exceed the increase in vehicle prices may be correct, the reverse may nevertheless be true for some potential buyers. 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 current technologies allow manufacturers to offer in individual vehicle models 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 further limit the range of fuel economy available within individual vehicle market segments, if they underestimate the premiums that prospective buyers of those models are willing to pay for improved fuel economy. As an illustration, the range of highway fuel economy ratings among current minivan models extends only from 23 to 28 mpg, while their combined city and highway ratings ranges only from 19 to 24 mpg.[1342] 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.

research/calendar/files/AllcottH.pdf (last accessed Jul. 13, 2012). For relevant background, with an emphasis on the importance of salience and attention, *see* Kahneman, D. Thinking, Fast and Slow (2011).

[1337] Greene, D., J. German, and M. Delucchi (2009). ''Fuel Economy: The Case for Market Failure'' in Reducing Climate Impacts in the Transportation Sector, Sperling, D., and J. Cannon, eds. Springer Science. Surprisingly, the authors find that uncertainty regarding the future price of gasoline appears to be less important than uncertainty surrounding the expected lifetimes of new vehicles. (Docket NHTSA–2009–0059–0154). On loss aversion in general, and its relationship to prospect theory (which predicts that certain losses will loom larger than probabilistic gains of higher expected value), *see* Kahneman.

[1338] 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.

[1339] *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.

[1340] Larrick, R. P., and J.B. Soll (2008). ''The MPG illusion'' *Science* 320: 1593–1594.

[1341] Sanstad, A., and R. Howarth (1994). '' 'Normal' Markets, Market Imperfections, and Energy Efficiency.'' Energy Policy 22(10): 811–818.

[1342] This is the range of combined city and highway fuel economy levels from lowest (Toyota Sienna AWD) to highest (Mazda 5) available for model year 2012; *http://www.fueleconomy.gov/feg/bestworstEPAtrucks.htm* (last accessed Jul. 13, 2012).

Some commenters endorsed the agency's analysis of the potential for various sources of market failure to inhibit manufacturers from supplying adequate fuel economy levels, and to cause potential buyers to underestimate the value of purchasing models that offer higher fuel economy. Consumer Federation of America endorsed the agency's focus on sources of manufacturers' hesitance to offer models with higher fuel economy, as well as on the more commonly cited market failures that can make buyers unwilling to invest in higher fuel economy. CFA also submitted more detailed discussions of some of these sources of potential market failure in support of its general comments. ICCT noted that the combination of uncertainty about the cost and effectiveness of new technologies to improve fuel economy with buyers' aversion to potential losses from purchasing higher-priced vehicles offering uncertain fuel savings was sufficient to explain the underinvestment in fuel economy, and to justify higher fuel economy standards. ICCT also argued that by removing consumers' option to buy low fuel economy vehicles, higher fuel economy standards minimize the effect of aversion on buyers' willingness to invest in higher fuel economy.

A fundamentally different explanation for buyers' apparent unwillingness to invest in higher fuel economy when it appears to offer such large financial returns is that NHTSA's estimates of private 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 benefits from saving fuel than do 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–146 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 final 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 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 $2,900–3,300 for cars and by $4,400–4,900 for light trucks.

If buyers are instead assumed to consider fuel savings over only a 10-year time horizon, Table IV–146 shows that this reduces the difference between the present value of fuel savings and the projected price increase for a MY 2025 car to $2,100–2,500, and to about $3,300–3,600 for a MY 2025 light truck. Finally, Table IV–146 shows that if buyers consider fuel savings only over the length of time for which they typically finance new car 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 $550–830, while the corresponding difference is reduced to $1,500–1,700 for a MY 2025 light truck.

TABLE IV–146—NHTSA ESTIMATED VALUE OF FUEL SAVINGS CONSIDERED BY BUYERS VS. VEHICLE PRICE INCREASES WITH ALTERNATIVE ASSUMPTIONS ABOUT VEHICLE BUYER TIME HORIZONS

Vehicle	Measure	Baseline fleet	Value over alternative time horizons (3% Discount rate)		
			Average lifetime	10 Years	Average loan term
MY 2025 Passenger Car	Fuel Savings	2008 2010	$4,506– $4,659	$3,694– $3,820	$2,121– $2,193
	Price Increase	2008 2010	($1,577)– ($1,361)	($1,577)– ($1,361)	($1,577)– ($1,361)
	Difference	2008 2010	$2,929– $3,298	$2,118– $2,459	$545– $833
MY 2025 Light Truck	Fuel Savings	2008 2010	$5,900– $5,472	$4,683– $4,343	$2,722– $2,525
	Price Increase	2008 2010	($1,040) ($1,047)	($1,040) ($1,047)	($1,040) ($1,047)
	Difference	2008 2010	$4,860– $4,425	$3,643– $3,296	$1,682– $1,477

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.[1343]

[1343] Office of Management and Budget, Circular A–4, "Regulatory Analysis," September 17, 2003, 33. *Available at http://www.whitehouse.gov/sites/*

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, making this figure 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–147 shows the effects of higher discount rates on vehicle buyers' evaluation of the fuel savings projected to result from the CAFE standards presented in this final rule, again using MY 2025 passenger cars and light trucks as an example. As Table IV–146 showed previously, average future fuel savings discounted at the OMB 3 percent consumer rate exceed the agency's estimated price increases by $2,900–3,300 for MY 2025 passenger cars and by $4,400–4,900 for MY 2025 light trucks. If vehicle buyers instead discount future fuel savings at the typical new-car loan rate prevailing during 2011 (approximately 5.2 percent), however, these differences decline to $2,500–2,800 for cars and $3,800–4,200 for light trucks, as Table IV–147 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 about 13 percent during 2011) reduces these differences to $1,100–1,500 for a MY 2025 passenger car and $2,200–2,500 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 require—rather than those that would result from simply extending the MY 2016 CAFE standards to apply to future model years—remain large.

TABLE IV–147—NHTSA ESTIMATED VALUE OF FUEL SAVINGS CONSIDERED BY BUYERS VS. VEHICLE PRICE INCREASES WITH ALTERNATIVE ASSUMPTIONS ABOUT CONSUMER DISCOUNT RATES

Vehicle	Measure	Baseline fleet	Value at Alternative Discount Rates		
			OMB consumer rate (3%)	New car loan rate (5.2%) [1344]	Consumer credit card rate (12.7%) [1345]
MY 2025 passenger car	Fuel savings	2008	$4,506–	$4,041–	$2,725–
		2010	$4,659	$4,178	$2,818
	Price increase	2008	($1,577)–	($1,577)–	($1,577)–
		2010	($1,361)	($1,361)	($1,361)
	Difference	2008	$2,929–	$2,464–	$1,148–
		2010	$3,298	$2,817	$1,457
MY 2025 light truck	Fuel savings	2008	$5,900–	$5,266–	$3,507–
		2010	$5,472	$4,883	$3,252
	Price increase	2008	($1,040)–	($1,040)–	($1,040)–
		2010	($1,047)	($1,047)	($1,047)
	Difference	2008	$4,860	$4,226	$2,467
		2010	$4,425	$3,836	$2,205

[1344] Interest rates on 48-month new vehicle loans made by commercial banks during 2011 averaged 5.73%, while new car loan rates at auto finance companies averaged 4.73%; *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 July 13, 2012).

[1345] The average rate on consumer credit card accounts at commercial banks during 2011 was 12.74%; *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 July 13, 2012).

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.[1346] 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 $200–300 for passenger cars and $1,300–1,600 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 some potential buyers hesitant—or perhaps even unwilling—to

default/files/omb/assets/regulatory_matters_pdf/a-4.pdf (last accessed Jul. 13, 2012).

[1346] 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.

purchase vehicles offering the increased fuel economy levels this final rule would require manufacturers to provide in future model years. Thus, vehicle buyers' assessment of the benefits and costs of this final rule in their purchase decisions may differ markedly from NHTSA's estimates.

If consumers' views about critical variables such as future fuel prices or the appropriate discount rate differ sufficiently from the assumptions used by the agency, some 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 manufacturers could—at some cost—retain those other features while improving fuel economy. Although the specific economic values that buyers attach to individual vehicle attributes such as fuel economy, performance, or passenger- and cargo-carrying capacity 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. 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 the range of models offered ensures that vehicles with those attributes continue to be available, then vehicle buyers will still have the opportunity to purchase them, although only at higher costs than they were previously available.

As indicated in its previous discussion of technology costs, NHTSA has approached this problem by attempting to develop cost estimates for fuel economy-improving technologies that include allowances for any additional costs necessary to maintain the reference fleet (or baseline) levels of performance, comfort, capacity, and safety of light-duty vehicle models. 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 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 presented in this final 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.

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 manufacturers' costs for providing it would not result in fuel economy levels comparable to those required by the rule even in its absence. One explanation is that these estimates are reasonable, but that for some combination of the reasons outlined above, the market for fuel economy is not responding efficiently to these potential economic returns. NHTSA believes the existing literature offers some support for the view that various failures in the market for fuel economy prevent an economically desirable outcome, which implies that there are likely to be substantial private gains from the final rule.

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 final 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–148 and Table IV–149 display the aggregate economic impacts of the rule as viewed from the perspective of potential buyers.

As the table shows, the final rule's total benefits to vehicle buyers (line 4) consist of the value of fuel savings over vehicles' full lifetimes measured using 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. The only reduction in the total private benefits to vehicle owners occurs as a result of the increased cost of maintaining the more technologically sophisticated vehicles that this rule forces manufacturers to produce and consumers to buy. Thus, the net private benefits to vehicle buyers (line 7) are equal to total private benefits (reported previously in line 4) minus the estimated incremental maintenance costs (line 6). The decline in fuel tax revenues (line 8) that results from reduced fuel purchases offsets the savings in fuel tax payments by vehicle buyers, which was previously included in the retail value of fuel savings (line 1). The offsetting savings in tax payments to vehicle buyers and tax revenue loss to government agencies is simply a transfer of funds between consumers and government, and thus does not represent a net social cost.[1347] (Thus the sum of lines 1 and 8 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 accounting of economy-wide benefits and costs.) Lines 9 and 10 of Table IV–148 and Table IV–149 report the value of reductions in air pollution and climate-related externalities resulting from lower emissions of criteria air pollutants and CO_2 during fuel production and consumption, while line 11 reports the savings in energy security externalities to the U.S. economy from reduced consumption

[1347] 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.

and imports of petroleum and refined fuel. Line 13 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—those that extend beyond the realm of vehicle buyers—from the final and augural CAFE standards (line 14) 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 15 of Table IV–148 and Table IV–149 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 16 of the table) resulting from the final rule consist of the sum of private (line 7) and external (line 14) benefits, minus technology costs (line 15). As expected, the figures reported in line 16 of the table are identical to those reported previously. Table IV–148 and Table IV–149 highlight several important features of this rule's economic impacts. First, comparing the rule's net private benefits (line 7) to its external effects (lines 8 through 14) makes it clear that a very large proportion of the final rule's benefits would be experienced by vehicle buyers, while only the small remaining fraction would be extend beyond vehicle buyers themselves. In turn, the vast majority of private benefits resulting from the higher fuel economy levels the final rule would require stem from fuel savings to vehicle buyers. Net external benefits from the final rule (line 14) are actually projected to be small, because losses in tax revenue and external costs from added driving combine to exceed the value of reductions in environmental and energy security externalities. 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–148—NHTSA ESTIMATED 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)	$13.5	$20.7	$37.0	$50.8	$65.8
2. Savings in refueling time	0.5	0.6	1.1	1.4	1.7
3. Consumer surplus from added driving	1.2	1.8	3.1	4.2	5.5
4. Total private benefits (= 1 + 2 + 3)	15.2	23.1	41.2	56.4	73.0
5. Reduction in private benefits from changes in other vehicle attributes	0.0	0.0	0.0	0.0	0.0
6. Maintenance costs	(0)	(0)	(0)	(1)	(1)
7. Net private benefits (= 4 + 5 + 6)	15.2	23.1	41.2	56.4	73.0
8. Change in fuel tax revenues	(1.3)	(2.0)	(3.6)	(4.9)	(6.3)
9. Reduced health damages from criteria emissions	0.4	0.6	1.1	1.5	1.9
10. Reduced climate damages from CO_2 emissions	1.2	1.8	3.3	4.6	6.0
11. Reduced energy security externalities	0.7	1.0	1.8	2.4	3.1
12. Reduction in externalities (= 9 + 10 + 11)	2.3	3.4	6.2	8.5	11.0
13. Increased costs of congestion, etc.	(0.8)	(1.2)	(2.0)	(2.7)	(3.4)
14. Net external benefits (= 8 + 12 + 13)	0.2	0.2	0.6	0.9	1.3
15. Technology costs	(4.4)	(5.8)	(8.7)	(11.9)	(14.8)
16. Net social benefits (= 7 + 14 + 15)	5.50	13.90	24.60	32.00	42.20

TABLE IV–149—NHTSA ESTIMATED 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)	$72.9	$82.8	$93.8	$103.0	$540.3
2. Savings in refueling time	1.9	2.2	2.5	2.8	14.6
3. Consumer surplus from added driving	6.1	7.0	7.8	8.6	45.2
4. Total private benefits (= 1 + 2 + 3)	80.9	92.0	104.1	114.4	600.1
5. Reduction in private benefits from changes in other vehicle attributes	0.0	0.0	0.0	0.0	0.0
6. Maintenance costs	(1)	(2)	(2)	(2)	(9)
7. Net private benefits (= 4 + 5 + 6)	80.9	92.0	104.1	114.4	600.1
8. Change in fuel tax revenues	(6.9)	(7.7)	(8.7)	(9.4)	(50.8)
9. Reduced health damages from criteria emissions	2.1	2.3	2.6	2.8	15.2
10. Reduced climate damages from CO_2 emissions	6.7	7.8	8.9	9.9	50.0
11. Reduced energy security externalities	3.4	3.9	4.4	4.7	25.4
12. Reduction in externalities (= 9 + 10 + 11)	12.2	14.0	15.9	17.4	90.6
13. Increased costs of congestion, etc.	(3.7)	(4.3)	(4.9)	(5.2)	(29.6)
14. Net external benefits (= 8 + 12 + 13)	1.6	2.0	2.0	2.8	10.2
15. Technology costs	(16.1)	(18.1)	(21.7)	(23.3)	(133.7)
16. Net social benefits (= 7 + 14 + 15)	49.10	53.80	59.40	66.50	346.60

As discussed in detail previously, NHTSA believes that the aggregate benefits from this final rule amply justify its total costs, but it remains possible that the agency has overestimated the value of fuel savings to buyers and subsequent owners of the cars and light trucks to which the higher CAFE standards it establishes would apply. It is also possible that the agency has failed to include adequate cost allowances to allow manufacturers to maintain other 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 final rule's benefits and costs. This analysis, which appears in Chapter VIII of the Final RIA accompanying this 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. An important conclusion of this analysis is that even if the private savings are significantly overstated, the benefits of the final and augural standards continue to exceed the costs.

7. What other impacts (quantitative and unquantifiable) will these standards have?

In addition to the quantified benefits and costs of fuel economy standards, the final standards established by this rule 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.

a. Technology Forcing

The final rule will improve the fuel economy of the U.S. new vehicle fleet, but it will also increase the cost (and presumably, the price) of new passenger cars and light trucks built during MYs 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 final rule in its later years, and also increase the set of feasible technologies in future years. We have attempted to estimate the effect of learning 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 future standards.

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. Nor have we projected whether technologies that were considered but not applied in the current rulemaking because of concerns about the likelihood of their commercialization during its timeframe, will in fact be helped towards commercialization as a result of the final standards.

b. Effects on Vehicle Costs

Actions that increase 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 final rule could raise average vehicle technology costs by over $1,500 by 2025, and for some manufacturers, average costs will increase by more than $2,500 (for some specific vehicle models, we estimate that the final 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). NHTSA has attempted to quantify these increased costs in detail, as reported in the previous discussion of the rule's likely impacts on vehicle sales.

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 may be significant, but has been unable to quantify these costs for purposes of this final rule.

To the extent that the final 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 final Joint TSD discusses the costs of charging infrastructure, neither of these costs have been incorporated into the rulemaking analysis.

c. 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 has been unable to quantify these effects for purposes of this final rule.

d. 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. If 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.

e. Effects on the Used Vehicle Market

The effect of this rule on the lifetimes, use, and retirement dates 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 retirement 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 retirement of older vehicles and the turnover of the vehicle fleet.

f. 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 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 final CAFE standards, 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 higher 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.

g. Distributional Effects

The agency's analysis of the final 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 final 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 final rule, while those who drive less than our average estimates will experience smaller fuel savings and benefits.

H. Vehicle Classification

Vehicle classification, for purposes of the CAFE program, refers to manufacturers' decisions regarding whether a vehicle is a passenger car or a light truck and whether NHTSA agrees; the vehicle would then be subject to the applicable passenger car or the light truck standards.[1348] 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 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.[1349] NHTSA created regulatory definitions for passenger automobiles and light trucks, found at 49 CFR Part 523, to guide the manufacturers in classifying vehicles and NHTSA in reviewing those classifications.

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.[1350] 49 CFR 523.5

[1348] For the purpose of the MYs 2012–2016 standards and this final rule establishing standards for MYs 2017 and beyond, EPA has agreed to use NHTSA's regulatory definitions for determining which vehicles would be subject to which CO_2 standards.

[1349] EPCA 501(2), 89 Stat. 901, codified at 49 U.S.C. 32901(a).

[1350] 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—both systems have the capability of providing power to all four wheels, 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

Continued

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 rulemaking establishing the MY 2011 standards 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 due to 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.[1351] 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,

• 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

• ''Like'' vehicles, such as the 2WD and 4WD versions of the same CUV, may have generally similar fuel economy-achieving capabilities, but different target standards 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 and CUVs 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 or CUV 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.

In the NPRM, the agency stated that it 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, NHTSA sought 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.

In the NPRM for MYs 2017 and beyond, NHTSA explained that we recognize that there are arguments both for and against maintaining the definition as currently written. 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 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 that 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,[1352] 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

''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.

[1351] *See, e.g.,* discussion of legislative history in 42 FR 38362, 38365–66 (Jul. 28, 1977).

[1352] Of the 430 light trucks models in the fleet, 175 of these had 3 rows.

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. NHTSA explained in the NPRM that the same is true for MYs 2017 and beyond. Without refitting the curves and changing the required levels of stringency for cars and trucks, simply moving vehicles from one fleet to another would 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, a MY 2008 baseline (or for that matter, a MY 2010 baseline) 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 in the NPRM to quantify the impact of such a reclassification of 3-row vehicles, but sought comment on whether and how we should do so for the final rule. If commenters believed that we should attempt to quantify the impact, we specifically sought 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 explained in the NPRM that the agency 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 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. As stated in the NPRM, 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 the time of the NPRM, however, since so little time has passed since our last rulemaking action, NHTSA explained that the agency does not believe that we have enough information about changes in the fleet to ascertain whether this is yet ripe for consideration. We sought comment on how the agency might go about reviewing this question as more information about manufacturer behavior is accumulated over time.

Few commenters provided much substantive analysis in response to the agency's request. Industry commenters generally opposed any changes to the car and truck definitions. The Alliance commented that the existing definitions for classifying vehicles are consistent with the statutes and Congress' intent, and that while NHTSA's adjustments to the definitions in prior rules were helpful clarifications, no further changes should be made.[1353] The Alliance stated that gaming of the definitions was unlikely because consumer demand for vehicle features is significantly more important to manufacturer decisions than regulatory classifications, and argued that the attribute-based standards decrease the incentive to reclassify vehicles since ''even larger vehicles can be 'CAFE positive' based on their status relative to their footprint target.'' [1354] The Alliance further argued that stability in the definitions was crucial, to avoid opening up the possibility of gaming and/or reduction in consumer choice, and because the current definitions were the basis for the analysis supporting the proposed rules.[1355] The Alliance stated that ''as a practical matter, a change to the classification definitions can be equivalent to a major change to the standards themselves, so ''[a]n amendment to the car/truck definitions could easily mean the difference between compliance and non-compliance for many manufacturers.'' [1356] Therefore, the Alliance argued, ''amendments to the classification rules would necessitate a brand new, top-to-bottom reanalysis of the standards by all manufacturers as well as NHTSA and EPA,'' and ''large portions of the rulemaking package [c]ould need significant readjustment as a result of that exercise.'' [1357]

Global Automakers similarly argued that if NHTSA adjusted definitions to make 3-row vehicles passenger cars rather than light trucks, it would ''likely necessitate changes to the * * * standards to make [them] less stringent to accommodate these vehicles, potentially reducing fuel savings.'' [1358] Global further argued that any changes to definitions would impose ''significant compliance costs on manufacturers,'' as the effective stringency of the standards would change, and disagreed that manufacturers would add a third row to CUVs in order to obtain the light truck target, because ''There are substantial cost and weight penalties associated with the addition of third row seats, so installing these seats cannot be justified in the absence of consumer demand for them.'' [1359] Ford [1360] and GM [1361] supported the Alliance comments; Toyota provided similar comments, stating that it knew of no new information that should cause the agency to revisit its conclusion on this issue from the 2012–2016 final rule.[1362] Toyota suggested that ''to the extent NHTSA is concerned about whether the classification definitions can keep pace with the evolving market through the 2017–2025 model year period, * * * the issue [should] be revisited during the mid-term review.'' [1363]

Environmental group commenters generally supported changes to the definitions. CBD expressed concern that manufacturers will be encouraged to redesign 2WD versions of SUVs and CUVs by giving them 4WD and other ''off-highway features'' to obtain the lower light truck curve target, particularly given the ''even greater disparity in mileage standards between trucks and passenger cars created by the NPRM.'' [1364] CBD argued, as it did in *CBD* v. *NHTSA,* that because light trucks may be used for carrying passengers, ''EPCA's drafters surely never intended manufacturers to be able to manipulate their products for the sole purpose of escaping higher efficiency standards.'' [1365] CBD stated that NHTSA must ''close the SUV loophole,'' [1366] but provided no legal analysis of how the agency should revise the definitions to address its concerns.

NRDC also stated that manufacturers could easily add 4WD technology to vehicles to reclassify them as light trucks rather than as cars, and the decision would be ''influenced by whether or not the cost to add the 4WD technology is less than adding the fuel efficiency and emissions technology necessary to stay compliant on the car curve.'' [1367] NRDC thus argued that the truck definitions should be revised to ensure that trucks have technologies ''that are necessary for true off-road capability vs. typical all-wheel on-road driving.'' [1368] UCS offered similar examples, and suggested that NHTSA add new criteria to ensure that light trucks have ''true off-road capability,'' such as ''a majority subset of the following 5 items: Limited slip center differential, limited slip rear differential, locking axles, skid plates, and 2-speed transfer cases.'' [1369] The Sierra Club also commented that NHTSA should revisit the light truck definition, but provided no suggestions as to what, specifically, it believed should be revised.[1370]

In response, NHTSA agrees with the point raised by industry commenters that the underlying analysis for this final rule was premised on the passenger car and light truck fleets being defined per the current definitions in 49 CFR Part 523, and we recognize that any change to those definitions in this final rule could conceivably require a fresh analysis and determination of what standards are maximum feasible for the separate car and truck fleets in each model year. If the determination of maximum feasible standards is based on a balancing of factors that accounts, in part, for the unique capabilities of a given fleet, then any changes to that fleet that affect its overall capabilities could presumably change the balancing, and thus the level of stringency that is maximum feasible. Thus, the following discussion is directed toward the future, *i.e.,* the future rulemaking to develop final standards for MYs 2022–2025.

A number of commenters expressed concern that manufacturers would convert passenger car 2WD SUVs and CUVs to 4WD versions, or add a third row, in order to obtain the lower target under the light truck curves. Industry commenters maintain that the decision to make such a change to a vehicle model is driven by consumer demand and not by regulations; in fact, Global argued, a vehicle may be better off as a car than as a truck in terms of how its fuel economy compares to its target, insofar as a third row adds cost and weight that may obviate the benefit of the lower target by making it harder to meet it. This contrasts with NRDC's argument that a manufacturer is likely to add 4WD to obtain the light truck target if doing so is cheaper than adding the technology necessary to meet the passenger car target. As discussed above, the agency does not have sufficient information at this time to evaluate the seriousness of this risk. We expect that the calculus of vehicle classification will vary significantly between manufacturers and between model years, and we agree with the suggestion by industry that consumer demand is likely the primary driver of decisions such as 4WD or a third row. Industry cannot remain profitable if it provides too many vehicles that the public does not want; public demand for features such as 2WD and cargo space currently appears to be just as robust as demand for 4WD and third rows, and we have no reason to think

[1353] Alliance, at 8.
[1354] *Id.* at 9.
[1355] *Id.*
[1356] *Id.*
[1357] *Id.*
[1358] Global, at 11.
[1359] *Id.*
[1360] Ford, at 28.
[1361] GM, at 2.
[1362] Toyota, at 21.
[1363] *Id.* at 21.
[1364] CBD, at 16.
[1365] *Id.* at 16–17.
[1366] *Id.* at 17.
[1367] NRDC, at 10.
[1368] *Id.*
[1369] UCS, at 9.
[1370] Sierra Club *et al.,* at 7.

that those trends will change significantly in the near future.

That said, while EPCA continues to be clear that some vehicles are to be passenger cars and some to be light trucks, the agency agrees with environmental and consumer group commenters that the question of what makes a vehicle ''off-road capable'' and what functional characteristics make a vehicle ''truck like'' are within the agency's discretion to resolve. We appreciate and will consider further the suggestions by UCS with regard to greater specification of what factors may be appropriate for the regulatory definition of ''off-road capable,'' even though we are not implementing them as part of this final rule for the reasons discussed above. We will continue to monitor this issue and will revisit it in the future rulemaking to develop final standards for MYs 2022–2025. During the interim, if interested parties compile information on these issues that they believe may be helpful to the agency's future consideration, we welcome them to contact us.

The final issue under the category of vehicle classification was raised by Ford: A discussion of whether aerodynamic components (often referred to as ''strakes'') made of flexible plastic and affixed in front of wheels, prevent a vehicle from meeting the running clearance requirements for being ''off-road capable.'' That question was answered by NHTSA in a letter of interpretation dated July 30, 2012, and thus does not need further discussion as part of this preamble.

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.[1371] 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 final rule for the 2017–2025 program, NHTSA expects automakers to continue increasing the use of innovative and advanced technologies as they evolve. The additional incentive programs finalized will 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 are not 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 a manufacturer's compliance with the CAFE standards, and it will be in the calculation of fuel economy levels that the additional incentives are applied. Specifically, what is being finalized in the CAFE program, as proposed by EPA: 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 will utilize 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 Sections II.F, III.C, and Chapter 5 of the joint TSD.

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 new incentives and calculations finalized, but we also refer readers to Section III.C for EPA's explanation of its authority and more specific detail regarding these 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.[1372] 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 2012. 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,[1373] 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 resolves discrepancies with the manufacturer prior to the end of the calendar year

[1371] *See* 49 U.S.C. 32903(g).

[1372] 49 CFR part 537 is authorized by 49 U.S.C. 32907.

[1373] See *http://www.nhtsa.gov/DOT/NHTSA/Vehicle%20Safety/Test%20Procedures/Associated%20Files/TP–537–01.pdf.*

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 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 proposed and is finalizing 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.[1374] 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 [1375] 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

[1374] See 49 U.S.C. 32912.

[1375] 49 U.S.C. 30120, Remedies for defects and noncompliance.

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 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.

c. What exemptions are allowed by NHTSA?

NHTSA allows vehicles defined as emergency vehicles to be exempted from complying with CAFE standards. The NHTSA definition for emergency vehicle was established in 1972 by EPCA and is defined for NHTSA in 49 U.S.C. 32902(e) [1376] and includes ambulances and law enforcement vehicles. The EPA definition was proposed as a part of the NPRM [1377] for this rulemaking and establishes for the EPA GHG program a harmonized definition for emergency vehicles similar to that prescribed by EPCA.[1378] The agencies received a comment from the Alliance in response to the NPRM, on July 27, 2012, asking for the agencies to consider broadening their definitions for emergency vehicles to include other types of vehicles used for emergency purposes. The Alliance comment requested that the EPCA definition be expanded to include ''fire suppression, search and rescue and other emergency vehicle types.''The Alliance also recommended adding these vehicles in the definition for emergency vehicle adopted by EPA in the June 8, 2012, DFR (see 77 FR 34130) for the EPA emissions criteria program. The Alliance argued that it is important to ensure harmonized treatment of emergency vehicles under EPA's criteria pollutant and greenhouse gas emission regulations and NHTSA's CAFE regulations.

At this time, NHTSA does not believe that it has sufficient information to create a regulatory definition for ''emergency vehicles'' that is different from the text in EPCA. The Alliance provided no definitions, examples, or testing data on the model types of fire suppression, search and rescue and other emergency type vehicles which could be analyzed to determine whether sufficient need exists to add them to the definition and allow for their exclusion. Without this information, amending the definition as requested by the Alliance could inadvertently allow for the exclusion of vehicles that are capable of complying with the CAFE standards, which would be contrary to the overarching purpose of EPCA, energy conservation. Therefore, NHTSA will retain the use of the EPCA definition for the CAFE program, which is already harmonized with EPA's proposed definition of ''emergency vehicle'' for the GHG program. While we expect to examine this issue further, our initial understanding is that harmonizing exempted vehicles between EPA's criteria emissions program and the CAFE/GHG programs may not be necessary. The most fundamental issue underlying the Alliance comment is concern over a loss in vehicle performance caused by the operation of the criteria emission control system on diesel vehicles. However, to comply with the final CAFE and GHG emission standards, the agencies do not believe that manufacturers would need to implement technologies that would reduce vehicle performance. In the agencies' analyses of the how the industry could comply with the standards, the CAFE and OMEGA models applied technologies that were projected to maintain vehicle performance. Therefore, it is not expected that broadening the definition of emergency vehicles for the CAFE program would affect vehicle performance. NHTSA notes, however, that should a manufacturer wish to exempt a vehicle that falls outside the coverage provided by EPCA, such as the ''other types of emergency vehicles'' identified by the Alliance, 49 U.S.C. 32902(e)(1)(C) allows DOT to undertake rulemaking to consider adding other vehicles to this category.

[1376] In 32902(e), the definition is as follows: Emergency vehicles.—(1) In this subsection, ''emergency vehicle'' means an automobile manufactured primarily for use—

(A) as an ambulance or combination ambulance-hearse;

(B) by the United States Government or a State or local government for law enforcement; or

(C) for other emergency uses prescribed by regulation by the Secretary of Transportation.

[1377] See 76 FR 75362 (Dec. 1, 2011).

[1378] In the NPRM, EPA proposed the following definition in 40 CFR 86.1818–12: (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.

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

EPCA/EISA sets forth statutory provisions for manufacturers building 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 both the alternative fuel and gasoline/diesel) vehicles. Consistent with the overarching purpose of EPCA/EISA, these statutory provisions establish incentives to help reduce petroleum usage and thus improve our nation's energy security.

By statute, 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.[1379] Thus, a 15 mpg dedicated alternative fuel vehicle would be rated as 100 mpg. Likewise, for dual-fueled vehicles, the vehicle's fuel economy rating is determined as the harmonic average of

[1379] 49 U.S.C. 32905(a).

the fuel economy on gasoline or diesel and the fuel economy on the alternative fuel vehicle divided by 0.15.[1380] For example, a dual-fueled vehicle that averages 25 mpg on gasoline or diesel could be considered a 40 mpg vehicle for CAFE purposes when considering its performance on the alternative fuel. This assumes that (1) the vehicle operates on gasoline or diesel 50 percent of the time and on alternative fuel 50 percent of the time; (2) fuel economy while operating on alternative fuel is 15 mpg (15/.15 = 100 mpg); and (3) fuel economy while operating on gas or diesel is 25 mpg. Thus:

CAFE FE = 1/{0.5/(mpg gas) + 0.5/(mpg alt fuel)} = 1/{0.5/25 + 0.5/100} = 40 mpg

Equation IV–4 NHTSA Example Dual Fueled Vehicle MPG Calculation

Considering a similar example for an alternative fueled vehicle powered by natural gas, a vehicle averaging 25 miles per 100 ft^3 of natural gas could have a 203 mpg fuel economy rating. 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.[1381] The equivalent fuel economy for 100 cubic feet (ft^3) of natural gas is equivalent to 0.823 gallons of gasoline as provided by EISA. Thus, if a vehicle averages 25 miles per 100 ft^3 of natural gas, then:

CAFE FE = (25/100) * (100/.823)*(1/0.15) = 203 mpg

Equation IV–5 NHTSA Example Natural Gas Vehicle MPG Calculation

EISA prescribes the incentive for dual-fueled automobiles not only as an adjustment to the vehicle but also limits the overall impact of these vehicles on a manufacturer's fleet performance. A cap for the overall impact of dual-fueled vehicles is specified through MY 2019, but progressively phases-out between MYs 2015 and 2019.[1382] The maximum fleet fuel economy increase attributable to this statutory incentive is as follows:

TABLE IV–150—STATUTORY FLEET MPG INCREASE CAPS BY MODEL YEAR

Model year	Fleet 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 incentives.

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, NHTSA questioned how the fuel economy of dual-fueled vehicles should 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 that must be addressed to avoid the inappropriate result of dual-fueled vehicles' fuel economy being measured like that of conventional gasoline vehicles, with no recognition of their alternative fuel capability, which would be contrary to the intent of EPCA/EISA. The need for such a method is of greater importance for future model years when the number of plug-in hybrid electric vehicles is expected to increase in MYs 2020 and beyond. 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 through their alternative fuel usage.

Therefore, after the expiration of the special calculation procedures in 49 U.S.C. 32905 for dual fuel vehicles, the agencies proposed for model years 2020 and later vehicles that the general provisions authorizing EPA to establish testing and calculation procedures would provide discretion to set the CAFE calculation procedures.[1383] EPA proposed to harmonize with the approach it uses under the GHG program to measure the emissions of dual-fuel vehicles, to reflect the real-world percentage of usage of alternative fuels by dual-fuel vehicles, but also to continue to incentivize the use of certain alternative fuels in dual-fuel vehicles as appropriate under EPCA/EISA to reduce petroleum usage. EPA is finalizing this approach as proposed for plug-in hybrid electric vehicles (PHEV) that runs on both gasoline (or diesel) and electricity. Specifically, for MYs 2020 and beyond, EPA will calculate the fuel economy test values for a plug-in hybrid electric vehicle PHEV, 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[1384] (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. For MYs 2020 and beyond, EPA will calculate the fuel economy test values for a dual fuel CNG vehicle (that runs on both the alternative fuel and on gasoline or diesel), EPA will use one of two calculation methods. EPA will use the SAE "utility factor" methodology if the dual fuel CNG vehicle meets two requirements. First, the vehicle must have a minimum natural gas range-to-gasoline range of 2.0. Second, the vehicle must be designed such that gasoline can only be used when the CNG tank is empty, though EPA is permitting a de minimis exemption for those dual fuel vehicle designs where a very small amount of gasoline is used to initiate combustion before changing over to a much greater volume of natural gas to sustain combustion. A dual fuel CNG vehicle that does not meet the above eligibility requirements would use a utility factor of 0.50, the value that has been used in the past for dual fuel vehicles under the CAFE program.

[1380] 49 U.S.C. 32905(b).

[1381] 49 U.S.C. 32905(c).

[1382] 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.

[1383] 49 U.S.C. 32904(a), (c).

[1384] SAE Standard J2841 "Utility Factor Definitions for Plug-In Hybrid Electric Vehicles Using Travel Survey Data." *Available at http://standards.sae.org/j2841_201009/* (last accessed Jul. 13, 2012).

Consistent with this approach, however, EPA's proposal did not 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, for CAFE compliance in MYs 2020 and beyond, EPA will continue treatment of E85 and other FFVs (other than PHEVs and CNG) as finalized in the MY 2016 GHG program, based on the relative weighting of gasoline and E85 (or other fuels) emissions performance on the actual national average use of E85 (or other fuels) in ethanol FFVs or optionally the manufacturer-specific data showing the percentage of miles that are driven on E85 vis-à-vis gasoline for that manufacturer's FFVs. For clarification in our regulations, NHTSA proposed, and is adding, Part 536.10(d) which states that for model years 2020 and beyond a manufacturer must calculate the fuel economy of dual-fuel vehicles in accordance with 40 CFR 600.510–12(c), (2)(v) and (vii), the sections of EPA's calculation regulations where EPA is proposing to incorporate these changes.

Additionally, to avoid manufacturers being encouraged to build only dedicated alternative fuel vehicles (which may be harder to refuel in some instances) because of the incentive 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 being discouraged from building dual-fuel vehicles which might not get a similar bonus, EPA proposed and is finalizing the use of 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. 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 proposed that manufacturers may increase their calculated fleet fuel economy for dual-fuel vehicles by an unlimited amount using these flexibilities.

As an example, for MYs 2020 and beyond, the calculation procedure for a dual-fuel vehicle that uses both gasoline and CNG (and meets the two criteria for using the ''utility factor'' method) 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:

CAFE FE = 1/{0.05/(mpg gas) + 0.95/(mpg CNG)} = 1/{0.05/25 + 0.95/203} = 150 mpg

As discussed in Section III.C, the agencies received favorable comments on the proposals for dual fuel and alternative fuel vehicles (with most focusing on PHEVs and dual fuel CNG vehicles). The Alliance of Automobile Manufacturers, Fisker Automotive, the Electric Drive Transportation Association, and the American Council for an Energy-Efficient Economy (ACEEE) supported the use of the SAE utility factor methodology for PHEVs. The natural gas advocacy groups (including America's Natural Gas Alliance/American Gas Association, American Public Gas Association, Clean Energy, Encana Natural Gas Inc., NGV America, and VNG.Co) and the Natural Resources Defense Council (NRDC) supported the use of cycle-specific fleet-based utility factors for dual fuel CNG vehicles, and supported the extension of this approach for MYs 2012–2015, but generally argued against any eligibility requirements for the application of utility factors for dual fuel CNG vehicles. NRDC suggested that EPA adopt the additional constraints on the design of dual-fuel CNG vehicles that were suggested in the NPRM to ensure that these vehicles operate preferentially on CNG. The groups opposing the use of the SAE utility factor did not necessarily reject its use, but rather argued that the values were too conservative. The American Petroleum Institute (API) and Securing America's Future Energy (SAFE) argued that agencies were underestimating the behavior of owners in maximizing tank refills and the likelihood of PHEV buyers to maximize their electricity vs. gasoline use. Other comments included ACEEE's and API's recommendation that EPA use lower 5-cycle range values for all-electric (or equivalent all-electric) operation in the calculation of the utility factor, and ACEEE's recommendation that fleet based utility factors be used for compliance, rather than the multiple-day individual utility factors (MDIUFs) that are used for fuel economy and environment labels.

Commenters generally supported the proposal for FFVs. The Alliance of Automobile Manufacturers, Ford, and General Motors supported the NPRM proposal as presented. The Renewable Fuels Association commented that the agencies should instead consider utility factors for ethanol FFVs, supporting its position by possibility of higher fuel prices than gasoline on a per mile basis (i.e., due to prices increasing with demand or limited refueling access) for CNG and PHEVs. The National Corn Growers Association argued that ''[t]he concern for high relative cost of mid or high level ethanol blends does not seem to be justified in the term of the CAFE/GHG and RFS2 rules since at some point in the renewable fuel volume ramp-up of RFS2, market forces would result in competitive prices for ethanol and gasoline in order for the required volumes to be sold.''

In consideration of the comments received, EPA and NHTSA are finalizing the proposed requirements for dual fuel PHEV and for alternative fueled vehicles, with the exception of adopting the use of a fleet based utility factor for PHEVs, as suggested by ACEEE (see 40 CFR 600.116(b)(1)). The bases for arguments opposing adoption were not substantial enough to deviate for the proposal compliance treatment of these vehicles (see Section III.C for further explanations).

As mentioned above, EPA and NHTSA are finalizing, as proposed, the use of SAE fleet-based utility factors for dual fuel CNG vehicles, and are also finalizing some additional requirements in order for a dual fuel CNG vehicle to be able to use the utility factors. Dual fuel CNG vehicles must meet two requirements in order to use the utility factor approach. One, the vehicle must have a minimum natural gas range-to-gasoline range of 2.0. This is to ensure that there is a vehicle range incentive to encourage vehicle owners to seek to use CNG fuel as much as possible (for example, if a vehicle had equal or greater range on gasoline than on natural gas, the agency is concerned that some owners would fuel more often on gasoline). While NRDC suggested a minimum natural gas range-to-gasoline range of 4.0, the agency believes that a ratio of 2.0, in concert with a (currently) much less expensive fuel, is very strong incentive to use natural gas fuel. Two, the vehicle must be designed such that gasoline can only be used when the CNG tank is empty, though the agencies are permitting a de minimis exemption for those dual fuel vehicle designs where a very small amount of gasoline is used to initiate combustion before changing over to a much greater volume of natural gas to sustain combustion. With these eligibility requirements, EPA and NHTSA believe that there will be strong economic motivation for consumers to preferentially seek out and use CNG fuel in dual fuel CNG vehicles. Consumers will have paid a premium for this feature, and will have greater range on CNG. We also believe that the utility factor approach is the most reasonable approach for projecting the real world use of CNG and gasoline fuels in such dual fuel CNG vehicles. The agencies believe that dual fuel CNG vehicles that would not meet the two criteria because they have higher driving ranges on gasoline/diesel would be more likely to operate more often on gasoline/diesel and the ''utility factor'' method would overestimate the operation on CNG. Therefore the agencies believe it is appropriate to use a fixed utility factor of 0.50, the value that has been used in the past for dual fuel vehicles under the CAFE program for these vehicles.

As noted above, there was widespread public support from the commenters for the utility factor approach for dual fuel CNG vehicles. The agencies are rejecting the one alternative approach that was suggested, the use of a fixed 95% utility factor, because it would allow a dual fuel CNG vehicle with a small CNG tank to benefit from a very large utility factor.

NHTSA and EPA are finalizing the proposed approach without changes for ethanol-capable dual-fueled vehicles. The agencies disagree with using utility factors for these vehicles. NHTSA supports EPA's positions that ethanol FFVs will primarily use gasoline fuel, as there was no extra vehicle cost, E85 fuel is no cheaper and in fact usually more expensive per mile, and use of E85 reduces overall vehicle range since there is only one fuel tank (as opposed to PHEVs and dual fuel CNG vehicles which have two fuel storage devices and therefore the use of the alternative fuel raises overall vehicle range). Data compiled by EPA shows that approximately 10 million ethanol FFVs in the US car and light truck fleet, fuel use data demonstrate that ethanol FFVs only use E85 less than one percent of the time. Therefore, NHTSA agrees with EPA to finalize FFVs compliance relative to the weighting of gasoline and E85 emissions performance on the actual national average use of E85 in ethanol FFVs, consistent with the provisions in the MYs 2012–2016 standards for GHG compliance.

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.[1385] 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.

In the NPRM, NHTSA proposed that the VMT estimates used in the credit adjustment factor should be 195,264 miles for passenger car credits and 225,865 miles for light truck credits for all over-compliance credits earned in MYs 2017–2025. NHTSA did not propose to change the VMT estimates used for these purposes for MYs 2012–2016. NHTSA proposed these values in the interest of harmonizing with EPA's GHG program, and sought comment on this approach as compared to the prior approach of adjustment factors with VMT estimates that vary by year. Additionally, NHTSA proposed to include VMT estimates for MY 2011, which the agency had not included in Part 536 as part of the MYs 2012–2016 rulemaking. The proposed MY 2011 VMT value for passenger cars was 152,922 miles, and for light trucks was 172,552 miles. The Alliance supported the fixed value VMT approach for MYs 2017–2025, and requested that NHTSA also revise the VMT values for MYs 2012–2016 to harmonize with EPA. NHTSA is finalizing the VMT value approach as proposed. With respect to the Alliance's comment regarding the VMT values for credits earned in MYs 2012–2016, the agency expressly did not propose to make this change, and we do not believe that the benefits of harmonization in this particular aspect for these model years outweigh the potential fuel savings losses that may occur if a change is made at this time.

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 $818,724,551.00 to date in CAFE penalties, the largest ever being paid by DaimlerChrysler for its MY 2006 import passenger car fleet, $30,257,920.00. For their MY 2010 fleets, five manufacturers paid CAFE fines for not meeting an applicable standard—Fiat, which included Ferrari and Maserati; Daimler (Mercedes-Benz); Porsche; Tata (Jaguar Land Rover) and Volvo—for a total of $23,803,411.50. 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

[1385] 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.

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 requested 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. No comments specific to this issue were received, so the agency will continue to attempt to evaluate this issue on its own.

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 finalized by EPA under its EPCA authority to calculate fuel economy levels for individual vehicles and for fleets. We refer the reader to Section III for more details, as well as Chapter 5 of the 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 will be available for manufacturers meeting MYs 2017–2025 CAFE standards.

As mentioned above with regard to EPA's finalized changes for the calculation of dual-fueled automobile fuel economy for MYs 2020 and beyond, NHTSA is modifying 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 531 and 49 CFR 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. The final changes to these sections 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.

a. ''Game Changing'' Technologies for Full Size Pick-Up Trucks

EPA is adopting two new types of incentives for improving the fuel economy performance of full size pickup trucks. The first incentive provides a credit to manufacturers that employ significant quantities of hybridized full size pickup trucks. The second incentive is 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 designed to promote technologies improving fuel economy and GHG performance for addressing the significant difficulty full size pickup trucks have 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 full size pickups and other large trucks due to these tradeoffs in utility purposes, and therefore have not been utilized 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 future more stringent light truck standards. 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.[1386] 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.

EPA and NHTSA proposed adopting the eligibility criteria for the incentives by adding definitions with the characteristics for: (1) Full size pickup trucks; (2) mild hybrid electric pickup trucks, and; (3) strong hybrid electric pickup trucks. NHTSA is finalizing these definitions by reference to 40 CFR 86.1803–01 in its regulation 49 CFR 523, ''Vehicle Classification.'' The agencies proposed 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. 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 believes these references are necessary to help explain to readers that the characteristics of full size pickup trucks make them eligible to gain fuel economy improvement values after a manufacturer meets either a minimum penetration of hybridized technologies or has other technologies that

[1386] 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).

significantly reduce fuel consumption. The improvement will 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.

i. Pickup Truck Hybridization

EPA proposed criteria that would provide an adjustment to the fuel economy of a manufacturer's full size pickup trucks if the manufacturer employs certain defined hybrid technologies for a significant quantity of its full size pickup trucks. After meeting 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. EPA is finalizing that manufacturers producing mild hybrid pickup trucks would gain a 0.0011 gal/mi (10 g/mi CO_2 equivalent) incentive by applying mild hybrid technology to at least 20 percent of the company's full sized pickups produced in MY 2017, which increases each year up to at least 80 percent of the company's full size pickups produced in MY 2021 (20–30–55–70–80% in model years 2017–2018–2019–2020–2021, respectively), after which point the adjustment would no longer be applicable. The mild hybrid penetration rates represent a change from the proposed rates, in response to comments received from industry that penetration levels proposed for mild hybrid credits are too ambitious in the initial model years and may be counter-productive, as launching a complex new technology on almost a third of first-year sales could be a risky business strategy in this highly competitive large truck market segment. As a result, EPA has changed this requirement to 20 and 30% in model years 2017 and 2018, respectively (compared to the proposed levels of 30% and 40% in MY 2017 and 2018, respectively), to help facilitate the smooth introduction of mild hybrid technology. NHTSA is incorporating reference to EPA's requirements in 40 CFR 600.512, which contains the final provisions. For strong hybrids, EPA is adopting provisions for strong hybrid technology to be applied to at least 10 percent of a company's full sized pickup production in each year for model years 2017–2025 to gain a 0.0023 gal/mi (20 g/mi CO_2 equivalent) incentive.

The fuel economy adjustment for each mild and strong hybrid full size pickup would be a decrease in measured fuel consumption. These adjustments are consistent with the GHG credits under EPA's program for mild and 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.

A number of comments were received in response to the proposed definitions for mild and strong hybrids. EPA had proposed that a 75 percent brake energy recovery criteria would be needed to qualify as a strong hybrid and a 15 percent recovery for a mild hybrid; the Alliance, Ford, Chrysler, Toyota, and MEMA recommended changing the criteria for determining whether a hybrid pickup truck is categorized as strong or mild by the percentage of energy recovery achieved during braking. GM also provided late oral comments to the agencies suggesting revisions to those percentage definitions, meeting with the agencies and providing a hybrid pickup truck for EPA's use in testing. Other industry commenters objected to EPA's characterization of the credit provisions as applying to only hybrid ''gasoline-electric'' vehicles, and requested that hybrids be defined more broadly. EPA and NHTSA agree that the provisions should not be applicable only to ''gasoline-electric'' vehicles and are clarifying in this final rule that the provisions also apply to non-gasoline (including diesel-, ethanol-, and CNG-fueled) hybrids. EPA also agreed with manufacturers that defining strong hybrids based upon the proposed percent efficiency in recovering braking energy is inappropriate. As identified through recent testing by EPA, the only large hybrid truck currently marketed would not satisfy the proposed 75 percent metric. Therefore, EPA is finalizing changes to the criteria, as discussed in Sections II and III above, such that now a 65 percent threshold instead of 75 percent is required for a pickup truck to qualify as a strong hybrid. NHTSA is finalizing the same definitions as EPA by referencing EPA's definitions in Part 523.

ii. Performance-Based Incentive for Full-Size Pickups

Another proposed incentive that is being finalized for full size pickup trucks will 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 its 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 incentive will allow a performance-based credit without the need for a specific technology or design requirements. A manufacturer can use any technology or set of technologies as long as the vehicle's CO_2 performance is at least 15 or 20% below the vehicle's footprint-based target. The fuel economy adjustment for each full size pickup that exceeds its applicable footprint curve target by 15 percent will decrease the vehicle's measured fuel consumption by a value of 0.0011gal/mi. Likewise, for each full size pickup that exceeds its applicable footprint curve target by 20 percent, the decrease in measured fuel consumption will 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 model 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 from one year to the next or its sales drop below the penetration threshold. The 0.0023 gal/mi adjustment would be available for a maximum of 5 consecutive 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.

Comments received to the NPRM primarily concerned the minimum penetration thresholds for full size pickup truck incentives requesting to reduce or eliminate the thresholds. Manufacturers cited multiple reasons for lower thresholds based upon prevailing production needs, unfamiliarity with new technology, and customer acceptance rates. EPA discusses in section III.C.3 that the goal of the ''game changing'' credits is to incentivize the widespread adoption of advanced technologies. Therefore, EPA has decided to finalize the penetration requirements as proposed, citing that eliminating or greatly reducing the minimum penetration requirements might retain the incentive for niche applications but would lose any assurance of widespread ''game-changing'' technology introduction and substantial penetration.

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. EPA proposed to allow manufacturers, starting in MY 2017, 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 generally do not relate to fuel economy and thus are not relevant to the CAFE program. This proposal to allow manufacturers to consider A/C efficiency improvement technologies for determining CAFE performance values is being finalized in this final rule.

Based upon comments received to the proposal, EPA is making several technical and programmatic changes to the proposed ''AC17'' test. The A/C 17 test is a more extensive test than the ''idle test'' used for MYs 2012–2016 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—beginning in 2020—the agencies will require that baseline emissions be measured in addition to emissions from vehicles with improved A/C systems.

Industry and industry representatives—including the Alliance, BMW, Ford, Toyota, Honda, Hyundai, Honeywell, and others—asked that an AC17 baseline configuration test in addition to an AC17 test of a vehicle with an improved A/C system not be required in 2017 since few or no baseline vehicles will be available in that time period. In response, EPA is finalizing that from 2017 to 2019 manufacturers will be eligible to receive GHG credits and fuel consumption improvement values from the menu simply by reporting the results of the AC17 test. In addition, a number of commenters, including the Alliance, Volvo, BMW, Ford, and others, asked the agencies to change the required AC17 test conditions—such as temperature, humidity, and solar soak period—to improve repeatability and reduce test burden. In response, EPA has altered some of the test condition requirements. A number of manufacturers commented that the definition of vehicle platform would require many vehicles to be tested, and asked for clarification on which vehicles are required to be tested, and on aspects of the test procedure, such as which instrumentation can be used during the test. In response, EPA has defined vehicle platform more clearly to minimize the testing burden. More detail on the technical and programmatic changes along with the comments received are provided in section II.F.

The details of the A/C efficiency performance provision are discussed as follows and in greater detail in Sections II.F, III.C, and Chapter 5 of the joint TSD.

For MYs 2017–2019, eligibility for A/C efficiency fuel consumption improvement values will be determined solely by completion of the AC17 testing on vehicles with more efficient A/C systems. Manufacturers can earn the A/C efficiency GHG credit and fuel consumption improvement values between 2017 and 2019 by running the A/C 17 test procedure on the highest sales volume vehicle in a 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). The amount of the fuel consumption improvement value that can be included in the manufacturer's CAFE calculations is equal to the value(s) on the menu for the particular technolog(ies) installed on the vehicle—up to a maximum amount, which is described in more detail below.

Starting in MY 2020, however, AC17 test results will be used not only to determine eligibility for AC efficiency fuel consumption improvement values, but will also play a part in calculating the amount of the value that can be claimed. From 2020 to 2025, the AC17 test would be run on the highest sales volume vehicle in a platform to validate that the performance and efficiency of a vehicle's A/C technology is commensurate with 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 AC17 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). The difference between the test of the baseline vehicle and the vehicle with new A/C technologies will determine the fuel consumption improvement value that can be included in the CAFE calculations. The manufacturer will be eligible for GHG credits and fuel consumption improvement values if the test results show an improvement over the baseline vehicle. If the test result comparisons indicate an emission and fuel consumption reduction greater than or equal to the maximum menu-based credit/fuel consumption improvement value, then the manufacturer will generate the appropriate maximum value based on the menu. However, if the test result does not demonstrate the full menu-based potential of the technology, then only partial GHG credit and fuel consumption improvement value can be earned.

Manufacturers take the results of the AC17 test(s) 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. For model years 2020 and later, if the results of the AC17 tests for the baseline and vehicle with improved A/C system demonstrates a 0.000282 gal/mi or greater improvement, then the full fuel consumption improvement value provided in the table for those two technologies can be taken. If the AC17 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 AC17 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 AC17 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.

Table IV–151 below shows the fuel consumption improvement values associated with different A/C efficiency improving technologies.

TABLE IV–151—NHTSA EFFICIENCY IMPROVING A/C TECHNOLOGIES AND IMPROVEMENT VALUES

Technology description	Estimated reduction in A/C CO_2 emissions and fuel consumption (percent)	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 controls that 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

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.

For model years 2020 and later if a vehicle with new A/C technologies is tested and the result is not commensurate with the expected level of fuel consumption reduction for technologies included on the vehicle, an engineering analysis can be submitted by the manufacturer to justify a claim for the fuel consumption improvement values.

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 for the MYs 2012–2016 GHG program and concluded 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 proposed to extend the off-cycle credits program to 2017 and later model years. EPA also proposed, 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 fleet performance value. The proposed off-cycle incentive for the CAFE program is being finalized for MYs 2017 and later as discussed below.

Starting with MY 2017, manufacturers will be able to generate fuel economy improvements by applying technologies listed on a pre-defined and pre-approved technology list. These credits would be verified and approved as part of certification, with no prior approval process needed. The ‘‘pick list’’ option will 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, the agencies have clarified the step-by-step application and approval process for demonstration of fuel consumption reductions and approval.

EPA and NHTSA are finalizing the off-cycle program as proposed with the exception of two differences made in response to comments received. The first change applies to EPA only and allows the pre-defined list to be used starting in MY 2014, rather than the proposed starting point of MY 2017. This change does not apply to CAFE, where the off-cycle credits program does not begin until MY 2017. Second, the agencies are deleting the minimum sales thresholds for technologies on the pre-defined list. For further explanation of the changes for the GHG program, see Section III.C.5.a and Section III.C.5.b, and for the CAFE program, see Section III.C.5.c. The agencies are also finalizing the step-by-step process and timeline for reviewing credit applications and providing a decision to manufacturers. The agencies plan to coordinate approvals whereas 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. The details of the testing protocols used for determining off-cycle technology benefits and the step-by-step EPA review and approval process are detailed more thoroughly in Section III.C.5.b.iii and Section III.C.5.b.v. The agencies are also clarifying, for purposes of the off-cycle program for CAFE, how consultation and coordination as required by 49 U.S.C. 32904(e) will occur. NHTSA has added regulatory text in 49 CFR 531.6 and 533.6 explaining that NHTSA will consult with EPA on manufacturer applications under 40 CFR 86.1869–12 and provide its views on the specific off-cycle technology under consideration to ensure its impact on fuel economy and the suitability of using the off-cycle technology to adjust the fuel economy performance. NHTSA's evaluation and review will consider whether the technology has a direct impact upon improving fuel economy performance; whether the technology is related to crash-avoidance technologies, safety critical systems or systems affecting safety-critical functions, or technologies designed for the purpose of reducing the frequency of vehicle crashes; information from any assessments conducted by EPA related to the application, the technology and/or related technologies; and other relevant factors. NHTSA also notes that since the off-cycle program for CAFE does not begin until MY 2017, but manufacturers may obtain approval for off-cycle credits in the GHG program prior to that model year which they wish to carry into the CAFE program, clarification is needed to explain what manufacturers should do in those circumstances. In those cases, manufacturers must concurrently submit a copy to NHTSA of the application that is being submitted to EPA if manufacturers anticipate seeking fuel consumption improvements for CAFE beginning in MY 2017 to ensure the smooth functioning of the program.

The changes finalized today by the agencies respond to issues raised by commenters. The agencies received several comments supporting the proposal to establish a pre-defined and pre-approved technology list for the CAFE program. Manufacturers who supported the list stated that it is a necessary element to streamline and simplify the off-cycle program for EPA and NHTSA. There were no comments received objecting to the pre-defined list, but comments were received on various aspects of the list, as discussed in detail in Section II.F. EPA has made changes to some of the technologies and credit values on the list as a result of these comments. Based on received information and meetings with manufacturers, the agencies are also clarifying the proposed credit values and calculation procedures for active transmission warmup, solar panels and solar control glazing in the final rule. These clarified values are presented in Table III–19 and the calculation methods described in detail in the Joint TSD Chapter 5.

Section II.F of the preamble provides an overview of the technologies, credit values, and comments the agencies received on the proposed technology list. Table IV–152 provides the list of the technologies and per vehicle credit levels for the CAFE program that are being adopted for the final rule.

TABLE IV–152—NHTSA OFF-CYCLE TECHNOLOGIES AND FINAL IMPROVEMENT VALUES FOR PASSENGER CARS AND LIGHT TRUCKS

Technology		Adjustments for cars		Adjustments for trucks	
		g/mi	gallons/mi	g/mi	gallons/mi
+High Efficiency Exterior Lights* (at 100 watt savings)		1.0	0.000113	1.0	0.000113
+Waste Heat Recovery (at 100W)		0.7	0.000079	0.7	0.000079
+Solar Panels (based on a 75 watt solar panel)**.	Battery Charging Only	3.3	0.000371	3.3	0.000371
	Active Cabin Ventilation and Battery Charging.	2.5	0.000281	2.5	0.000281
+Active Aerodynamic Improvements (for a 3% aerodynamic drag or Cd reduction).		0.6	0.000068	1.0	0.000113
Engine Idle Start-Stop	w/heater circulation system #	2.5	0.000281	4.4	0.000495
	w/o heater circulation system	1.5	0.000169	2.9	0.000326
Active Transmission Warm-Up		1.5	0.000169	3.2	0.000360
Active Engine Warm-up		1.5	0.000169	3.2	0.000360
Solar/Thermal Control		Up to 3.0	0.000338	Up to 4.3	0.000484

Since one purpose of the off-cycle improvement incentive is to encourage market penetration of the technologies (see 75 FR 25438), EPA proposed 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 proposed 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. Ten percent seemed 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 specific to HEVs, PHEVs, and EVs, 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 requested comments on applying this type of threshold, the appropriateness of 10 percent as the threshold for listed technologies that are not P/H/EV-specific, and the proposed treatment of hybrid-based technologies.

The agencies received comments from several manufacturers and suppliers recommending not to adopt the proposed sales thresholds. Commenters argued, for example, that a sales threshold would impede the development of these early stage technologies because manufacturers typically introduce new, expensive technologies on high-end, low-volume models, and requiring a technology across a certain percentage of the fleet in order to allow access to credits would create incentives for the manufacturer simply to forego the technology, if no credit is available, and focus instead on other ways to improve fuel economy. The agencies believe these issues have merit and consequently for the final rule have decided not to adopt sales thresholds as a condition. The agencies believe that several points raised by the commenters are persuasive in demonstrating that a sales threshold could have the opposite effect, dissuading manufacturers from introducing technologies.

The agencies also proposed in the NPRM to impose a cap on the amount of improvement a manufacturer could generate to 0.001125 gal/mile per year on a combined car and truck fleet-wide average basis for the CAFE program. As proposed, the cap would not have applied 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. Additionally, if manufacturers wished 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.

The agencies are finalizing the proposed technology cap as specified in the NPRM. Some commenters had argued that the cap is too conservative or, conversely, that it may discourage the maximum adoption of the pre-defined off-cycle technologies, but the agencies believe that the cap is sufficient enough and appropriately structured. The cap is appropriate because the default credit values are based on limited data, and also because the agencies recognize 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. Furthermore, the agencies are finalizing the approach discussed above by which manufacturers may generate credits beyond the cap limitation through the agency approval process. Comments were also received requesting to change the approach for adding technologies in meeting the cap limitation. The agencies view these issues as beyond the scope of this rulemaking, and expect to review these issues further and address them as a part of the future NHTSA rulemaking to develop final standards for MYs 2022–2025 and concurrent mid-term evaluation.

As proposed, EPA is finalizing 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 regulations at 40 CFR 600.510–12. Note that although the table above 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.

5. Other CAFE Enforcement Issues

a. Electronic Reporting

NHTSA proposed in the NPRM to modify 49 CFR Part 537 to eliminate the current option for manufacturers to mail hardcopy submissions of CAFE reports to NHTSA and proposed to receive all reports electronically. 49 CFR Part 537 requires light vehicle manufacturers to submit pre-model year (PMY), mid-model year (MMY), and supplemental reports to NHTSA containing projected estimates of how manufacturers plan to comply with NHTSA standards. Manufacturers are required to submit pre-model year reports by December prior to each year, mid-model reports by July of the model year and a supplemental report whenever changes are needed to a previously submitted CAFE report. After the end of the model year, EPA verifies manufacturers' end-of-the-year data and sends the final verified values to NHTSA. In general, manufacturers' pre and mid model reports contain projected estimates of the manufacturers' CAFE standards, the average fuel economy for each fleet, and, primarily in the PMY report, more specific information about the vehicles in each manufacture's fleet, such as loaded vehicle weight, engine displacement, horsepower and other defining characteristics of the vehicle. Manufacturers currently may provide reports either by hardcopy or CD-ROM including 5 copies of reports mailed to the NHTSA Administrator or electronically sending reports to a secure email address, *cafe@dot.gov*, an option that was added in the MYs 2012–2016 final rule. NHTSA proposed in the NPRM to modify § 537.5(c)(4) to require manufacturers to submit all reports electronically by CD-ROM or by email. The agency proposed that electronic data be submitted in a Microsoft Excel spreadsheet format for all of the manufacturer's data, with the exception of any supporting documentation such as cover letters or any requests for confidentiality which had to be provided in a pdf format. The agency explained that its long range goal was to use the data as part of a step approach it discussed in the NPRM to eventually develop a new CAFE database allowing manufacturers to submit electronic CAFE reports through the NHTSA Web site using an XML schema.

Having examined the issue more closely, NHTSA has discovered that there are complications with the amendment to Part 537 in the MYs 2012–2016 final rule allowing confidential pre- and mid-model year reports to be submitted via email. The regulation governing NHTSA's determinations of confidentiality, 49 CFR Part 512, currently states that if a manufacturer wishes to submit information that it claims to be confidential to the agency electronically, the only acceptable electronic format is a ''physical medium such as a CD-ROM.'' [1387] Email submissions of confidential material would not conform with this requirement. The only exception to this requirement under the current Part 512 is early warning reporting data submitted to NHTSA under 49 CFR part 579.

Thus, unless and until the agency undertakes rulemaking to include submission of confidential CAFE data by email within Part 512, NHTSA will have to continue to accept such data in electronic format by CD-ROM only. Because manufacturers are required under Part 537 to submit both confidential and non-confidential (*i.e.,* redacted) versions of the pre- and mid-model year reports to NHTSA, we will continue to accept the non-confidential versions by email to *cafe@dot.gov*, but the confidential versions will need to come in by CD-ROM. As discussed in the NPRM, we will also be eliminating the option of providing pre- and mid-model year reports in hard copy, in the interest of maximizing efficiency and reducing paperwork burden. No comments were received disagreeing with this proposal.

The only comments that were received on the question of electronic CAFE reporting were from Ford, who supported the concept of electronic reporting and NHTSA's move to all electronic reporting in an Excel format. However, Ford argued that when the agency eventually made that transition, it should continue to allow manufacturers to submit data in formats to which they are already accustomed, such as the current (totally unrestricted) formats allowed for hardcopy submissions under Part 537, or the same format as required by EPA's ''VERIFY'' database. Ford argued that manufacturers have spent significant time and resources updating their databases to conform to EPA's new VERIFY requirements commencing in model year 2009,[1388] and that Canada also uses the VERIFY database system to access CAFE information, so it would be easiest for manufacturers if NHTSA employed an identical format for CAFE reporting under Part 537.

In response, we reiterate that NHTSA's intent in the NPRM proposal was not to impact the format of the existing reports but simply to require manufacturers to submit CD-ROMs rather than paper. No changes are being made at this time to the format of the Part 537 submissions. However, as discussed in the NPRM and as supported by comments, the agency does intend to continue investigating the possibility of reducing industry's reporting burdens even further through a long term goal of developing a means to receive electronic submissions through the NHTSA Web site using an XML schema. NHTSA will consider the existing formats of the EPA VERIFY system as it moves forward towards this goal. We note, however, that while NHTSA is currently aware of a number of data requirements that NHTSA and EPA already share in common where the EPA VERIFY system format could be used for receiving data, at the same time, NHTSA has unique data requirements not collected by EPA that may require additional information to be independently reported to NHTSA. For example, only NHTSA requires manufacturers to report information on the criteria used to classify an automobile as a non-passenger vehicle or a light truck. Any future changes to the Part 537 reporting requirements would, of course, occur through rulemaking, and we continue to invite manufacturer feedback as the agency develops its ideas for modernizing this data collection system.

b. Reporting of How a Vehicle Is Classified as a Light Truck

In the NPRM, NHTSA proposed to restructure and clarify how manufacturers report information used to make the determination that an automobile can be classified as a light truck for CAFE purposes, and sought comments on the proposed change. The agency felt that this proposed change was necessary because the previous requirements in 49 CFR Part 537 specified that manufacturers must provide information on some, but not all, of the functions and features used to classify an automobile as a light truck, and it is important for compliance reasons to understand and be able to readily verify the methods used to ensure manufacturers are classifying vehicles correctly. In addition, the regulation required that the information be distributed in different locations throughout a manufacturer's report, making it difficult for the agency to clearly determine exactly what functions or features a manufacturer is using to classify a vehicle as a light truck. For the NPRM, NHTSA proposed to relocate the language requesting manufacturers to provide their vehicle classification determination information in Sections 537.7(c)(4)(xvi)(B)(1) and(2), (xvii) and (xviii) into a revised Section 537.7(c)(5) consolidating all the required information. NHTSA believed that by incorporating all the requirements into one section, the classification determination process would be significantly more accurate and easily identifiable.

In response, Ford commented in support of the proposed consolidation of all truck classification determination data into one location, but argued that the proposed regulatory text had duplicative requirements for reporting light truck cargo-carrying volumes in sections 537.7(c)(4)(xix)(B)(2) and (5)(i)(D). Ford requested that NHTSA allow manufacturers to streamline their reporting, as long as all the data required for NHTSA to confirm CAFE calculations, fleet classification, and NHTSA's fleet analyses are present and easily identified.

Upon further review of the proposed regulatory text, we believe that our intentions were not clearly articulated. In the proposal, NHTSA intended for sections 537.7(c)(4)(xix)(B)(1) and (2) to require manufacturers to provide the passenger-carrying volume and cargo-carrying volume values, respectively, and for section 537.7(c)(5)(i)(D) to require the difference between the two volumes and an indication whether a vehicle's cargo volume is larger than its passenger volume. However, after reviewing Ford's comment, we now understand how these requirements could be interpreted as duplicative. Therefore, for the final rule, NHTSA is revising section 537.7(c)(5)(i)(D) to clarify that the manufacturer must indicate whether the cargo-carrying volume is greater than the passenger-carrying volume; if so it must also provide the difference between the two values. Finally, Ford requested that NHTSA allow manufacturers to streamline their reporting, as long as all the data required to confirm CAFE calculations, fleet classification, and NHTSA's fleet analyses are present and easily identified. NHTSA agrees that streamlining its reporting requirements is important, and believes that the changes finalized in this rule to Part 537 will help to accomplish that. With these changes, manufacturers can provide the agency with all the necessary data in a

[1387] *See* 49 CFR 512.6(c).

[1388] *See* 76 FR 75340

simpler format that allows the agency, and perhaps also the manufacturer, to understand quickly and easily how light truck vehicle classification determination decisions are made.

c. Base Tire Definition Revision

The CAFE standards are attribute-based, and thus each manufacturer has its own ''standard,'' or compliance obligation, defined by the vehicles it produces for sale in each fleet in a given model year. A manufacturer calculates its fleet standard from the attribute-based target curve standards derived from the unique footprint values, which are the products of the average front and rear vehicle track width and wheelbase dimensions, of the vehicles in each model type. Vehicle track width dimensions are determined with a vehicle equipped with ''base tires,'' which NHTSA currently defines in 49 CFR Part 523 as the tire specified as standard equipment by a manufacturer on each vehicle configuration of a model type.[1389]

The calculation of footprint, and thus the definition of base tire, is important in the CAFE program because they ultimately affect a manufacturer's compliance obligation, and consistency in how manufacturers' compliance obligations are determined is vital for predictability and fairness of the program. In the NPRM (*See* 76 FR 75351), NHTSA proposed to modify the definition of base tire by deleting the reference to ''standard equipment'' and adding a reference to ''the tire installed by the vehicle manufacturer that has the highest production sales volume on each vehicle configuration of a model type.'' NHTSA believed that this modification would ensure that the tires most frequently installed on each vehicle configuration would become the basis for setting a manufacturer's fuel economy standard, which the agency expected would help to reduce inconsistencies and confusion that existed in identifying base tires for both the agency and the manufacturers. NHTSA sought comment on this approach, and on other approaches that could be used for selecting base tires.[1390]

The agencies received several comments in response to the NPRM. Global Automakers agreed with NHTSA that clarification would help avoid different interpretations of ''base tire'' by different manufacturers, but the Alliance, Toyota and GM requested that the agency defer the decision on changing the base tire definition and discuss the issue further with industry before making changes. The Alliance argued that because the highest sales tire can change throughout the model year based on many factors beyond a manufacturer's control or foresight, NHTSA should therefore use a definition which allows all vehicles to be included in the fleet average ''using a representative footprint based on the physical vehicle, not a footprint based on a moving target of sales.'' The Alliance, and Ford individually, stated that specifying that base tire (and thus footprint measurement) could vary by vehicle configuration was ''confusing'' because footprint is a physical measurement and unrelated to vehicle configuration, which the manufacturers implied was a defined term for purposes of fuel economy. The Alliance and Ford requested that NHTSA adopt EPA's definition of ''base tire,'' Global Automakers requested that NHTSA and EPA simply adopt the same definition of ''base tire,'' and Hyundai supported NHTSA's proposed definition. Additionally, the Alliance warned that a decision by NHTSA to adopt its proposed definition could impact manufacturer acceptance of the final standards, since all manufacturers had assessed their ability to comply with the standards in July 2011 based on their own interpretation and understanding of what base tire means.

In response, again, any changes to NHTSA's definition for base tire are in the interest of ensuring consistency in how manufacturers' compliance obligations are determined, to boost the predictability and fairness of the program. With respect to the comments on determining a base tire for each vehicle configuration, NHTSA agrees that the factors defining a vehicle configuration (engine, transmission, fuel system, axle ratio and inertial weight) may not necessarily define a unique footprint. For example, it is possible for a single ''vehicle configuration'' to contain all cab/bed/wheelbase variations of a pick-up truck, from a standard cab with a short wheelbase to a crew cab with a long bed and long wheelbase. In this example, one vehicle configuration can have multiple unique wheelbases and associated footprints. Thus, using ''vehicle configuration'' in the definition of base tire does not clearly address the agency's interest in maximizing consistency, because if a vehicle configuration includes multiple footprints, it is not clear which footprint a manufacturer should use for designating the base tire associated with that configuration, nor is it clear how the other footprints would be incorporated into the manufacturer's calculation of its compliance obligation. NHTSA will therefore be removing the concept of vehicle configuration from its definition for base tire.

NHTSA also agrees with the commenters' theme that in order to be most effective, a definition for base tire must be related to footprint. If ''vehicle configuration'' in the CAFE context is not particularly related to footprint, and thus to base tire, perhaps another term is better related. Since the NPRM, NHTSA has analyzed base tires and the related footprint dimensions submitted by manufacturers in their pre-model year (PMY) reports[1391] for model years 2011 and 2012. We have observed that some manufacturers provided wheelbase, front and rear track width, and footprint values in these reports using the calculation sheet provided to them by EPA in September 2010 (hereafter referenced as the EPA calculator). EPA, with input from NHTSA, developed the EPA calculator for manufacturers' and agency use in calculating the footprint-based fuel economy standard (required mpg value) for manufacturers' CAFE fleets when submitting end-of-year data to EPA.[1392] The majority of manufacturers that did not submit PMY information on the EPA calculator used a format substantially similar to it, some for unique model types and others by unique vehicle configurations. In either case, the information submitted by manufacturers specified, at a minimum, the carline, basic engine, and transmission class associated with each footprint. These parameters match EPA's definition of ''model type,'' which means a unique combination of car line, basic engine, and transmission class.[1393] Thus, while ''vehicle configuration'' may not

[1389] *See* 49 CFR 523.2.

[1390] For reference, EPA currently defines ''base tire'' as the ''tire specified as standard equipment by the manufacturer.'' 40 CFR 600.002. It further defines ''standard equipment'' as ''those features or equipment which are marketed on a vehicle over which the purchaser can exercise no choice.'' 40 CFR 86.1803–01. In the NPRM, EPA noted that some manufacturers may be applying this base tire definition in different ways, which could lead to differences across manufacturers in how they are calculating footprint values, and thus compliance obligations. EPA further noted NHTSA's proposal to change its definition for base tire in 49 CFR 523.2, and sought comment on whether EPA should change its definition for base tire as well. *See* 76 FR 75088–89.

[1391] *See* 49 CFR 537.7.

[1392] EPA has also prepared a similar calculator for GHG standards that are similarly based on all unique footprints of vehicles in each fleet.

[1393] ''Transmission class,'' in turn, includes transmission type, *e.g.,* manual, automatic, or semi-automatic; number of forward gears used in fuel economy testing; drive system, *e.g.,* front wheel drive, rear wheel drive, four wheel drive; torque converter type, if applicable; etc. *See* 40 CFR 600.002.

necessarily define a unique footprint, it appears that manufacturers understand and are capable of using ''model type'' as a way to define groups of vehicles with unique footprints, and that ''model type'' can be used for determining fleet-specific compliance obligations.

With respect to the comments objecting to NHTSA's proposal to tie the ''base tire'' definition to the vehicle configuration of the ''highest production sales volume,'' the agency does not believe that using the highest tire sales volume to select base tires creates any more difficulty for manufacturers when the supply and volume of other vehicle components, or vehicles themselves, can unexpectedly change throughout the model year. As with any other model year, unexpected or adjusted volume level changes could have an impact on reported base tires and fleet average standard calculations which we would expect to be revised accordingly in a manufacturer's final year-end report.

However, in considering the issue further, NHTSA recognizes that utilizing the highest production sales volume tire instead of ''the tire used as standard equipment'' may lead to standards *not* derived from each unique footprint within a manufacturer's fleet but rather derived only from those footprints associated with the highest production tire. The Alliance stated that all vehicles should be included in the fleet average using a representative footprint based on the physical vehicle, not a footprint based on a moving target of sales. It appears that the Alliance is suggesting that the agency remove the link between footprint and base tire but is not clear as to its intent. The agency does not disagree with the concept of using representative vehicles to calculate a manufacturer's fleet average standard, as long as each unique footprint and base tire combination is included when calculating each fleet average standard. Otherwise, the agency does not see how to ensure consistency, and thus predictability and fairness, in how footprint values are calculated, and thus in how compliance obligations are calculated.

As mentioned, the Alliance and GM suggested that the agency defer the decision on changing the base tire definition until further analysis and discussions with industry could take place. The Alliance explained that various options exist and stated that each one had its own risks, but did not provide any details or recommendations. The Alliance argued that changing the definition now could create a rule that would not be acceptable by some manufacturers because any change could negatively impact fleet standard projections. GM also commented that additional time be taken to make any decisions in order to minimize the potential for any unnecessary complications and unintended consequences resulting from revising the definition. Global, Ford and Toyota stated that the agencies should harmonize any final definitions. The agency agrees with manufacturers that it should move in the direction of harmonization with EPA on the base tire definition. We also agree with manufacturers that the agency should evaluate all the potential risks on fleet standards associated with the available options manufacturers have for selecting base tires. The agency believes that a proper evaluation of the various options will require additional time and effort beyond the scope of this rulemaking.

For this final rule, the agency has decided to modify the NPRM base tire definition by removing the terms ''highest production sales volume'' and ''vehicle configuration'' in response to the concerns raised by commenters. In addition, to align the definition more closely with EPA's, we have added back the term ''standard equipment.'' For clarification purposes, we are adding language to ensure that manufacturers provide a base tire size for each combination of a vehicle's footprint and model type.

For the final rule, the definition for base tire will therefore be as follows: ''the tire size specified as standard equipment by the manufacturer on each unique combination of a vehicle's footprint and model type.'' For purposes of harmonization, EPA is adopting this same definition in its final rule (see preamble section III.E.10 and 40 CFR 600.002). Standard equipment would mean those features or equipment which are marketed on a vehicle over which the purchaser can exercise no choice, in accordance with the EPA definition in 40 CFR 86.1803–01. NHTSA believes these changes will harmonize both agencies' definitions and will allow manufacturers to use the same approach for calculating attribute-based standards for NHTSA's Parts 531 and 533 and EPA's GHG programs. In addition, each unique footprint and model type combination must be used to calculate a manufacturer's target and fleet standards. Therefore, NHTSA expects manufacturers to report these projected values in their PMY reports. These revised reporting requirements for base tire are a part of the provisions that are being finalized in the following section. Allowing manufacturers to group and report vehicles within a model type by similar footprints reduces the burden that would otherwise exist by having to identify the multiple ''vehicle configurations'' that exist within each model type. As such, manufacturers can submit the EPA calculator, or similar formatted data as specified in Part 537.7, with an additional column reporting the base tire sizes for each table line entry.

NHTSA does not believe that this definition represents any material change in the reporting requirements already present in the CAFE program. Manufacturers are already required to report base tires under Part 537 beginning in MY 2010, and have been required to calculate their footprint values since model year 2008 for light trucks, optionally,[1394] and then mandatory for both passenger cars and light trucks in model year 2011.[1395] Moreover, since EPA already uses ''model type'' as a basis for calculating footprint for the GHG program, this change to the definition for base tire should enhance harmonization between the programs and reduce manufacturer reporting burden, insofar as the submissions to both agencies should better encompass identical information. And finally, allowing manufacturers to group and report vehicles within a model type by similar footprints would reduce the burden that would otherwise exist by having to identify the multiple ''vehicle configurations'' that exist within each model type. As such, manufacturers can submit the EPA calculator, or similar formatted data as specified in Part 537.7, with an additional column reporting the base tire sizes for each table line entry. NHTSA believes these changes provide a clear definition for footprint calculations and, thus, fleet compliance projections, calculations, finalizations and enforcement efforts.

d. Confirming Target and Fleet Standards

As discussed in the NPRM, because Part 537 as currently written requires only a breakdown of footprint values by vehicle configurations rather than by each unique model type and footprint combination, NHTSA is currently unable to verify manufacturers' reported target standards. To remedy that, the agency proposed to harmonize the NHTSA and EPA reporting requirements relating to the derivation of a manufacturer's fleet standards. The agency proposed to accomplish this by relocating paragraphs

[1394] The final rule was published on April 6, 2006. *See* 71 FR 17566.

[1395] The final rule was published on March 30, 2009. *See* 74 FR 14196, per 49 U.S.C. § 32902(b)(3).

537.7(c)(4)(xvi)(A)(3) through (6) and (B)(3) through (6), to a revised paragraph 537.7(b)(3). NHTSA sought comments on these proposed changes.

Because no comments were received on this issue, and because NHTSA continues to believe that the change will be beneficial, NHTSA is finalizing the proposal as specified with one addition. To harmonize further with EPA and standardize the data content and format that can be submitted to both agencies, NHTSA is adding an optional requirement, shown below in the regulatory text for paragraphs § 537.7(b)(3)(i)(E) and (ii)(E), for manufacturers to provide the calculated target standard along with each required unique model type and footprint combination listing used to calculate the fleet standard. This information would be beneficial to NHTSA for assisting in the validation of the manufacturer's calculated fleet standards, and the agency believes that optionally requesting this information in Part 537 does not constitute a material change to the existing reporting requirements and should require no additional work on the part of manufacturers, because this information will already be submitted to EPA. If manufacturers choose not to provide this optional data to NHTSA along with the related required data, NHTSA may consider changing this to a mandatory requirement in a future rulemaking.

e. Public Reporting

Several commenters in response to the NPRM requested that NHTSA consider expanding the amount of CAFE information it provides to the public each year. NACAA commented that once the program is in place, it is critical that agencies closely track the progress of manufacturers in meeting standards. NRDC stated that EPA and NHTSA should create greater public transparency by annually publishing data on each manufacturer's credit status and technology penetration rates to ensure greater public confidence in the program's effectiveness. NRDC further commented that the agencies should publish an annual public report that includes at a minimum the following for each manufacturer's passenger car and light truck fleets: the amount of cumulative credits or deficits; the amount of transfers; the amount of traded credits and the name of the receiving party; the amount of credits generated from A/C, pickup credits, dedicated and dual fuel, and off-cycle.

UCS commented that the agencies could further improve transparency by having a clear public accounting of credits and program compliance explaining that over the years it has been exceedingly difficult to independently verify whether manufacturers are compliant with their CAFE obligations. Given the numerous compliance flexibility mechanisms being proposed by the agencies as well as a multitude of opportunities for trading, transferring, banking, and borrowing of credits, USC believes that it is critical that manufacturers' compliance ledgers be documented, publicly available, and sufficiently granular to assess by which measures companies are complying with the regulations. USC urged the agencies to undertake an effort to provide clear public accounting of credits and program compliance. UCS also stated that in order for it and other public interest groups to effectively assess industry compliance and behavior, the agencies should expand the public availability and quality of disaggregated vehicle data. Because of the new attribute-based standards, USC argued that it is critical that sub-model level data be regularly published that includes not only fuel economy and greenhouse gas emissions performance specifications, but at a minimum, finalized sales, vehicle footprint, regulatory vehicle classification, and other listed technical data. Additional comments similar to USC were also received from the Sierra Club. Sierra Club requested that public information for model years 2017 to 2025 be expanded to include enough detail to sufficiently assess manufacturers' credits balances and activities, compliance margins and vehicle model type characteristics and performance.

In response to the commenters' requests to increase the transparency of CAFE compliance data, we are continuing to consider this issue as we develop the new CAFE database discussed above. We also note that as part of the MY 2011 CAFE final rule, NHTSA issued 49 CFR part 536 to implement a new CAFE credit trading and transfer program as authorized by EISA. In Paragraph 536.5(e) of the regulation, NHTSA adopted new provisions for periodically publishing the names and credit holdings of all credit holders. Credit holdings will include a manufacturer's credit balance accounting for all transferred and traded credit transactions which have occurred over a specified transaction period. NHTSA plans to make manufacturer's credit balances available to the public on the NHTSA Web site before the end of calendar year 2012.

NHTSA also already publishes a report on its Web site titled, ''The Summary of Fuel Economy Report,'' which provides a bi-annual status report on CAFE fleet standards, performance values and production volumes by manufacturer, and makes manufacturers' pre-model and mid-model year CAFE reports publicly available at the end of each current calendar year in dockets at *http://www.regulations.gov*. Starting in model year 2017, and as detailed in the next section, manufacturers' CAFE reports will also be required to contain most of the information requested by NRDC such as the amount of the incentive gained by a manufacturer in its fleet average performance as generated by A/C, full size pickup trucks, dedicated and dual fuel, and off-cycle technology improvements. Finally, manufacturers' CAFE reports also already address USC's concerns for providing information sufficiently granular enough to assess the measure by which companies will comply with regulations and provides the information on a vehicle configuration level which addresses USC's and Sierra Club's requests for model type information.

f. Additional Enforcement Issues

The agency proposed in the NPRM to add requirements in 537.7(c)(4) for manufacturers to report air conditioning efficiency, full-size pickup truck and off-cycle technology improvements used to acquire the incentives in 40 CFR 86.1866, and the amount of each incentive. As proposed, the technology credits or incentives would need to be reported for each vehicle configuration making up the model types used to determine a manufacturer's fleet average performance.

Ford argued that these particular types of vehicle characteristics—those necessary to earn fuel economy adjustment values for air conditioning efficiency, full-size pickup truck and off-cycle technology improvements—will not vary by fuel economy configuration and will likely only vary by vehicle line. Ford requested instead that manufacturers be allowed to delineate the credit applicability specifically, as needed, but for cases where credits apply across a much broader section of vehicles, manufacturers should be allowed to report on that level rather than being required to report at the vehicle configuration level.

Upon further consideration, NHTSA agrees that these technology improvements likely need not be specified at the vehicle configuration level because the fuel economy adjustment incentive is derived based upon the technology and is not necessarily affected by being applied to any particular vehicle based upon vehicle configuration or model type. The important information that NHTSA seeks to receive is what air conditioning, off-cycle and hybrid technologies are being used, what the adjustment incentive is (gallons/mile) for each technology, and the number of vehicles in the fleet using the respective technology. These adjustment incentives form the inputs to adjust the manufacturer's fleet CAFE values in accordance with the equations in 40 CFR 600.510–12, and manufacturers must also submit this adjusted CAFE value to NHTSA. Therefore, for the final rule, we plan to move the provisions proposed in section (c)(4)(xvi), (xvii) and (xviii) into a new section numbered (c)(7) and require manufacturers to report their technologies by vehicle make and model types. Manufacturers will also be required to report their adjusted fleet average performance values and other required information used in the equation specified in 40 CFR 600.510–12(c)(1).

J. Record of Decision

This final rule constitutes the Record of Decision (ROD) for NHTSA's final rule for CAFE standards for model years 2017 and beyond, pursuant to the National Environmental Policy Act (NEPA) and the Council on Environmental Quality's (CEQ) implementing regulations.[1396] *See* 40 CFR 1505.2.

As required by CEQ regulations, this ROD sets forth the following: (1) The agency's decision; (2) alternatives considered by NHTSA in reaching its decision, including the environmentally preferable alternative; (3) the factors balanced by NHTSA in making its decision, including considerations of national policy; (4) how these factors and considerations entered into its decision; and (5) the agency's preferences among alternatives based on relevant factors, including economic and technical considerations and agency statutory missions. This ROD also briefly addresses mitigation.

1. The Agency's Decision

In the Draft Environmental Impact Statement (Draft EIS) and the Final Environmental Impact Statement (Final EIS), the agency identified a Preferred Alternative, labeled as Alternative 3. As NHTSA noted in the Final EIS, under the Preferred Alternative, on an mpg basis, the estimated annual increases in the average required fuel economy levels between MYs 2017 and 2021 average 3.8 to 3.9 percent for passenger cars and 2.5 to 2.7 percent for light trucks. The estimated annual increases in the average required fuel economy levels set forth for MYs 2022–2025—also on an mpg basis—are assumed to average 4.7 percent for passenger cars and 4.8 to 4.9 percent for light trucks.[1397] After carefully reviewing and analyzing all of the information in the public record, the Final EIS, and public and agency comments submitted on the EIS and the NPRM, NHTSA has decided to finalize the Preferred Alternative.

2. Alternatives NHTSA Considered in Reaching its Decision

When preparing an EIS, NEPA requires an agency to compare the potential environmental impacts of its proposed action and a reasonable range of alternatives. In the Draft and Final EIS, NHTSA analyzed a No Action Alternative and three action alternatives. The action alternatives represent a range of potential actions the agency could take. The environmental impacts of these alternatives, in turn, represent a range of potential environmental impacts that could result from NHTSA's chosen action in setting maximum feasible fuel economy standards for light duty vehicles.

The No Action Alternative in the Draft and Final EIS assumes that NHTSA would not issue a rule regarding CAFE standards for MY 2017–2025 passenger cars and light trucks; rather, the No Action Alternative assumes that NHTSA's latest CAFE standards (the MY 2016 fuel economy standards, issued in conjunction with EPA's MY 2016 GHG standards) would continue indefinitely. This alternative provides an analytical baseline against which to compare the environmental impacts of the other alternatives presented in the EIS.[1398] NEPA expressly requires agencies to consider a ''no action'' alternative in their NEPA analyses and to compare the effects of not taking action with the effects of action alternatives in order to demonstrate the environmental effects of the action alternatives. The No Action Alternative assumes that average fuel economy levels and GHG emissions performance in the absence of the agencies' action would equal what manufacturers would achieve without additional regulation.

For the EIS, in addition to the No Action Alternative, NHTSA analyzed a range of action alternatives with fuel economy stringencies that increased on average 2 percent to 7 percent annually from the MY 2016 standards for passenger cars and for light trucks. As NHTSA noted in the Final EIS, the agency believes that, based on the different ways the agency could weigh EPCA's four statutory factors, the ''maximum feasible'' level of CAFE stringency falls within this range.

Throughout the Final EIS, estimated impacts were shown for three action alternatives that illustrate this range of average annual percentage increases in fuel economy: a 2 percent per year average increase in stringency for both passenger cars and light trucks (Alternative 2); the Preferred Alternative with annual percentage increases in stringency for passenger cars and for light trucks that, on average, fall between the 2 percent and 7 percent per year increases (Alternative 3); and a 7 percent per year average increase in stringency for both passenger cars and light trucks (Alternative 4).

Alternatives 2 and 4 were intended to provide the lower and upper bounds of a reasonable range of alternatives. In the EIS, the agency provided environmental analyses of these points to enable the decisionmaker and the public to determine the environmental impacts of points that fall between Alternatives 2 and 4. The action alternatives evaluated in the EIS therefore provided decisionmakers with the ability to select from a wide variety of other potential alternatives with stringencies that increase annually at average percentage rates between 2 and 7 percent. This includes, for example, alternatives with stringencies that increase at different rates for passenger cars and for light trucks and stringencies that increase by different rates in different years. For a discussion of the environmental impacts associated with the alternatives, *see* Chapters 3–7 of the Final EIS.

[1396] NEPA is codified at 42 U.S.C. 4321–47. CEQ NEPA implementing regulations are codified at 40 Code of Federal Regulations (CFR) Parts 1500–08.

[1397] Because the standards are attribute-based, average required fuel economy levels, and therefore rates of increase in those averages, depend on the future composition of the fleet, which is uncertain and subject to change. The target curves identified as the Preferred Alternative and analyzed in the Final EIS are the same as those that defined the Preferred Alternative in the Draft EIS and outlined as the proposal in the NPRM. They are also the same as those being finalized by NHTSA in this final rule.

[1398] *See* 40 CFR 1502.2(e), 1502.14(d). CEQ has explained that ''[T]he regulations require the analysis of the no action alternative even if the agency is under a court order or legislative command to act. This analysis provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of the action alternatives. [*See* 40 CFR 1502.14(c).] * * * Inclusion of such an analysis in the EIS is necessary to inform Congress, the public, and the President as intended by NEPA. [*See* 40 CFR 1500.1(a).]'' Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 FR 18026 (Mar. 23, 1981).

The Final EIS recognizes the unique uncertainties inherent in projecting the makeup of the U.S. vehicle fleet far into the future. In order to take account of uncertainties regarding the future vehicle fleet, and how manufacturers would respond to increased fuel economy standards in the future, the Final EIS presents the potential environmental impacts for each of the alternatives using two different assumptions regarding market-driven fuel economy improvements and two different sets of fleet-characteristic assumptions. *See* Sections 2.2.1 and 2.2.2 of the Final EIS for a detailed discussion of NHTSA's assumptions.

3. NHTSA's Environmental Analysis, Including Consideration of the Environmentally Preferable Alternative

NHTSA's environmental analysis indicates that Alternative 4 is the overall Environmentally Preferable Alternative because it would result in the largest reductions in fuel use and GHG emissions among the alternatives considered. Under each action alternative the agency considered, the reduction in fuel consumption resulting from higher fuel economy causes emissions that occur during fuel refining and distribution to decline. For most of these pollutants, this decline is more than sufficient to offset the increase in tailpipe emissions that results from increased driving due to the fuel efficiency rebound effect, leading to a net reduction in total emissions from fuel production, distribution, and use. Because it leads to the largest reductions in fuel refining, distribution, and consumption among the alternatives considered, Alternative 4 would also lead to the lowest total emissions of CO_2 and other GHGs, as well as most criteria air pollutants and mobile source air toxics (MSATs).

Alternative 4 would lead to the greatest reduction of CO_2 and N_2O emissions compared to the other action alternatives, including the Preferred Alternative. Thus, emissions of these GHGs would be lower under Alternative 4 than under each of the other action alternatives throughout the analysis period, regardless of the assumptions used (e.g. fleet characteristics and fuel economy under the No Action Alternative). While the pattern of CH_4 emissions among the alternatives is more complicated and changes over time, emissions of CH_4 under Alternative 4 would rise compared to the No Action Alternative after about 2050, depending on the assumptions used, due to increases in tailpipe emissions resulting from the fuel efficiency rebound effect and from increased use of diesel-fueled vehicles. However, this slight increase in CH_4 would be vastly outweighed by much larger decreases in CO_2 emissions on a global warming potential-weighted basis. Alternative 4 would lead to a reduction of global atmospheric CO_2 concentrations in 2100 of up to 0.5 percent, a reduction in global mean surface temperatures of up to 0.5 percent, and a reduction in sea-level rise of up to 0.4 percent from their respective levels under the No Action Alternative.

For toxic air pollutants, results are mixed. Alternatives 3 and 4 are the Environmentally Preferable Alternatives depending on the pollutant and assumptions used. The greatest reductions in emissions of benzene and 1,3-butadiene occur under Alternative 4 in later analysis years. The greatest reductions in diesel particulate matter (DPM) occur under Alternative 3 (the Preferred Alternative) in later analysis years. Under all action alternatives, emissions of acetaldehyde, acrolein, and formaldehyde would generally increase in later years, depending on the assumptions used. These emissions increases are mainly due to the fuel efficiency rebound effect, which more than offsets emission reductions from decreased fuel usage. Under different assumptions, the fuel efficiency rebound effect would not fully offset emissions reductions from decreased fuel usage, and emissions of these pollutants would instead decrease.

For criteria pollutants, the greatest relative reductions in emissions compared to the No Action Alternative occur under Alternative 4 for CO, $PM_{2.5}$, and VOCs, for which emissions related to light duty vehicles decrease by as much as 26 percent by 2060. Emissions of NO_X and SO_2 related to the use of light duty vehicles are an exception in later analysis years. For those criteria pollutants in later analysis years, NHTSA's analysis indicates that Alternative 3 is generally the Environmentally Preferable Alternative because it leads to the largest reductions in NO_X and SO_2.

At the time the analysis for the Final EIS was performed, EIA's final version of AEO 2012 was not yet released. The AEO 2012 Early Release Reference Case, used for the criteria air pollutant results described above, did not account for new standards for power plants, which are expected to result in substantial reductions of emissions of some air pollutants discussed in the air quality chapter.

As we stated in the Final EIS, NHTSA believes it is reasonable to consider an additional analysis assuming steady improvements to the electrical grid during the course of the next several decades—the period during which any EV deployment associated with this program would occur. In the Final EIS, NHTSA performed an additional air quality analysis in order to take into account changes to the efficiency of power plants and the mix of fuel sources used. Emissions and other environmental impacts from electricity production depend on the efficiency of the power plant and the mix of fuel sources used, sometimes referred to as the ''grid mix.'' In the United States, the current grid mix is composed of coal, nuclear, natural gas, hydroelectric, oil, and renewable energy resources, with the largest single source of electricity being from coal. As a result of EPA's Acid Rain Program, the Clean Air Interstate Rule, the recent Mercury and Air Toxics Standards, and general advances in technology, emissions from the power-generation sector are expected to decline over time. Low natural gas prices and higher coal prices, as well as slower growth in electrical demand, are currently resulting in a shift away from coal-based electricity generation. Together, these trends suggest a future grid mix that is likely to produce lower upstream emissions per unit of electricity used to charge EVs than the NEMS AEO 2012 Early Release-based 2020 projection, especially in terms of reductions in criteria pollutant emissions.

Under the cleaner grid mix analyzed in the EIS,[1399] the greatest relative reductions in emissions of criteria pollutants related to the use of light duty vehicles occur under Alternative 4 for CO, $PM_{2.5}$, and VOCs, for which emissions decrease by as much as 26 percent by 2060 compared to the No Action Alternative. For SO_2 and NO_X, the greatest emissions reductions generally occur under Alternative 3. Under Alternative 4, emissions of SO_2 and NO_X either increase or decrease compared to the No Action Alternative, depending upon assumptions used. Any increase in emissions of these pollutants is smaller than increases that occur under Alternative 4 for the analysis described above.

EIA's final version of AEO 2012, which accounts for new EPA standards for power plants such as the Mercury and Air Toxics Standards, projects

[1399] NHTSA analyzed the ''GHG Price, Economy-wide'' case from AEO 2011, which assumes future carbon trading. This scenario assumes high levels of natural gas and renewables for electricity generation, with generation from coal-fired power plants reduced to 21 percent from the EIA projected 2020 contribution of 40 percent used in the main analysis.

nearly a 75 percent decrease in SO_2 emissions and a 14 percent reduction in NO_X from the electric power sector in the 2010–2015 timeframe. EIA's Short-term Energy Outlook for July 2012 shows that coal was responsible for nearly 50 percent of U.S. electrical generation in 2005, and is projected to fall to an average of less than 37 percent for 2012, which will also contribute to a reduction in these emissions. The full AEO 2012 projects coal accounting for 38 percent of total U.S. electricity generation by 2035, and natural gas accounting for 28 percent. As EIA notes in AEO 2012, the decrease in coal's generation is mostly offset by growth in natural gas and renewable energy. Like the cleaner grid mix analyzed in the Final EIS, EIA's updated projections indicate a cleaner future grid with lower upstream emissions per unit of electricity generated.

For more detailed discussion of the environmental impacts associated with the alternatives, *see* Chapters 3 through 7 of the Final EIS. For detailed results of NHTSA's Alternate Grid Mix Case, *see* Appendix H of the Final EIS.

4. Factors Balanced by NHTSA in Making Its Decision

For discussion of the factors balanced by NHTSA in making Its decision, *see* Sections IV.D and IV.F of this final rule.

5. How the Factors and Considerations Balanced by NHTSA Entered Into Its Decision

For discussion of how the factors and considerations balanced by the agency entered into NHTSA's Decision, *see* Section IV.F of this final rule.

6. The Agency's Preferences among Alternatives Based on Relevant Factors, Including Economic and Technical Considerations and Agency Statutory Missions

For discussion of the agency's preferences among alternatives based on relevant factors, including economic and technical considerations, *see* Section IV.F of this final rule.

7. Mitigation

The CEQ regulations specify that a ROD must ''state whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not.'' 40 CFR 1505.2(c). The majority of the environmental effects of NHTSA's action are positive, *i.e.,* beneficial environmental impacts, and would not raise issues of mitigation. Emissions of criteria and toxic air pollutants are generally projected to decrease under the final standards under all analysis years as compared to their levels under the No Action Alternative. Analysis of the environmental trends reported in the Final EIS for the Preferred Alternative indicates that the only exceptions to this decline are emissions of CO, acetaldehyde, acrolein, and 1,3-butadiene, and emissions of SO_2 and formaldehyde in some analyses and years. *See* Chapter 4 of the Final EIS. The agency forecasts these emissions increases because, under all the alternatives analyzed in the EIS, increase in vehicle use due to improved fuel efficiency is projected to result in growth in total miles traveled by light duty vehicles. The growth in VMT outpaces emissions reductions for some pollutants, resulting in projected increases for these pollutants. In addition, as described above, NHTSA's NEPA analysis predicted increases in emissions of air toxic and criteria pollutants under certain alternatives based on assumptions about the type of technologies manufacturers will use to comply with the standards and the resulting rate and type of emissions.

NHTSA's authority to promulgate new fuel economy standards is limited and does not allow regulation of criteria pollutant from vehicles or of factors affecting those emissions, including driving habits. Consequently, NHTSA must set CAFE standards but is unable to take steps to mitigate the impacts of these standards. Chapter 8 of the Final EIS outlines a number of other initiatives across the government that could ameliorate the environmental impacts of motor vehicle use, including the use of light duty vehicles.

K. 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 CAFE standards promulgated in this final rule will be economically significant if adopted. Accordingly, OMB reviewed the rule under Executive Order 12866. The rule is also significant within the meaning of the Department of Transportation's Regulatory Policies and Procedures.

The benefits and costs of this proposal are described above. Because the rule is economically significant under both the Department of Transportation's procedures and OMB guidelines, the agency has prepared a Final Regulatory Impact Analysis (FRIA) and placed it in the docket and on the agency's Web site. Further, pursuant to Circular A–4, we have prepared a formal probabilistic uncertainty analysis for this final rule. The circular requires such an analysis for complex rules where there are large, multiple uncertainties whose analysis raises technical challenges or where effects cascade and where the impacts of the rule exceed $1 billion. This final rule meets these criteria on all counts.

2. National Environmental Policy Act

Under NEPA, a Federal agency must prepare an EIS on proposals for major Federal actions that significantly affect the quality of the human environment.[1400] The purpose of an EIS is to inform decisionmakers and the public of the potential environmental impacts of a proposed action and reasonable alternative actions the agency could take.[1401] The EIS is used by the agency, in conjunction with other relevant material, to plan actions and make decisions. To inform its development of the final CAFE standards, NHTSA prepared a Draft and a Final EIS, which analyze, disclose, and compare the potential environmental impacts of a reasonable range of action alternatives, including a Preferred Alternative,[1402] pursuant to Council on Environmental Quality (CEQ) NEPA implementing regulations,

[1400] 40 CFR 1502.3.

[1401] 40 CFR 1502.1.

[1402] The Preferred Alternative in the Final EIS is equivalent to the action the agency is adopting in this final rule.

DOT Order 5610.1C, and NHTSA regulations.[1403] The Final EIS analyzes direct, indirect, and cumulative impacts, and discusses impacts in proportion to their significance. For more detailed discussion of the environmental impacts analyzed, *see* the Final EIS and Final EIS Summary, available at Docket No. NHTSA–2011–0056 and on the agency's Web site at *http://www.nhtsa.gov/fuel-economy*.

The Final EIS quantitatively and qualitatively analyzes the potential environmental impacts of a range of alternative CAFE standards on fuel and energy use, air quality, and global climate change. The Final EIS also qualitatively describes potential environmental impacts to a variety of other resources including land use and development, hazardous materials and regulated wastes, historic and cultural resources, noise, and environmental justice.

CEQ regulations emphasize agency cooperation early in the NEPA process and allow a lead agency (in this case, NHTSA) to request the assistance of other agencies that either have jurisdiction by law or have special expertise regarding issues considered in an EIS.[1404] NHTSA invited EPA to be a cooperating agency in the preparation of the EIS because of its special expertise in the areas of climate change and air quality.

In preparing the Final EIS, NHTSA took a number of steps to ensure public involvement. On May 10, 2011, NHTSA published a notice of intent to prepare an environmental impact statement for new CAFE standards, requesting comment on the scope of the agency's analysis.[1405] On November 25, 2011, EPA published a Notice of Availability of the Draft EIS for the new proposed CAFE standards.[1406] NHTSA requested public input on the agency's Draft EIS by January 31, 2012; publication of the Notice of Availability triggered the Draft EIS public comment period. NHTSA mailed (both electronically and through regular U.S. mail) over 1,000 copies of the Draft EIS to stakeholders and interested parties, including Federal, State, and local officials and agencies; elected officials, environmental and public interest groups; Native American tribes; and other interested organizations and individuals. NHTSA and EPA held joint public hearings on the Draft EIS and NPRM on January 17, 2012, in Detroit, Michigan; on January 19, 2012, in Philadelphia, Pennsylvania; and on January 24, 2012, in San Francisco, California.

NHTSA received thousands of written and oral comments to the NPRM and the Draft EIS. The transcripts from the public hearings and written comments submitted to NHTSA are part of the administrative record and are available on the Federal Docket, available online at *http://www.regulations.gov*, Reference Docket Nos. NHTSA–2011–0056 and NHTSA–2010–0131. NHTSA reviewed and analyzed all relevant comments received during the public comment period and revised the Final EIS in response to comments where appropriate.[1407] For a more detailed discussion of the comments NHTSA received, *see* Section 1.5 of the Draft EIS and Chapter 9 of the Final EIS.

On July 9, 2012, NHTSA submitted the Final EIS to EPA, in accordance with CEQ NEPA implementing regulations.[1408] On that day, NHTSA also posted the Final EIS on its Web site, *http://www.nhtsa.gov/fuel-economy*, and notified over 1,000 stakeholders and interested parties about its availability (both electronically and through regular U.S. mail). On July 13, 2012, EPA published a Notice of Availability of the Final EIS in the **Federal Register**. *See* 77 FR 41403 (July 13, 2012).

In developing the CAFE standards adopted in this final rule, NHTSA has been informed by the analyses contained in the *Final Environmental Impact Statement, Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2017–2025,* Docket No. NHTSA–2011–0056 (Final EIS). For purposes of this rulemaking, the agency referred to an extensive compilation of technical and policy documents available in NHTSA's EIS and rulemaking dockets and EPA's docket. NHTSA's EIS and rulemaking dockets and EPA's rulemaking docket can be found online at *http://www.regulations.gov*, Reference Docket Nos.: NHTSA–2011–0056 (EIS), NHTSA–2010–0131 (NHTSA rulemaking), and EPA–HQ–OAR–2010–0799 (EPA rulemaking).

Based on the foregoing, NHTSA concludes that the environmental analysis and public involvement process complies with NEPA implementing regulations issued by CEQ, DOT Order 5610.1C, and NHTSA regulations.

3. Clean Air Act (CAA) as Applied to NHTSA's Action

The CAA (42 U.S.C. § 7401) is the primary Federal legislation that addresses air quality. Under the authority of the CAA and subsequent amendments, EPA has established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants, which are relatively commonplace pollutants that can accumulate in the atmosphere as a result of normal levels of human activity. EPA is required to review each NAAQS every five years and to revise those standards as may be appropriate considering new scientific information.

The air quality of a geographic region is usually assessed by comparing the levels of criteria air pollutants found in the ambient air to the levels established by the NAAQS (taking into account, as well, the other elements of a NAAQS: averaging time, form, and indicator). Concentrations of criteria pollutants within the air mass of a region are measured in parts of a pollutant per million parts of air (ppm) or in micrograms of a pollutant per cubic meter ($\mu g/m^3$) of air present in repeated air samples taken by monitors using specified types of monitors. These ambient concentrations of each criteria pollutant are compared to the levels, averaging time, and form specified by the NAAQS in order to assess whether the region's air quality is in attainment with the NAAQS.

When the measured concentrations of a criteria pollutant within a geographic region are below those permitted by the NAAQS, the region is designated by the EPA as an attainment area for that pollutant, while regions where concentrations of criteria pollutants exceed Federal standards are called nonattainment areas (NAAs). Former NAAs that have attained the NAAQS are designated as maintenance areas. Each NAA is required to develop and implement a State Implementation Plan (SIP), which documents how the region will reach attainment levels within time periods specified in the CAA. In maintenance areas, the SIP documents how the State intends to maintain attainment with the NAAQS. When EPA revises a NAAQS, States must revise their SIPs to address how they will attain the new standard.

Section 176(c) of the CAA prohibits Federal agencies from taking actions in nonattainment or maintenance areas

[1403] NEPA is codified at 42 U.S.C. 4321–4347. CEQ NEPA implementing regulations are codified at 40 CFR Parts 1500–1508, and NHTSA's NEPA implementing regulations are codified at 49 CFR Part 520.

[1404] 40 CFR 1501.6.

[1405] Notice of Intent to Prepare an Environmental Impact Statement for New Corporate Average Fuel Economy Standards, 76 FR 26996 (May 10, 2011).

[1406] Notice of Availability of the Draft Environmental Impact Statement for New Corporate Average Fuel Economy Standards Model Year 2017–2025, 76 FR 72702, 72703 (Nov. 25, 2011).

[1407] The agency also changed the Final EIS as a result of updated information that became available after issuance of the Draft EIS.

[1408] 40 CFR § 1506.9.

that do not ''conform'' to the SIP. The purpose of this conformity requirement is to ensure that Federal activities do not interfere with meeting the emissions targets in the SIPs, do not cause or contribute to new violations of the NAAQS, and do not impede the ability to attain or maintain the NAAQS. EPA has issued two sets of regulations to implement CAA Section 176(c):

(1) The Transportation Conformity Rules (40 CFR Part 93, Subpart A), which apply to transportation plans, programs, and projects funded or approved under U.S.C. Title 23 or the Federal Transit Laws (49 U.S.C. Chapter 53). Projects funded by the Federal Highway Administration (FHWA) or the Federal Transit Administration (FTA) usually are subject to transportation conformity. See 40 CFR 93.102.

(2) The General Conformity Rules (40 CFR Part 93, Subpart B) apply to all other federal actions not covered under transportation conformity. The General Conformity Rule established emissions thresholds, or de minimis levels, for use in evaluating the conformity of a project. If the net emissions increases attributable to the project are less than these thresholds, then the project is presumed to conform and no further conformity evaluation is required. If the emissions increases exceed any of these thresholds, then a conformity determination is required. The conformity determination can entail air quality modeling studies, consultation with EPA and state air quality agencies, and commitments to revise the SIP or to implement measures to mitigate air quality impacts.

The final fuel economy standards are not funded or approved under Title 23 or the Federal Transit Act. Further, NHTSA's CAFE program is not a highway or transit project funded or approved by FHWA or FTA. Accordingly, this final rule is not subject to transportation conformity.

Under the General Conformity Rule, a conformity determination is required where a Federal action would result in total direct and indirect emissions of a criteria pollutant or precursor equaling or exceeding the rates specified in 40 CFR 93.153(b)(1) and (2) for nonattainment and maintenance areas. As explained below, NHTSA's action results in neither direct nor indirect emissions as defined in 40 CFR 93.152.

The General Conformity Rule defines direct emissions as those of ''a criteria pollutant or its precursors that are caused or initiated by the Federal action and originate in a nonattainment or maintenance area and occur at the same time and place as the action and are reasonably foreseeable.'' 40 CFR 93.152. Because NHTSA's action only sets fuel economy standards for light duty vehicles, it causes no direct emissions within the meaning of the General Conformity Rule.

Indirect emissions under the General Conformity Rule include emissions or precursors: (1) That are caused or initiated by the Federal action and originate in the same nonattainment or maintenance area but occur at a different time or place than the action; (2) that are reasonably foreseeable; (3) that the agency can practically control; and (4) for which the agency has continuing program responsibility. 40 CFR 93.152. Each element of the definition must be met to qualify as an indirect emission. NHTSA has determined that, for the purposes of general conformity, emissions that occur as a result of the fuel economy standards are not caused by NHTSA's action, but rather occur due to subsequent activities that the agency cannot practically control. ''[E]ven if a Federal licensing, rulemaking, or other approving action is a required initial step for a subsequent activity that causes emissions, such initial steps do not mean that a Federal agency can practically control any resulting emissions'' (75 *FR* 17254, 17260; 40 CFR 93.152). NHTSA cannot control vehicle manufacturers' production of vehicles and consumer purchasing and driving behavior. For the purposes of analyzing the environmental impacts of this action under NEPA, NHTSA has made assumptions regarding the technologies manufacturers will install and how companies will react to increased fuel economy standards. For example, NHTSA's NEPA analysis predicted increases in air toxic and criteria pollutants to occur in some nonattainment areas under certain alternatives based on assumptions about the rebound effect. However, NHTSA's rule does not mandate specific manufacturer decisions or driver behavior. NHTSA's NEPA analysis assumes a rebound effect, wherein the standards could create an incentive for additional vehicle use by reducing the cost of fuel consumed per mile driven. This rebound effect is an estimate of how NHTSA assumes some drivers will react to the rule and is useful for estimating the costs and benefits of the rule, but the agency does not have the statutory authority, or the program responsibility, to control the actual vehicle miles traveled by drivers. Accordingly, changes in air toxic and criteria pollutant emissions that result from NHTSA's fuel economy standards are not changes that the agency can practically control; therefore, this action causes no indirect emissions and a general conformity determination is not required.

4. National Historic Preservation Act (NHPA)

The NHPA (16 U.S.C. 470) sets forth government policy and procedures regarding ''historic properties''—that is, districts, sites, buildings, structures, and objects included in or eligible for the National Register of Historic Places (NRHP). *See also* 36 CFR Part 800. Section 106 of the NHPA requires federal agencies to ''take into account'' the effects of their actions on historic properties. The agency concludes that the NHPA is not applicable to NHTSA's Decision because it does not directly involve historic properties. The agency has, however, conducted a qualitative review of the related impacts of the alternatives on potentially affected resources, including historic and cultural resources. *See* Section 7.3 of the Final EIS. Executive Order 12898 (Environmental Justice)

Under Executive Order 12898, Federal agencies are required to identify and address any disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. Pursuant to this order, the Final EIS includes a qualitative analysis of the potential effects of the standards on minority and low-income populations. *See* Section 7.6 of the Final EIS.

5. Fish and Wildlife Conservation Act (FWCA)

The FWCA (16 U.S.C. 2900) provides financial and technical assistance to States for the development, revision, and implementation of conservation plans and programs for nongame fish and wildlife. In addition, the Act encourages all Federal agencies and departments to utilize their authorities to conserve and to promote conservation of nongame fish and wildlife and their habitats. The agency concludes that the FWCA is not applicable to NHTSA's Decision because it does not directly involve fish and wildlife.

6. Coastal Zone Management Act (CZMA)

The Coastal Zone Management Act (16 U.S.C. 1450) provides for the preservation, protection, development, and (where possible) restoration and enhancement of the nation's coastal zone resources. Under the statute, States are provided with funds and technical assistance in developing coastal zone management programs. Each participating State must submit its program to the Secretary of Commerce for approval. Once the program has been approved, any activity of a Federal agency, either within or outside of the coastal zone, that affects any land or water use or natural resource of the coastal zone must be carried out in a manner that is consistent, to the maximum extent practicable, with the enforceable policies of the State's program.

The agency concludes that the CZMA is not applicable to NHTSA's Decision because it does not involve an activity within, or outside of, the nation's coastal zones. The agency has, however, conducted a qualitative review of the related direct, indirect, and cumulative impacts, positive or negative, of the alternatives on potentially affected resources, including coastal zones. *See* Section 5.5 of the Final EIS.

7. Endangered Species Act (ESA)

Under Section 7(a)(2) of the ESA federal agencies must ensure that actions they authorize, fund, or carry out are ''not likely to jeopardize'' federally listed threatened or endangered species or result in the destruction or adverse modification of the designated critical habitat of these species. 16 U.S.C. 1536(a)(2). If a federal agency determines that an agency action may affect a listed species or designated critical habitat, it must initiate consultation with the appropriate Service—the U.S. Fish and Wildlife Service of the Department of the Interior and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service of the Department of Commerce, depending on the species involved—in order to ensure that the action is not likely to jeopardize the species or destroy or adversely modify designated critical habitat. *See* 50 CFR 402.14. Under this standard, the federal agency taking action evaluates the possible effects of its action and determines whether to initiate consultation. *See* 51 FR 19926, 19949 (Jun. 3, 1986).

NHTSA received one comment to the Draft EIS indicating that the agency should engage in consultation under Section 7 of the ESA when analyzing the overall impact of GHG emissions and other air pollutants. Pursuant to Section 7(a)(2) of the ESA, NHTSA has considered the effects of the proposed CAFE standards and has reviewed applicable ESA regulations, case law, and guidance to determine what, if any, impact there might be to listed species or designated critical habitat. NHTSA has considered issues related to emissions of CO_2 and other GHGs, and issues related to non-GHG emissions. Based on this assessment, NHTSA has determined that the agency's action of setting CAFE standards, which will result in nationwide fuel savings and which, consequently, will generally result in emissions reductions from what would otherwise occur in the absence of the CAFE standards, does not require consultation under Section 7(a)(2) of the ESA. For discussion of the agency's rationale, *see* page 9–101 of the Final EIS. Accordingly, NHTSA has concluded its review of this action under Section 7 of the ESA.

8. Floodplain Management (Executive Order 11988 and DOT Order 5650.2)

These Orders require Federal agencies to avoid the long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to restore and preserve the natural and beneficial values served by floodplains. Executive Order 11988 also directs agencies to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains through evaluating the potential effects of any actions the agency may take in a floodplain and ensuring that its program planning and budget requests reflect consideration of flood hazards and floodplain management. DOT Order 5650.2 sets forth DOT policies and procedures for implementing Executive Order 11988. The DOT Order requires that the agency determine if a proposed action is within the limits of a base floodplain, meaning it is encroaching on the floodplain, and whether this encroachment is significant. If significant, the agency is required to conduct further analysis of the proposed action and any practicable alternatives. If a practicable alternative avoids floodplain encroachment, then the agency is required to implement it.

In this rulemaking, the agency is not occupying, modifying and/or encroaching on floodplains. The agency, therefore, concludes that the Orders are not applicable to NHTSA's Decision. The agency has, however, conducted a review of the alternatives on potentially affected resources, including floodplains. *See* Section 5.5 of the Final EIS.

9. Preservation of the Nation's Wetlands (Executive Order 11990 and DOT Order 5660.1a)

These Orders require Federal agencies to avoid, to the extent possible, undertaking or providing assistance for new construction located in wetlands unless the agency head finds that there is no practicable alternative to such construction and that the proposed action includes all practicable measures to minimize harms to wetlands that may result from such use. Executive Order 11990 also directs agencies to take action to minimize the destruction, loss or degradation of wetlands in ''conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.'' DOT Order 5660.1a sets forth DOT policy for interpreting Executive Order 11990 and requires that transportation projects ''located in or having an impact on wetlands'' should be conducted to assure protection of the Nation's wetlands. If a project does have a significant impact on wetlands, an EIS must be prepared.

The agency is not undertaking or providing assistance for new construction located in wetlands. The agency, therefore, concludes that these Orders do not apply to NHTSA's Decision. The agency has, however, conducted a review of the alternatives on potentially affected resources, including wetlands. *See* Section 5.5 of the Final EIS.

10. Migratory Bird Treaty Act (MBTA), Bald and Golden Eagle Protection Act (BGEPA), Executive Order 13186

The MBTA provides for the protection of migratory birds that are native to the United States by making it illegal for anyone to pursue, hunt, take, attempt to take, kill, capture, collect, possess, buy, sell, trade, ship, import, or export any migratory bird covered under the statute. The statute prohibits both intentional and unintentional acts. Therefore, the statute is violated if an agency acts in a manner that harms a migratory bird, whether it was intended or not. *See, e.g., United States* v. *FMC Corp.,* 572 F.2d 902 (2nd Cir. 1978).

The BGEPA (16 U.S.C. 668) prohibits any form of possession or taking of both bald and golden eagles. Under the BGEPA, violators are subject to criminal and civil sanctions as well as an enhanced penalty provision for subsequent offenses.

Executive Order 13186, ''Responsibilities of Federal Agencies to Protect Migratory Birds,'' helps to further the purposes of the MBTA by requiring a Federal agency to develop a Memorandum of Understanding (MOU) with the Fish and Wildlife Service when it is taking an action that has (or is likely to have) a measurable negative impact on migratory bird populations.

The agency concludes that the MBTA, BGEPA, and Executive Order 13186 do not apply to NHTSA's Decision because there is no disturbance and/or take involved in NHTSA's Decision.

11. Department of Transportation Act (Section 4(f))

Section 4(f) of the Department of Transportation Act of 1966 (49 U.S.C. 303), as amended by Pub. Law 109–59, is designed to preserve publicly owned parklands, waterfowl and wildlife refuges, and significant historic sites. Specifically, Section 4(f) of the Department of Transportation Act provides that DOT agencies cannot approve a transportation program or project that requires the use of any publicly owned land from a significant public park, recreation area, or wildlife and waterfowl refuge, or any land from a significant historic site, unless a determination is made that:

(1) There is no feasible and prudent alternative to the use of land, and

(2) The program or project includes all possible planning to minimize harm to the property resulting from use, or

(3) A transportation use of Section 4(f) property results in a *de minimis* impact.

The agency concludes that Section 4(f) is not applicable to NHTSA's Decision because this rulemaking does not require the use of any publicly owned land.

12. 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 this final rule will not have a significant economic impact on a substantial number of small entities. The following is NHTSA's statement providing the factual basis for the certification (5 U.S.C. 605(b)).

The final rule directly affects 19 large single stage motor vehicle manufacturers.[1409] According to current information, the final rule 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 those presented 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, and that no comments were received on this issue, a regulatory flexibility analysis was not prepared.

13. 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.'' [1410] 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 and EPA consulted extensively with California and other states in the development of the proposal, and several state agencies provided comments to the proposed standards.

Additionally, in his January 26 memorandum, the President requested NHTSA to ''consider whether any provisions regarding preemption are consistent with the EISA, the Supreme Court's decision in *Massachusetts* v. *EPA* and other relevant provisions of law and the policies underlying them.'' Comments were received on this topic, but NHTSA is deferring consideration of the preemption issue. The agency believes that it is unnecessary to address the issue further at this time because of the consistent and coordinated Federal standards that will apply nationally under the National Program.

14. Executive Order 12988 (Civil Justice Reform)

Pursuant to Executive Order 12988, ''Civil Justice Reform,'' [1411] NHTSA has considered whether this rulemaking would have any retroactive effect. This final rule does not have any retroactive effect.

15. 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 2010 results in $136 million (111.000/81.606 = 1.36). 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-

[1409] 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.

[1410] 64 FR 43255 (Aug. 10, 1999).

[1411] 61 FR 4729 (Feb. 7, 1996).

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 final rule will not result in the expenditure by State, local, or tribal governments, in the aggregate, of more than $136 million annually, but it will result in the expenditure of that magnitude by vehicle manufacturers and/or their suppliers. In promulgating this final rule, NHTSA considered a variety of alternative average fuel economy standards lower and higher than those proposed. NHTSA is statutorily required to set standards at the maximum feasible level achievable by manufacturers based on its consideration and balancing of relevant factors and has concluded that the final fuel economy standards are the maximum feasible standards for the passenger car and light truck fleets for MYs 2012–2016 in light of the statutory considerations.

16. 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.

17. Executive Order 13045

Executive Order 13045 [1412] 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 final rule on children, and explain why the final regulation is preferable to other potentially effective and reasonably foreseeable alternatives considered by us.

As noted in Chapter 4 of NHTSA's Final EIS, the criteria pollutants assessed in the agencies have been shown to cause a range of adverse health effects at various concentrations and exposures, including: Damage to lung tissue, reduced lung function, exacerbation of existing respiratory and cardiovascular diseases, difficulty breathing, irritation of the upper respiratory tract, bronchitis and pneumonia, educed resistance to respiratory infections, alterations to the body's defense systems against foreign materials, reduced delivery of oxygen to the body's organs and tissues, impairment of the brain's ability to function properly, cancer and premature death. When these gases and particles accumulate in the air in high enough concentrations, they can harm humans, especially children, the elderly, the ill, and other sensitive individuals.

Diesel Particulate Matter (DPM) is a component of diesel exhaust. DPM particles are very fine, with most particles smaller than 1 micron, and their small size allows inhaled DPM to reach the lungs. Particles typically have a carbon core coated with condensed organic compounds such as POM, which include mutagens and carcinogens. EPA classifies many of the compounds included in the POM class as probable human carcinogens based on animal data. Polycyclic aromatic hydrocarbons (PAHs) are a subset of POM that contains only hydrogen and carbon atoms. Studies have found that maternal exposures to Polycyclic aromatic hydrocarbons (PAHs) in a population of pregnant women were associated with several adverse birth outcomes, including low birth weight and reduced length at birth, and impaired cognitive development in preschool children (3 years of age) (Perera et al. 2003, 2006).

As noted in Chapter 5 of the Final EIS, potential increases in allergens under a changing climate could increase respiratory health risks, particularly for children. Recent research has projected increases in weed pollen and grass pollen under various climate change simulations; these allergens are known to exacerbate children's asthma and cause hospitalizations (Sheffield and Landrigan 2011 citing Héguy et al. 2008, Schmier and Ebi 2009, and Ziska et al. 2008). Consistent with earlier studies, increased temperatures from climate change are projected to increase ground-level ozone concentrations, triggering asthma attacks among children (Bernstein and Myers 2011). Exposure to smoke from forest fires, which are likely to occur more frequently in the future, cause asthma and respiratory illnesses in children (Bernstein and Myers 2011 citing Liu et al. 2010, Bernstein and Mysers 2011 citing Kunzli et al. 2006).

Additionally, the Final EIS notes that substantial morbidity and childhood mortality has been linked to water- and food-borne diseases. A recent study investigates how six regions in the tropics and subtropics—including South America, North Africa, the Middle East, equatorial Africa, southern Africa, and Southeast Asia, all of which have high incidence of dehydration and diarrhea—could experience increases in diarrhea incidence as average temperatures rise. This study estimates an average temperature increase of 4 °C (7.2 °F) over land in the study area by the end of the century, compared to a 1961 to 1990 baseline, based on an ensemble average of 19 climate models using a moderate (A1B) emission scenario. A relatively simple linear regression relationship was developed between diarrhea incidence and temperature increase based on the results of five independent studies. Applying this relationship, the projected mean increase in the relative risk of contracting diarrhea across the six study regions is eight to 11 percent in the period 2010 to 2039, 15 to 20 percent in the period 2040 to 2069, and 22 to 29 percent in the period 2070 to 2099 (Kolstad and Johansson 2011). Climate change is also projected to affect the rates of water- and food-borne diseases. Currently, foodborne diseases cause an estimated 5,000 deaths, 325,000 hospitalizations, and 76 million illnesses annually in the United States (Ge et al. 2011 citing Mead et al. 1999). A new study tested how climate change can affect the spread of Salmonella. Both extended dryness and heavy rain were tested, and the authors found that these conditions facilitated the transfer of Salmonella typhimurium into the edible portions of lettuce and green onion when Salmonella was present in the soil. If climate change were to cause excessive drought or heavy rain, it could increase the risk of disease outbreaks (Ge et al. 2011).

In the United States, Lyme disease is a common vector-borne disease, with children between the ages of 5 and 9 having the highest incidence of infection (Bernstein and Myers 2011 citing Bacon et al. 2008). In response to warming temperatures, populations of the black legged tick (Ixodes scapularis, often known as the deer tick) have been expanding and increasing in number across North America northward toward Canada and lower Michigan in the United States (Bernstein and Myers 2011 citing Ogden et al. 2010).

Globally, there has been an increase in cases of skin cancer over the past several decades, due in part to increased exposure to UV-B radiation caused by

[1412] 62 FR 19885 (Apr. 23, 1997).

factors such as lifestyle changes and stratospheric ozone depletion. Studies suggest that higher temperatures contribute to the development of skin carcinoma, and one new study estimates that a long-term temperature increase of 2 °C (3.6 °F) compared to 1990 temperatures could raise the carcinogenesis effects of UV radiation by 10 percent (Andersen 2011 citing van der Leun and de Gruijl 2002).

The impacts of climate change on food and water security will be particularly burdensome on children, who are more susceptible to malnutrition and disease (Sheffield and Landrigan 2011). In the Sahel region of Africa, expanding arid climates could hinder agricultural production, resulting in an increase in malnutrition, stunting, and anemia throughout the population. By 2025, an additional six million people in Mali, Africa—of which one million are children—are at heightened risk of malnutrition due to climate and livelihood changes from increasing temperatures and decreased rainfall across the region. As the arid region expands, it is projected that approximately 250,000 children will suffer stunting, 200,000 children will be malnourished, and more than 100,000 will be anemic (Jankowska et al. 2012).

Thus, as detailed in the Final EIS, NHTSA has evaluated the environmental, health, and safety effects of the rule on children and fetuses. The Final EIS also explains why the standards are preferable to other potentially effective and reasonably foreseeable alternatives considered by the agency.

18. 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.

Voluntary consensus standards are technical standards developed or adopted by voluntary consensus standards bodies. Technical standards are defined by the NTTAA as ''performance-base or design-specific technical specification and related management systems practices.'' They pertain to ''products and processes, such as size, strength, or technical performance of a product, process or material.''

Examples of organizations generally regarded as voluntary consensus standards bodies include the American Society for Testing and Materials (ASTM), the Society of Automotive Engineers (SAE), and the American National Standards Institute (ANSI). If NHTSA does not use available and potentially applicable voluntary consensus standards, we are required by the Act to provide Congress, through OMB, an explanation of the reasons for not using such standards.

There are currently no voluntary consensus standards relevant to today's final CAFE standards.

19. Executive Order 13211

Executive Order 13211 [1413] 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 final rule and explain why the final regulation is preferable to other potentially effective and reasonably foreseeable alternatives considered by us.

The final rule seeks to establish passenger car and light truck fuel economy standards that will reduce the consumption of petroleum and will not have any adverse energy effects. Accordingly, this final rulemaking action is not designated as a significant energy action.

20. Department of Energy Review

In accordance with 49 U.S.C. 32902(j)(1), we submitted this final rule to the Department of Energy for review. That Department did not make any comments that we have not addressed.

21. 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, Labeling, Reporting and recordkeeping requirements.

49 CFR Part 523, 531, and 533

Fuel Economy.

49 CFR Part 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 amends 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 85 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.

* * * * *

(a) * * *

(2) * * *

(i) * * *

(D) Optionally, compliance with greenhouse gas emission requirements may be demonstrated by comparing emissions from the vehicle prior to the fuel conversion to the emissions after the fuel conversion. This comparison must be based on FTP test results from the emission data vehicle (EDV) representing the pre-conversion test group. The sum of CO_2, CH_4, and N_2O shall be calculated for pre- and post-conversion FTP test results, where CH_4 and N_2O are weighted by their global warming potentials of 25 and 298, respectively. The post-conversion sum of these emissions must be lower than the pre-conversion conversion greenhouse gas emission results. CO_2 emissions are calculated as specified in 40 CFR 600.113–12. If statements of

[1413] 66 FR 28355 (May 22, 2001).

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.

* * * * *

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) Documents listed in this section have been incorporated by reference into this part. The Director of the Federal Register approved the incorporation by reference as prescribed in 5 U.S.C. 552(a) and 1 CFR part 51. Anyone may inspect copies at the U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave. NW., Room B102, EPA West Building, Washington, DC 20460, (202) 566–1744, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

(b) American Society for Testing and Materials (ASTM). Anyone may purchase copies of these materials from American Society for Testing and Materials at 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA, 19428–2959, (610) 832–9585, or *http://www.astm.org/*.

(1) ASTM C1549–09, Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer, approved August 1, 2009, IBR approved for § 86.1869–12(b).

(2) ASTM D975–04c, Standard Specification for Diesel Fuel Oils, published 2004, IBR approved for §§ 86.213–11, 86.1910.

(3) ASTM D1945–91, Standard Test Method for Analysis of Natural Gas by Gas Chromatography, published 1991, IBR approved for §§ 86.113–94, 86.513–94, 86.1213–94, 86.1313–94.

(4) ASTM D2163–91, Standard Test Method for Analysis of Liquefied Petroleum (LP) Gases and Propane Concentrates by Gas Chromatography, published 1991, IBR approved for §§ 86.113–94, 86.1213–94, 86.1313–94.

(5) ASTM D2986–95a (Reapproved 1999), Standard Practice for Evaluation of Air Assay Media by the Monodisperse DOP (Dioctyl Phthalate) Smoke Test, published 1999, IBR approved for § 86.1310–2007.

(6) ASTM D5186–91, Standard Test Method for Determination of Aromatic Content of Diesel Fuels by Supercritical Fluid Chromatography, published 1991, IBR approved for §§ 86.113–07, 86.1313–91, 86.1313–94, 86.1313–98, 86.1313–2007.

(7) ASTM E29–67 (Reapproved 1980), Standard Recommended Practice for Indicating Which Places of Figures Are To Be Considered Significant in Specified Limiting Values, published 1980, IBR approved for § 86.1105–87.

(8) ASTM E29–90, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications, published 1990, 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.

(9) ASTM E29–93a, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications, published 1993, IBR approved for §§ 86.004–15, 86.007–11, 86.007–15, 86.098–15, 86.1803–01, 86.1823–01, 86.1824–01, 86.1825–01, 86.1837–01.

(10) ASTM E903–96, Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres, approved April 10, 1996, IBR approved for § 86.1869–12(b).

(11) ASTM E1918–06, Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field, approved August 15, 2006, IBR approved for § 86.1869–12(b).

(12) ASTM F1471–93, Standard Test Method for Air Cleaning Performance of a High-Efficiency Particulate Air-Filter System, published 1993, IBR approved § 86.1310–2007.

(c) American National Standards Institute (ANSI). Anyone may purchase copies of these materials from 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, 1994, IBR approved for §§ 86.001–9, 86.004–9, 86.098–8, 86.099–8, 86.099–9, 86.1810–01.

(2) [Reserved]

(d) California Air Resources Board, 1001 I Street, Sacramento, CA, 95812, (916) 322–2884, *http://www.arb.ca.gov*.

(1) California Regulatory Requirements Applicable to the ''LEV II'' Program, including:

(i) California Non-Methane Organic Gas Test Procedures, August 5, 1999, IBR approved for §§ 86.1803–01, 86.1810–01, 86.1811–04.

(ii) [Reserved]

(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.

(e) International Organization for Standardization (ISO). Anyone may purchase copies of these materials from 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, Road vehicles—Diagnostic systems—Part 2: CARB requirements for interchange of digital information, February 1, 1994, IBR approved for §§ 86.005–17, 86.007–17, 86.099–17, 86.1806–01, 86.1806–04, 86.1806–05.

(2) ISO 14230–4:2000(E), Road vehicles—Diagnostic systems—KWP 2000 requirements for emission-related systems, June 1, 2000, IBR approved for §§ 86.005–17, 86.007–17, 86.099–17, 86.1806–01, 86.1806–04, 86.1806–05.

(3) ISO 15765–4.3:2001, Road Vehicles—Diagnostics on Controller Area Networks (CAN)—Part 4: Requirements for emissions-related systems, December 14, 2001, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(4) ISO 15765–4:2005(E), Road Vehicles—Diagnostics on Controller Area Networks (CAN)—Part 4: Requirements for emissions-related systems, January 15, 2005, IBR approved

for §§ 86.007–17, 86.010–18, 86.1806–05.

(5) ISO 13837:2008(E), Road Vehicles—Safety glazing materials—Method for the determination of solar transmittance, First edition, April 15, 2008, IBR approved for § 86.1869–12(b).

(f) National Institute of Standards and Technology (NIST). Anyone may purchase copies of these materials from National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD, 20899, *http://www.nist.gov*.

(1) NIST Special Publication 811, Guide for the Use of the International System of Units (SI), 1995 Edition, IBR approved for § 86.1901.

(2) [Reserved]

(g) Society of Automotive Engineers (SAE). Anyone may purchase copies of these materials from 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, Methane Measurement Using Gas Chromatography, December 1991, (as found in 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 J1634, Electric Vehicle Energy Consumption and Range Test Procedure, Cancelled October 2002, IBR approved for § 86.1811–04(n).

(3) SAE J1349, Engine Power Test Code—Spark Ignition and Compression Ignition, June 1990, IBR approved for §§ 86.094–8, 86.096–8.

(4) 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).

(5) SAE J1850, Class B Data Communication Network Interface, July 1995, IBR approved for §§ 86.099–17, 86.1806–01.

(6) SAE J1850, Class B Data Communication Network Interface, Revised May 2001, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(7) SAE J1877, Recommended Practice for Bar-Coded Vehicle Identification Number Label, July 1994, IBR approved for §§ 86.095–35, 86.1806–01.

(8) SAE J1892, Recommended Practice for Bar-Coded Vehicle Emission Configuration Label, October 1993, IBR approved for §§ 86.095–35, 86.1806–01.

(9) SAE J1930, Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms, Revised May 1998, IBR approved for §§ 86.004–38, 86.007–38, 86.010–38, 86.096–38, 86.1808–01, 86.1808–07.

(10) SAE J1930, Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms—Equivalent to ISO/TR 15031–2: April 30, 2002, Revised April 2002, IBR approved for §§ 86.005–17, 86.007–17, 86.010–18, 86.1806–04, 86.1806–05.

(11) SAE J1937, Engine Testing with Low Temperature Charge Air Cooler Systems in a Dynamometer Test Cell, November 1989, IBR approved for §§ 86.1330–84, 86.1330–90.

(12) SAE J1939, Recommended Practice for a Serial Control and Communications Vehicle Network, Revised October 2007, IBR approved for §§ 86.010–18.

(13) SAE J1939–11, Physical Layer—250K bits/s, Shielded Twisted Pair, December 1994, IBR approved for §§ 86.005–17, 86.1806–05.

(14) SAE J1939–11, Physical Layer—250K bits/s, Shielded Twisted Pair, Revised October 1999, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(15) SAE J1939–13, Off-Board Diagnostic Connector, July 1999, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(15) SAE J1939–13, Off-Board Diagnostic Connector, Revised March 2004, IBR approved for § 86.010–18.

(16) SAE J1939–21, Data Link Layer, July 1994, IBR approved for §§ 86.005–17, 86.1806–05.

(18) SAE J1939–21, Data Link Layer, Revised April 2001, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(19) SAE J1939–31, Network Layer, Revised December 1997, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(20) SAE J1939–71, Vehicle Application Layer, May 1996, IBR approved for §§ 86.005–17, 86.1806–05.

(21) SAE J1939–71, Vehicle Application Layer—J1939–71 (through 1999), Revised August 2002, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(22) SAE J1939–71, Vehicle Application Layer (Through February 2007), Revised January 2008, IBR approved for § 86.010–38.

(23) SAE J1939–73, Application Layer—Diagnostics, February 1996, IBR approved for §§ 86.005–17, 86.1806–05.

(24) SAE J1939–73, Application Layer—Diagnostics, Revised June 2001, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(25) SAE J1939–73, Application Layer—Diagnostics, Revised September 2006, IBR approved for §§ 86.010–18, 86.010–38.

(26) SAE J1939–81, Recommended Practice for Serial Control and Communications Vehicle Network Part 81—Network Management, July 1997, IBR approved for §§ 86.005–17, 86.007–17, 86.1806–04, 86.1806–05.

(27) SAE J1939–81, Network Management, Revised May 2003, IBR approved for § 86.010–38.

(28) SAE J1962, Diagnostic Connector, January 1995, IBR approved for §§ 86.099–17, 86.1806–01.

(29) SAE J1962, Diagnostic Connector Equivalent to ISO/DIS 15031–3; December 14, 2001, Revised April 2002, IBR approved for §§ 86.005–17, 86.007–17, 86.010–18, 86.1806–04, 86.1806–05.

(30) SAE J1978, OBD II Scan Tool—Equivalent to ISO/DIS 15031–4; December 14, 2001, Revised April 2002, IBR approved for §§ 86.005–17, 86.007–17, 86.010–18, 86.1806–04, 86.1806–05.

(31) SAE J1979, E/E Diagnostic Test Modes, July 1996, IBR approved for §§ 86.099–17, 86.1806–01.

(32) SAE J1979, E/E Diagnostic Test Modes, Revised September 1997, IBR approved for §§ 86.004–38, 86.007–38, 86.010–38, 86.096–38, 86.1808–01, 86.1808–07.

(33) SAE J1979, E/E Diagnostic Test Modes—Equivalent to ISO/DIS 15031–5; April 30, 2002, Revised April 2002, IBR approved for §§ 86.005–17, 86.007–17, 86.099–17, 86.1806–01, 86.1806–04, 86.1806–05.

(34) SAE J1979, (R) E/E Diagnostic Test Modes, Revised May 2007, IBR approved for § 86.010–18, 86.010–38.

(35) SAE J2012, Recommended Practice for Diagnostic Trouble Code Definitions, July 1996, IBR approved for §§ 86.099–17, 86.1806–01.

(36) SAE J2012, (R) Diagnostic Trouble Code Definitions Equivalent to ISO/DIS 15031–6: April 30, 2002, Revised April 2002, IBR approved for §§ 86.005–17, 86.007–17, 86.010–18, 86.1806–04, 86.1806–05.

(37) SAE J2064 FEB2011, R134a Refrigerant Automotive Air-Conditioned Hose, Revised February 2011, IBR approved for § 86.1867–12(a) and (b).

(38) SAE J2284–3, High Speed CAN (HSC) for Vehicle Applications at 500 KBPS, May 2001, IBR approved for §§ 86.096–38, 86.004–38, 86.007–38, 86.010–38, 86.1808–01, 86.1808–07.

(39) SAE J2403, Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature—Truck and Bus, Revised August 2007, IBR approved for §§ 86.007–17, 86.010–18, 86.010–38, 86.1806–05.

(40) SAE J2534, Recommended Practice for Pass-Thru Vehicle Programming, February 2002, IBR approved for §§ 86.004–38, 86.007–38,

86.010–38, 86.096–38, 86.1808–01, 86.1808–07.

(41) SAE J2534–1, (R) Recommended Practice for Pass-Thru Vehicle Programming, Revised December 2004, IBR approved for § 86.010–38.

(42) SAE J2727 FEB2012, Mobile Air Conditioning System Refrigerant Emission Charts for R–134a and R–1234yf, Revised February 2012, IBR approved for § 86.1867–12(a) and (b).

(43) SAE J2765 OCT2008, Procedure for Measuring System COP [Coefficient of Performance] of a Mobile Air Conditioning System on a Test Bench, issued October 2008, IBR approved for § 86.1868–12(h).

(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]

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 paragraphs (a) and (d) 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.

* * * * *

(d) Practice runs over the prescribed driving schedule may be performed at test point, provided an emission sample is not taken, for the purpose of finding the appropriate throttle action to maintain the proper speed-time relationship, or to permit sampling system adjustment. Both smoothing of speed variations and excessive accelerator pedal perturbations are to be avoided. When using two-roll dynamometers a truer speed-time trace may be obtained by minimizing the rocking of the vehicle in the rolls; the rocking of the vehicle changes the tire rolling radius on each roll. This rocking may be minimized by restraining the vehicle horizontally (or nearly so) by using a cable and winch.

* * * * *

■ 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 intervals of not more than 30 seconds.

* * * * *

§ 86.166–12 [Removed and Reserved]

■ 8. Section 86.166–12 is removed and reserved:

■ 9. Section 86.167–17 is added to read as follows:

§ 86.167–17 AC17 Air Conditioning Emissions Test Procedure.

(a) *Overview.* The AC17 test procedure consists of four elements: a pre-conditioning cycle, a 30-minute soak period under simulated solar heat, followed by measurement of emissions over an SC03 drive cycle and a Highway Fuel Economy Driving Schedule (HFET) drive cycle. The vehicle is preconditioned with a single 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. This entire sequence is conducted in an environmental test facility. Vehicles are tested for any or all of the following emissions, depending upon the specific test requirements and the vehicle fuel type: gaseous exhaust THC, NMHC, NMOG, CO, NO_X, CO_2, N_2O, CH_4, CH_3OH, C_2H_5OH, C_2H_4O, and HCHO. For purposes of measuring the impact of air conditioning systems on CO_2 emissions, this sequence is run twice: once with air conditioning on and once with air conditioning off. The following figure shows the basic sequence of the test procedure.

(b) *Equipment requirements.* Equipment requirements are specified in subpart B of part 86 of this chapter.

(c) *Fuel specifications.* The test fuel specifications are given in § 86.113. Test fuels representing fuel types for which there are no specifications provided in § 86.113 may be used if approved in advance by the Administrator.

(d) *Analytical gases.* The analytical gases must meet the criteria given in § 86.114.

(e) *Driving cycles.* (1) The driving schedules for the EPA Urban Dynamometer Driving Schedule (UDDS) and the SC03 cycle are contained in appendix I of this part. The driving schedule for the Highway Fuel Economy Driving Schedule (HFET) is set forth in appendix I of part 600 of this chapter.

(2) The speed tolerance at any given time on the driving schedules is defined by upper and lower limits. The upper limit is 2 mph higher than the highest point on trace within 1 second of the given time. The lower limit is 2 mph lower than the lowest point on the trace within 1 second of the given time. Speed variations greater than the tolerances (such as may occur during gear changes) are acceptable provided they occur for less than 2 seconds on any occasion. Speeds lower than those prescribed are acceptable provided the vehicle is operated at maximum available power during such occurrences.

(f) *Equipment calibration.* The equipment used for fuel economy testing must be calibrated according to the provisions of § 86.116.

(g) *Vehicle preparation.* The vehicle shall be prepared for testing according to § 86.132(a) through (g), concluding with a 12–36 hour soak.

(h) *Dynamometer procedures.* (1) The AC17 test procedure consists of a pre-conditioning UDDS, a 30-minute soak period under simulated solar heat, followed by measurement of emissions over an SC03 drive cycle and a Highway Fuel Economy Driving Schedule (HFET) drive cycle.

(2) Except in cases of component malfunction or failure, all emission control systems installed on or incorporated in a new motor vehicle must be functioning during all procedures in this subpart. The Administrator may authorize maintenance to correct component malfunction or failure.

(3) Use § 86.129 to determine road load power and test weight. 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.

(4) Tests shall be run on a large single roll electric dynamometer or an equivalent dynamometer configuration that satisfies the requirements of § 86.108–00.

(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 separately for each driving schedule over which emissions are measured (SC03, and HFET).

(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.

(i) *Testing facility requirements.* (1) *Ambient air temperature.* (i) Ambient air temperature shall be controlled within the test cell during all emission sampling phases of the test sequence to 77 ± 2 °F on average and 77 ± 5 °F as an instantaneous measurement. During phases of the test where emissions are not being sampled, ambient air temperature shall be controlled to these same tolerances, except that periods outside the specified ranges are allowed to occur as long as the total cumulative time outside the specified ranges does not exceed three minutes.

(ii) Record air temperature continuously at intervals of not more than 30 seconds. Alternatively, you may use a moving average over intervals of not more than 30 seconds to record and report air temperature. You must maintain records of test cell air temperatures and values of average test temperatures.

(2) *Ambient humidity.* (i) Ambient humidity shall be controlled, within the test cell, during all emission sampling phases of the test sequence to an average of 69 ± 5 grains of water/pound of dry air and an instantaneous measurement of 69 ± 10 grains of water/pound of dry air. During phases of the test where emissions are not being sampled, ambient humidity shall be controlled to these same tolerances, except that periods outside the specified ranges are allowed to occur as long as the total cumulative time outside the specified ranges does not exceed three minutes.

(ii) Humidity shall be recorded continuously at intervals of not more than 30 seconds. Records of cell humidity and values of average test humidity shall be maintained by the manufacturer.

(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.

(4) *Minimum test cell size.* The requirements of § 86.161–00(c) regarding test cell size requirements shall apply.

(5) *Test cell air flow requirements.* The requirements of § 86.161–00(e) regarding air flow supplied to the vehicle shall apply. Air flow at a maximum of 4 miles/hour may be provided during periods of idle and key-off soak if required for maintenance of ambient requirements.

(j) *Interior temperature measurement.* The interior temperature of the vehicle shall be measured during all the emission sampling phases of the test.

(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.

(2) The temperature at each location shall be recorded a minimum of every 5 seconds.

(k) *Air conditioning system settings.* For tests being conducted to measure emissions with the air conditioning operating, the air conditioner settings shall be as follows:

(1) Automatic systems shall be set to automatic and the temperature control set to 72 deg F, with blower or fan speed and vent location controlled by the automatic mode.

(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.''

(l) *Test procedure.* The AC17 air conditioning test is composed of the following sequence of activities.

(1) Position the test vehicle on the dynamometer (vehicle may be driven) and restrain.

(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 (i) of this section for 30 ±1 minutes. If emissions are being measured with the air conditioner operating, the solar heat system must be turned on and generating 850 W/m^2 within 1 minute of turning the engine off. Otherwise the solar heat system shall be turned off.

(9) Initiate data logging, sampling of exhaust gases, and integrating measured values. Start the engine. If emissions are being measured with the air conditioner operating, you must start the engine with the air conditioning system running as specified in paragraph (k) of this section. Otherwise the air conditioning system should be completely off. Initiate the driver's trace when the engine starts. Fifteen seconds after the engine starts, place vehicle in gear.

(10) Eighteen seconds after the engine starts, begin the initial vehicle acceleration of the SC03 driving schedule.

(11) Operate the vehicle according to the SC03 driving schedule, as described in appendix I, paragraph (h), of this part.

(12) At the end of the deceleration which is scheduled to occur at 594 seconds, simultaneously stop all SC03 and start all HFET sampling, recording, and integrating; including background sampling. Record the measured roll or shaft revolutions.

(13) Allow the vehicle to idle for 14–16 seconds.

(14) Operate the vehicle according to the HFET driving schedule, as described in appendix I to 40 CFR part 600.

(15) Turn the engine off 2 seconds after the end of the last deceleration, i.e., engine off at 765 seconds.

(16) Five seconds after the engine stops running, stop all HFET sampling, recording, and integrating (including background sampling), indicating the end of the test cycle. Record the measured roll or shaft revolutions.

(17) Turn off the solar heat system, if applicable.

(m) *Calculations.* The final reported test results for each emission constituent being evaluated is the average of the SC03 and HFET gram per mile emissions, which shall be calculated using the following formula:

$$Y_{WM} = 0.5 \times \left(\frac{Y_{SC03}}{D_{SC03}}\right) + 0.5 \times \left(\frac{Y_{HFET}}{D_{HFET}}\right)$$

Where:

Y_{WM} = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMHC, NMHCE, CH_4, NO_X, or CO_2, in grams per vehicle mile.

Y_{SC03} = Mass emissions as calculated from the SC03 phase of the test, in grams per test phase.

D_{SC03} = The measured driving distance from the SC03 phase of the test, in miles.

Y_{HFET} = Mass emissions as calculated from the HFET phase of the test, in grams per test phase.

D_{HFET} = The measured driving distance from the HFET phase of the test, in miles.

(n) *Measuring the net impact of air conditioner operation.* This test may be used to determine the net impact of air conditioner operation as may be required under § 86.1868, which requires that CO_2 be measured using the procedures in this section with both air conditioning on and off. To do this, you must follow these steps:

(1) Conduct the test procedure described in this section with the air conditioning system operating, being sure to follow the appropriate instructions regarding air conditioner operation and use of the solar heat system. Analyze the data and calculate the weighted CO_2 emissions in grams per mile according to paragraph (m) of this section.

(2) Allow the vehicle to remain on the dynamometer, with the engine shut off, for 10 to 15 minutes after emissions sampling has concluded. The solar heat system should be turned off.

(3) Conduct the test procedure described in paragraph (l) of this section with the air conditioning system turned off, being sure to follow the appropriate instructions regarding air conditioner operation (off) and use of the solar heat system (off). Analyze the data and calculate the weighted CO_2 emissions in

grams per mile according to paragraph (m) of this section.

(4) Calculate the incremental CO_2 emissions due to air conditioning operation by subtracting the CO_2 grams per mile determined in paragraph (n)(3) of this section from the CO_2 grams per mile determined in paragraph (n)(1) of this section.

(o) *Records required and reporting requirements.* For each test the manufacturer shall record the information specified in § 86.142–90. Emission results and the results of all calculations 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)(i) Effective for the 2013 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 with all associated and applicable provisions in this part and in part 600 of this chapter.

(ii) Such a manufacturer may optionally earn credits in the 2012 model year by demonstrating fleet average CO_2 emission levels below the fleet average CO_2 standard that would have been applicable in model year 2012 if the manufacturer had not been exempt. Once the small business manufacturer opting into the greenhouse gas emission standards completes certification for the 2013 model year, that manufacturer will be eligible to generate greenhouse gas emission credits for their 2012 model year production, after the conclusion of the 2012 model year for that manufacturer. Manufacturers electing to earn these 2012 credits must comply with the model year reporting requirements in § 600.512–12 for that model year. The 2012 fleet average must be calculated according to § 600.510 and other applicable requirements in part 600 of this chapter, and 2012 credits must be calculated according to § 86.1865 and other applicable requirements in this part.

(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 for U.S. sale, where ''U.S.'' means 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) or, if a manufacturer has been granted operational independence status under § 86.1838(d), eligibility shall be based on vehicle production of that manufacturer.

* * * * *

■ 11. Section 86.1803–01 is amended as follows:

■ a. By adding definitions for ''full size pickup truck'', ''good engineering judgment'', ''gross combination weight rating'', mild hybrid electric vehicle'', ''platform'', and ''strong hybrid electric vehicle'' in alphabetical order.

■ b. By revising the definitions for ''emergency vehicle'', ''footprint'', and ''gross vehicle weight rating.''

The revisions and additions read as follows:

§ 86.1803–01 Definitions.

* * * * *

Emergency vehicle means one of the following:

(1) For the greenhouse gas emission standards in § 86.1818, 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.

(2) For provisions related to defeat devices and other AECDs under this subpart, emergency vehicle means a motor vehicle that is an ambulance or a fire truck.

* * * * *

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.

* * * * *

Full size pickup truck means a light truck which has a passenger compartment and an open cargo box and which meets the following specifications:

(1) 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 or cover. Vehicles produced with detachable covers are considered ''open'' for the purposes of these criteria.

(2) 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 or 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 height of the top of the open pickup bed 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.

(3)(i) 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

(ii) 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.

* * * * *

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.

* * * * *

Mild hybrid electric vehicle means a hybrid electric vehicle that has start/stop capability and regenerative braking capability, where the recovered energy over the Federal Test Procedure is at least 15 percent but less than 65 percent of the total braking energy, as measured and calculated according to § 600.116–12(c).

* * * * *

Platform means a segment of an automobile manufacturer's vehicle fleet in which the vehicles have a degree of commonality in construction (primarily in terms of body and chassis design). Platform does not consider the model name, brand, marketing division, or level of decor or opulence, and is not generally distinguished by such characteristics as powertrain, roof line, number of doors, seats, or windows. A platform may include vehicles from various fuel economy classes, and may include light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles.

* * * * *

Strong hybrid electric vehicle means a hybrid electric vehicle that has start/stop capability and regenerative braking capability, where the recovered energy over the Federal Test Procedure is at least 65 percent of the total braking energy, as measured and calculated according to § 600.116–12(c).

* * * * *

■ 12. Section 86.1810–09 is amended by revising paragraph (f)(2) to read as follows:

§ 86.1810–09 General standards; increase in emissions; unsafe condition; waivers.

* * * * *

(f) * * *

(2) For vehicles that comply with the cold temperature NMHC standards described in § 86.1811–10(g) and the CO_2, N_2O, and CH_4 exhaust emission standards described in § 86.1818–12, manufacturers must submit an engineering evaluation indicating that common calibration approaches are utilized at high altitudes (except when there are specific high altitude calibration needs to deviate from low altitude emission control practices). Any deviation from low altitude emission control practices must be included in the auxiliary emission control device (AECD) descriptions submitted at certification. Any AECD specific to high altitude must require engineering emission data for EPA evaluation to quantify any emission impact and validity of the AECD.

* * * * *

■ 13. Section 86.1818–12 is amended as follows:

■ a. By revising paragraphs (c)(2)(i)(A) through (C).

■ b. By revising paragraphs (c)(3)(i)(A) through (C).

■ c. By adding paragraph (c)(3)(i)(D).

■ d. By adding paragraph (c)(4).

■ e. By revising paragraph (d).

■ f. By revising paragraph (e)(1) introductory text.

■ g. By revising paragraph (e)(1)(i) introductory text.

■ h. By revising paragraph (e)(1)(i)(B).

■ i. By adding paragraph (e)(1)(i)(D).

■ j. By adding paragraph (e)(1)(iv).

■ k. By revising paragraph (e)(3).

■ l. By revising paragraph (f) introductory text.

■ m. By revising paragraphs (f)(3) and (4).

■ n. By adding paragraphs (g) and (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.

* * * * *

(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

(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, except that for any vehicle footprint the maximum CO_2 target value shall be the value specified for the same model year in paragraph (c)(2)(i)(B) of this section:

$$\text{Target } CO_2 = [a \times f] + b$$

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, except that for any vehicle footprint the maximum CO_2 target value shall be the value specified for the same model year in paragraph (c)(3)(i)(D) of this section:

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, except that for any vehicle footprint the maximum CO_2 target value shall be the value specified for the same model year in paragraph (c)(3)(i)(D) of this section:

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

Model year	Minimum footprint	CO_2 target value (grams/mile)
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 emission standards described in this section. The manufacturer must notify the Administrator that they are making such an election in the model year reports required under § 600.512 of this chapter. Such vehicles should be excluded from both the calculation of the fleet average standard for a manufacturer under this paragraph (c) and from the calculation of the fleet average carbon-related exhaust emissions in § 86.510–12.

(d) *In-use CO_2 exhaust emission standards.* The in-use CO_2 exhaust emission standard shall be the combined city/highway carbon-related exhaust emission value calculated for the appropriate vehicle carline/subconfiguration according to the provisions of § 600.113–12(g)(4) of this chapter multiplied by 1.1 and rounded to the nearest whole gram per mile. For in-use vehicle carlines/subconfigurations for which a combined city/highway carbon-related exhaust emission value was not determined under § 600.113–12(g)(4) of this chapter, the in-use CO_2 exhaust emission standard shall be the combined city/highway carbon-related exhaust emission value calculated according to the provisions of § 600.208 of this chapter for the vehicle model type (except that total model year production data shall be used instead of sales projections) multiplied by 1.1 and rounded to the nearest whole gram per mile. For vehicles that are capable of operating on multiple fuels, except plug-in hybrid electric vehicles, a separate in-use standard shall be determined for each fuel that the vehicle is capable of operating on. These standards apply to in-use testing performed by the manufacturer pursuant to regulations at §§ 86.1845 and 86.1846 and to in-use testing performed by EPA.

(e) * * *

(1) The interim fleet average CO_2 standards in this paragraph (e) are optionally applicable to each qualifying manufacturer, where the terms ''sales'' or ''sold'' as used in this paragraph (e) means vehicles produced for U.S. sale, where ''U.S.'' means the states and territories of the United States.

(i) A qualifying manufacturer is a manufacturer with sales of 2009 model year combined passenger automobiles and light trucks of greater than zero and less than 400,000 vehicles that elects to participate in the Temporary Leadtime Allowance Alternative Standards described in this paragraph (e).

* * * * *

(B) In the case where two or more qualifying manufacturers combine as the result of merger or the purchase of 50 percent or more of one or more companies by another company, and if the combined 2009 model year sales of the merged or combined companies is less than 400,000 but more than zero (combined passenger automobiles and light trucks), the corporate entity formed by the combination of two or more qualifying manufacturers shall continue to be a qualifying manufacturer, except the provisions of paragraph (e)(1)(i)(D) shall apply in the case where one of the merging companies elects to voluntarily opt out of the Temporary Leadtime Allowance Alternative Standards as allowed under paragraph (e)(1)(iv) of this section. The total number of vehicles that the corporate entity is allowed to include under the Temporary Leadtime Allowance Alternative Standards shall be determined by paragraph (e)(2) or (e)(3) of this section, where sales is the total combined 2009 model year sales of all of the merged or combined companies. Vehicles sold by the companies that combined by merger/acquisition to form the corporate entity that were subject to the Temporary Leadtime Allowance Alternative Standards in paragraph (e)(4) of this section prior to the merger/acquisition shall be combined to determine the remaining number of vehicles that the corporate entity may include under the Temporary Leadtime Allowance Alternative Standards in this paragraph (e).

* * * * *

(D) In the case where two or more manufacturers combine as the result of merger or the purchase of 50 percent or more of one or more companies by another company, where one of the manufacturers chooses to voluntarily opt out of the Temporary Leadtime Allowance Alternative Standards under the provisions of paragraph (e)(1)(iv) of this section, the new corporate entity formed by the combination of two or more manufacturers is not a qualifying manufacturer. Such a manufacturer shall meet the emission standards in paragraph (c) of this section beginning with the model year that is numerically two years greater than the calendar year in which the merger/acquisition(s) took place. If one or more of the merged or combined manufacturers was complying with the Temporary Leadtime Allowance Alternative Standards prior to the merger/combination, that manufacturer is no longer eligible for the Temporary Leadtime Allowance Alternative Standards beginning with the model year that is numerically two years greater than the calendar year in which the merger/acquisition(s) took place. The cumulative number of vehicles that such a manufacturer may include in the Temporary Leadtime Allowance Alternative Standards, including those that were included by all merged manufacturers prior to the merger/acquisition, is limited to 100,000.

* * * * *

(iv) In the event of a merger, acquisition, or combination with another manufacturer, a qualifying manufacturer that has not certified any vehicles to the Temporary Leadtime Allowance Alternative Standards in any model year may voluntarily opt out of the Temporary Leadtime Allowance Alternative Standards. A manufacturer making this election must notify EPA in writing of their intent prior to the end of the model year in which a merger or combination with another manufacturer becomes effective. The notification must indicate that the manufacturer is electing to not use the Temporary Leadtime Allowance Alternative

Standards in any model year, and that any manufacturers that are either purchased by or merged with the manufacturer making this election must also meet the emission standards in paragraph (c) of this section beginning with the model year that is numerically two years greater than the calendar year in which the merger/acquisition(s) took place.

* * * * *

(3)(i) Qualifying manufacturers with sales of 2009 model year combined passenger automobiles and light trucks in the United States of greater than zero and less than 50,000 vehicles may select any combination of 2012 through 2015 model year passenger automobiles and/or light trucks to include under the Temporary Leadtime Allowance Alternative Standards determined in this paragraph (e) up to a cumulative total of 200,000 vehicles, and additionally may select up to 50,000 2016 model year vehicles to include under the Temporary Leadtime Allowance Alternative Standards determined in this paragraph (e). To be eligible for the provisions of this paragraph (e)(3) qualifying manufacturers must provide annual documentation of good-faith efforts made by the manufacturer to purchase credits from other manufacturers. Without such documentation, the manufacturer may use the Temporary Leadtime Allowance Alternative Standards according to the provisions of paragraph (e)(2) of this section, and the provisions of this paragraph (e)(3) shall not apply. Vehicles selected to comply with these standards shall not be included in the calculations of the manufacturer's fleet average standards under paragraph (c) of this section.

(ii) Manufacturers that qualify in the 2016 model year for the expanded Temporary Leadtime Allowance Alternative Standards described in paragraph (e)(3)(i) of this section, may, subject to certain restrictions, use an alternative compliance schedule that provides additional lead time to meet the standards in paragraph (c) of this section for the 2017 through 2020 model years.

(A) The alternative compliance schedule is as follows. In lieu of the standards in paragraph (c) of this section that would otherwise be applicable to the model year shown in the first column of the table below, a qualifying manufacturer may comply with the standards in paragraph (c) of this section determined for the model year shown in the second column of the table. In the 2021 and later model years the manufacturer must meet the standards designated for each model year in paragraph (c) of this section.

Model year	Applicable standards
2017	2016
2018	2016
2019	2018
2020	2019

(B) A manufacturer using the alternative compliance schedule in paragraph (e)(3)(ii) of this section may not sell or otherwise transfer credits generated in years when the alternative phase-in is used to other manufacturers. Other provisions in § 86.1865 regarding credit banking, deficit carry-forward, and within-manufacturer transfers across fleets apply.

* * * * *

(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 automobiles 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. Vehicles certified using the N_2O data submittal waiver provisions of § 86.1829(b)(1)(iii)(G) are not required to be tested for N_2O under the in-use testing programs required by § 86.1845 and § 86.1846.

* * * * *

(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.

(4) *CO_2- equivalent debits.* CO_2-equivalent debits for test groups using an alternative N_2O and/or CH_4 standard as determined under paragraph (f)(3) of this section shall be calculated according to the following equation and rounded to the nearest whole megagram:

$$\text{Debits} = [\text{GWP} \times (\text{Production}) \times (\text{AltStd—Std}) \times \text{VLM}]/1{,}000{,}000$$

Where:

Debits = N_2O or CH_4 CO_2-equivalent debits for a test group using an alternative N_2O or CH_4 standard;

GWP = 25 if calculating CH_4 debits and 298 if calculating N_2O debits;

Production = The number of vehicles of that test group domestically produced plus those imported as defined in § 600.511 of this chapter;

AltStd = The alternative standard (N_2O or CH_4) selected by the manufacturer under paragraph (f)(3) of this section;

Std = The exhaust emission standard for N_2O or CH_4 specified in paragraph (f)(1) of this section; and

VLM = 195,264 for passenger automobiles and 225,865 for light trucks.

(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. A manufacturer that has sought and received EPA approval for alternative standards for the 2017 model year may, at their option, choose to comply with those standards in the 2015 and 2016 model years in lieu of requesting a conditional exemption under § 86.1801(k).

(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 for U.S. sale, where ''U.S.'' means 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), or, if a manufacturer has been granted operational independence status under § 86.1838(d), eligibility shall be based on vehicle production of that manufacturer. 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 4999, 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 4999, and if the increase in sales is the result of corporate acquisitions, mergers, or purchase by another manufacturer, the manufacturer shall comply with the emission standards described in paragraph (c) of this section, as applicable, beginning with the first model year after the last year of the three consecutive model years.

(ii) If a manufacturer's average sales for three consecutive model years exceeds 4999 and is less than 50,000, and if the increase in sales is solely the result of the manufacturer's expansion in vehicle production (not the result of corporate acquisitions, mergers, or purchase by another manufacturer), the manufacturer shall comply with the emission standards described in paragraph (c), of this section, 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 three model years in the U.S. market, and in subsequent years the average sales for any three consecutive years must remain below 5,000 vehicles. Vehicles sold in violation of these limits within the first five model years 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. After the first five model years, the eligibility provisions in paragraph (g)(1) of this section apply, where violating the sales thresholds is no longer a violation of the condition on the certificate, but is instead grounds for losing eligibility for alternative standards.

(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 in 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 year 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, powertrain, 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, or projected to be employed, 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, and the carry-forward provisions for credits and deficits apply.

(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 paragraph (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.

■ 14. 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.

* * * * *

■ 15. 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, 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 may also be used for 2017 and 2018 model year vehicles only if the application for certification for those vehicles is based upon data carried over from a prior model year, as allowed under this subpart. No 2019 and later model year vehicles may be waived from testing for N_2O emissions. Such a statement must be based on previous emission tests, development tests, or other appropriate information and good engineering judgment. Vehicles certified to N_2O standards using a compliance statement in lieu of submitting test data are not required to collect and submit N_2O emission data under the in-use verification testing requirements of § 86.1845.

* * * * *

■ 16. Section 86.1838–01 is amended by adding paragraph (d) to read as follows:

§ 86.1838–01 Small volume manufacturer certification procedures.

* * * * *

(d) *Operationally independent manufacturers.* Manufacturers may submit an application to EPA requesting treatment as an operationally independent manufacturer. A manufacturer that is granted operationally independent status may qualify for certain specified regulatory provisions on the basis of its own vehicle production and/or sales volumes, and would not require aggregation with related manufacturers. In this paragraph (d), the term ‘‘related manufacturer(s)’’ means manufacturers that would qualify for aggregation under the requirements of paragraph (b)(3) of this section.

(1) To request consideration for operationally independent status, the manufacturer must submit an application demonstrating that the following criteria are met, and have been continuously met for at least two years prior to submitting the application to EPA. The application must be signed by the president or the chief executive officer of the manufacturer.

(i) The applicant does not receive any financial or other means of support of economic value from any related manufacturers for purposes of vehicle design, vehicle parts procurement, research and development, and production facilities and operation. Any transactions with related manufacturers must be conducted under normal commercial arrangements like those conducted with other external parties. Any such transactions with related manufacturers shall be demonstrated to have been at competitive pricing rates to the applicant.

(ii) The applicant maintains wholly separate and independent research and development, testing, and vehicle manufacturing and production facilities.

(iii) The applicant does not use any vehicle engines, powertrains, or platforms developed or produced by related manufacturers.

(iv) The applicant does not hold any patents jointly with related manufacturers.

(v) The applicant maintains separate business administration, legal, purchasing, sales, and marketing departments as well as wholly autonomous decision making on all commercial matters.

(vi) The Board of Directors of the applicant may not share more than 25 percent of its membership with any related manufacturer. No top operational management of the applicant may be shared with any related manufacturer, including the president, the chief executive officer (CEO), the chief financial officer (CFO), and the chief operating officer (COO). No individual director or combination of directors that is shared with a related manufacturer may exercise exclusive management control over either or both companies.

(vii) Parts or components supply agreements between the applicant and related companies must be established through open market processes. An applicant that sells or otherwise provides parts and/or vehicle components to a manufacturer that is not a related manufacturer must do so through the open market at competitive pricing rates.

(2) Manufacturers that have been granted operationally independent status must report any material changes to the information provided in the application within 60 days of the occurrence of the change. If such a change occurs that results in the manufacturer no longer meeting the requirements of the application, the manufacturer will lose the eligibility to be considered operationally independent. The EPA will confirm that the manufacturer no longer meets one or more of the criteria and thus is no longer considered operationally independent, and will notify the manufacturer of the change in status. A manufacturer who loses the eligibility for operationally independent status must transition to the appropriate emission standards no later than the third model year after the model year in which the loss of eligibility occurred. For example, a manufacturer that loses eligibility in their 2018 model year would be required to meet appropriate standards in the 2021 model year. A manufacturer that loses eligibility must meet the applicable criteria for three

consecutive model years before they are allowed to apply for a reinstatement of their operationally independent status.

(3) The manufacturer applying for operational independence shall engage an independent certified public accountant, or firm of such accountants (hereinafter referred to as ''CPA''), to perform an agreed-upon procedures attestation engagement of the underlying documentation that forms the basis of the application as required in this paragraph (d).

(i) The CPA shall perform the attestation engagements in accordance with the Statements on Standards for Attestation Engagements established by the American Institute of Certified Public Accountants.

(ii) The CPA may complete the requirements of this paragraph with the assistance of internal auditors who are employees or agents of the applicant, so long as such assistance is in accordance with the Statements on Standards for Attestation Engagements established by the American Institute of Certified Public Accountants.

(iii) Notwithstanding the requirements of paragraph (d)(2)(ii) of this section, an applicant may satisfy the requirements of this paragraph (d)(2) if the requirements of this paragraph (d)(2) are completed by an auditor who is an employee of the applicant, provided that such employee:

(A) Is an internal auditor certified by the Institute of Internal Auditors, Inc. (hereinafter referred to as ''CIA''); and

(B) Completes the internal audits in accordance with the standards for internal auditing established by the Institute of Internal Auditors.

(iv) Use of a CPA or CIA who is debarred, suspended, or proposed for debarment pursuant to the Governmentwide Debarment and Suspension Regulations, 2 CFR part 1532, or the Debarment, Suspension, and Ineligibility Provisions of the Federal Acquisition Regulations, 48 CFR part 9, subpart 9.4, shall be deemed in noncompliance with the requirements of this section.

■ 17. Section 86.1848–10 is amended by adding paragraphs (c)(9)(iii) through (v) to read as follows:

§ 86.1848–10 Compliance with emission standards for the purpose of certification.

* * * * *

(c) * * *

(9) * * *

(iii) For manufacturers using the conditional exemption under § 86.1801(k), failure to fully comply with the fleet production thresholds that determine eligibility for the exemption will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of the stated sales and/or production thresholds will not be covered by the certificate(s).

(iv) For manufacturers that are determined to be operationally independent under § 86.1838(d), failure to report a material change in their status within 60 days as required by § 86.1838(d)(2) will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of the operationally independent criteria will not be covered by the certificate(s).

(v) For manufacturers subject to an alternative fleet average greenhouse gas exhaust emission standard approved under § 86.1818(g), failure to comply with the annual sales thresholds that are required to maintain use of those standards, including the thresholds required for new entrants into the U.S. market, will be considered a failure to satisfy the terms and conditions upon which the certificate(s) was (were) issued and the vehicles sold in violation of stated sales and/or production thresholds will not be covered by the certificate(s).

* * * * *

■ 18. Section 86.1865–12 is amended as follows:

■ a. By revising paragraph (k)(5) introductory text.

■ b. By revising paragraph (k)(5)(i) through (iii).

■ c. By redesignating paragraph (k)(5)(iv) as (k)(5)(v).

■ d. By adding paragraph (k)(5)(iv).

■ e. By revising paragraph (k)(6).

■ f. By revising paragraph (k)(7)(i).

■ g. By adding paragraph (k)(7)(iv).

■ h. By adding paragraph (k)(7)(v).

■ i. By revising paragraph (k)(8)(iv)(A).

■ j. By revising paragraph (l)(1)(ii) introductory text.

■ k. By revising paragraph (l)(1)(ii)(F).

■ l. By revising paragraph (l)(2)(iii) introductory text.

■ m. By revising paragraph (l)(2)(iv) introductory text.

■ n. By revising paragraph (l)(2)(v).

The revisions and additions 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):

(i) Air conditioning leakage credits earned according to the provisions of § 86.1867–12(b);

(ii) Air conditioning efficiency credits earned according to the provisions of § 86.1868–12(c);

(iii) Off-cycle technology credits earned according to the provisions of § 86.1869–12(d).

(iv) Full size pickup truck credits earned according to the provisions of § 86.1870–12(c).

* * * * *

(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 from the 2009 model year that remain 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 from these model years 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.

* * * * *

(iv) Credits generated in the 2017 through 2020 model years under the provisions of § 86.1818(e)(3)(ii) may not be traded or otherwise provided to another manufacturer.

(v) Credits generated under any alternative fleet average standards approved under § 86.1818(g) may not be traded or otherwise provided to another manufacturer.

* * * * *

(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.

* * * * *

(2) * * *

(iii) Manufacturers calculating air conditioning leakage and/or efficiency credits under paragraph § 86.1871–12(b) shall include the following information for each model year and separately for passenger automobiles and light trucks and for each air conditioning system used to generate credits:

* * * * *

(iv) Manufacturers calculating advanced technology vehicle credits under paragraph § 86.1871–12(c) shall include the following information for each model year and separately for passenger automobiles and light trucks:

* * * * *

(v) Manufacturers calculating off-cycle technology credits under paragraph § 86.1871–12(d) shall include, for each model year and separately for passenger automobiles and light trucks, all test results and data required for calculating such credits.

* * * * *

■ 19. Section 86.1866–12 is revised to read as follows:

§ 86.1866–12 CO_2 credits for advanced technology vehicles.

(a) 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 for U.S. sale, where ''U.S.'' means the states and territories of 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, as specified by this paragraph (a).

(1) 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 for U.S. sale, where ''U.S.'' means the states and territories of the United States, in the 2012 through 2016 model years, except that a manufacturer that produces 25,000 or more such vehicles for U.S. sale 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.

(2) Model years 2017 through 2021: For electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles produced for U.S. sale, where ''U.S.'' means the states and territories of the United States, in the 2017 through 2021 model years, such use of zero (0) grams/mile CO_2 is unrestricted.

(3) 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 for U.S. sale by a manufacturer in the 2022 through 2025 model years, except that a manufacturer that produces for U.S. 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 for U.S. sale by a manufacturer in the 2022 through 2025 model years. Vehicles produced for U.S. sale in excess of these limitations will account for greenhouse gas emissions according to § 600.113(n).

(b) For electric vehicles, plug-in hybrid electric vehicles, fuel cell vehicles, dedicated natural gas vehicles, and dual-fuel natural gas vehicles as those terms are defined in § 86.1803–01, that are certified and produced for U.S. sale in the 2017 through 2021 model years and that meet the additional specifications in this section, the manufacturer may use the production multipliers in this paragraph (b) when determining the manufacturer's fleet average carbon-related exhaust emissions under § 600.512 of this chapter. Full size pickup trucks eligible for and using a production multiplier are not eligible for the performance-based credits described in § 86.1870–12(b).

(1) 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

(2)(i) The production multipliers, by model year, for plug-in hybrid electric vehicles, dedicated natural gas vehicles, and dual-fuel natural gas vehicles are as follows:

Model year	Production multiplier
2017	1.6
2018	1.6
2019	1.6
2020	1.45
2021	1.3

(ii) 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 in § 86.1). The equivalent all-electric range of a PHEV is determined from the following formula:

$$EAER = R_{CDA} \times ((CO2_{CS} - CO2_{CD}/CO2_{CS}))$$

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 in § 86.1).

CO_{2CS} = 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 in § 86.1).

CO_{2CD} = 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 in § 86.1).

(3) 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.

■ 20. Section 86.1867–12 is revised to read as follows:

§ 86.1867–12 CO_2 credits for reducing leakage of air conditioning refrigerant.

Manufacturers may generate credits applicable to the CO_2 fleet average program described in § 86.1865–12 by implementing specific air conditioning system technologies designed to reduce air conditioning refrigerant leakage over the useful life of their passenger automobiles and/or light trucks. Credits shall be calculated according to this section for each air conditioning system that the manufacturer is using to generate CO_2 credits. Manufacturers may also generate early air conditioning refrigerant leakage credits under this section for the 2009 through 2011 model years according to the provisions of § 86.1871–12(b).

(a) The manufacturer shall calculate an annual rate of refrigerant leakage from an air conditioning system in grams per year according to the procedures specified in SAE J2727 (incorporated by reference in § 86.1). In doing so, the refrigerant permeation rates for hoses shall be determined using the procedures specified in SAE J2064 (incorporated by reference in § 86.1) The annual rate of refrigerant leakage from an air conditioning system shall be rounded to the nearest tenth of a gram per year. The procedures of SAE J2727 may be used to determine leakage rates for HFC–134a and HFO–1234yf; manufacturers should contact EPA regarding procedures for other refrigerants. The annual rate of refrigerant leakage from an air conditioning system shall be rounded to the nearest tenth of a gram per year.

(b) The CO_2-equivalent gram per mile leakage reduction used to calculate the total leakage credits generated by an air conditioning system shall be determined according to this paragraph (b), separately for passenger automobiles and light trucks, and rounded to the nearest tenth of a gram per mile:

(1) Passenger automobile leakage credit for an air conditioning system:

$$Leakage\ Credit = MaxCredit \times \left[1 - \left(\frac{LeakScore}{16.6}\right) \times \left(\frac{GWP_{REF}}{1430}\right)\right] - HiLeakDis$$

Where:

MaxCredit is 12.6 (grams CO_2-equivalent/mile) for air conditioning systems using HFC–134a, and 13.8 (grams CO_2-equivalent/mile) for air conditioning systems using a refrigerant with a lower global warming potential.

LeakScore means the annual refrigerant leakage rate determined according to the procedures in SAE J2727 (incorporated by reference in § 86.1), where the refrigerant permeation rates for hoses shall be determined using the procedures specified in SAE J2064 (incorporated by reference in § 86.1). If the calculated rate is less than 8.3 grams/year (or 4.1 grams/year for systems using only electric compressors), the rate for the purpose of this formula shall be 8.3 grams/year (or 4.1 grams/year for systems using only electric compressors).

GWP_{REF} means the global warming potential of the refrigerant as indicated in paragraph (e) of this section or as otherwise determined by the Administrator;

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 calculated result of the equation is less than zero, HiLeakDis shall be set equal to zero, or if the calculated result of the equation is greater than 1.8 g/mi, HiLeakDis shall be set to 1.8 g/mi:

$$HiLeakDis = 1.8 \times \left(\frac{(LeakScore - LeakThreshold)}{3.3}\right)$$

Where,

LeakThreshold = 11.0 for air conditioning systems with a refrigerant capacity less than or equal to 733 grams; or

LeakThreshold = [Refrigerant Capacity × 0.015] for air conditioning systems with a refrigerant capacity greater than 733 grams, where RefrigerantCapacity is the maximum refrigerant capacity specified for the air conditioning system, in grams.

(2) Light truck leakage credit for an air conditioning system:

$$Leakage\ Credit = MaxCredit \times \left[1 - \left(\frac{LeakScore}{20.7}\right) \times \left(\frac{GWP_{REF}}{1430}\right)\right] - HiLeakDis$$

Where:

MaxCredit is 15.6 (grams CO_2-equivalent/mile) for air conditioning systems using HFC–134a, and 17.2 (grams CO_2-equivalent/mile) for air conditioning systems using a refrigerant with a lower global warming potential.

LeakScore means the annual refrigerant leakage rate determined according to the provisions of SAE J2727 (incorporated by reference in § 86.1),, where the refrigerant permeation rates for hoses shall be determined using the procedures specified in SAE J2064 (incorporated by reference in § 86.1). If the calculated rate is less than 10.4 grams/year (or 5.2 grams/year for systems using only electric compressors), the rate for the purpose of this formula shall be 10.4 grams/year (or 5.2 grams/year for systems using only electric compressors).

GWP_{REF} means the global warming potential of the refrigerant as indicated in paragraph (e) of this section or as otherwise determined by the Administrator;

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 calculated result of the equation is less than zero, HiLeakDis shall be set equal to zero, or if the calculated result of the equation is greater than 2.1 g/mi, HiLeakDis shall be set to 2.1 g/mi:

$$HiLeakDis = 2.1 \times \left(\frac{(LeakScore - LeakThreshold)}{3.3}\right)$$

Where:

LeakThreshold = 11.0 for air conditioning systems with a refrigerant capacity less than or equal to 733 grams; or

LeakThreshold = [Refrigerant Capacity × 0.015] for air conditioning systems with a refrigerant capacity greater than 733 grams, where RefrigerantCapacity is the maximum refrigerant capacity specified for the air conditioning system, in grams.

(c) 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)(1) or (b)(2) 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 leakage credit value from paragraph (b)(1) or (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.

(d) The results of paragraph (c) 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).

(e) 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 section. The Administrator will determine values for refrigerants not included in this paragraph (e) upon request by a manufacturer.

(1) For HFC–134a, GWP_{REF} = 1430;

(2) For HFC–152a, GWP_{REF} = 124;

(3) For HFO–1234yf, GWP_{REF} = 4;

(4) For CO_2, GWP_{REF} = 1.

■ 21. Section 86.1868–12 is added to read as follows:

§ 86.1868–12 CO_2 credits for improving the efficiency of air conditioning systems.

Manufacturers may generate credits applicable to the CO_2 fleet average program described in § 86.1865–12 by implementing specific air conditioning system technologies designed to reduce air conditioning-related CO_2 emissions over the useful life of their passenger automobiles and/or light trucks. Credits shall be calculated according to this section for each air conditioning system that the manufacturer is using to generate CO_2 credits. Manufacturers may also generate early air conditioning efficiency credits under this section for the 2009 through 2011 model years according to the provisions of § 86.1871–12(b). For model years 2012 and 2013 the manufacturer may determine air conditioning efficiency credits using the requirements in paragraphs (a) through (d) of this section. For model years 2014 through 2016 the eligibility requirements specified in either paragraph (e) or (f) of this section must be met before an air conditioning system is allowed to generate credits. For model years 2017 and later the eligibility requirements specified in paragraph (g) of this section must be met before an air conditioning system is allowed to generate credits.

(a)(1) 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:

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

(2) 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:

Air conditioning technology	Passenger automobiles (g/mi)	Light trucks (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).	1.5	2.2
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).	1.0	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

(b) 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 (a) of this section, the total credit value is the sum of the gram per mile values for the appropriate model year listed in paragraph (a) of this section for each item that applies to the air conditioning system.

(1) In the 2012 through 2016 model years the total credit value for an air conditioning system for passenger automobiles or light trucks may not be greater than 5.7 grams per mile.

(2) 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.

(c) 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 (b) or (e) 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 (b) of this section applies.

VLM = vehicle lifetime miles, which for passenger automobiles shall be 195,264 and for light trucks shall be 225,865.

(d) The results of paragraph (c) 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).

(e) 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 (e) or, alternatively, by using the AC17 reporting requirements specified in paragraph (f) of this section. The Air Conditioning Idle Test Procedure is not applicable after the 2016 model year.

(1) 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.

(2) Using good engineering judgment, the manufacturer must select the vehicle configuration to be tested that is expected to result in the greatest increased CO_2 emissions as a result of the operation of the air conditioning system for which efficiency credits are being sought. If the air conditioning system is being installed in passenger automobiles and light trucks, a separate determination of the quantity of credits for passenger automobiles and light trucks must be made, but only one test vehicle is required to represent the air conditioning system, provided it represents the worst-case impact of the system on CO_2 emissions.

(3) The manufacturer shall determine an idle test threshold (ITT) for the tested vehicle configuration. A comparison of this threshold value with the CO_2 emissions increase recorded over the Air Conditioning Idle Test Procedure in § 86.165–12 determines the total credits that may be generated by an air conditioning system. The manufacturer may choose one of the following idle test threshold (ITT) values for an air conditioning system:

(i) 14.9 grams per minute; or

(ii) The value determined from the following equation, rounded to the nearest tenth of a gram per minute:

$$Idle\ Test\ Threshold\ (ITT) = 20.5 - (1.58 \times Displacement)$$

Where:

Displacement = the engine displacement of the test vehicle, expressed in liters and rounded to the nearest one tenth of a liter.

(4)(i) If the CO_2 emissions value determined from the Idle Test Procedure in § 86.165–12 is less than or equal to the idle test threshold (ITT) determined in paragraph (e)(3) of this section, the total CO_2 efficiency credit value (Credit) for use in paragraph (c) of this section shall be the applicable value determined in paragraph (b) of this section.

(ii) If the CO_2 emissions value determined from the Idle Test Procedure in § 86.165–12 is greater than the idle test threshold (ITT) determined in paragraph (e)(3) of this section, the total CO_2 efficiency credit value (Credit) for use in paragraph (c) of this section shall be determined using the following formula:

$$Credit = TCV \times \left[1 - \left(\frac{ITP - ITT}{6.4}\right)\right]$$

Where:

Credit = The CO_2 efficiency credit value (Credit) that must be used in paragraph (c) of this section to calculate the total credits (in Megagrams) of air conditioning efficiency credits;

TCV = The total CO_2 efficiency credit value determined according to paragraph (b) 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 determined in paragraph (e)(3) of this section and rounded to the nearest one tenth of a gram per minute:

(iii) Air conditioning systems that record an increased CO_2 emissions value on the Idle Test Procedure in § 86.165–14 that is greater than or equal to the idle test threshold (ITT) determined in paragraph (e)(3) of this section plus 6.4 grams per minute are not eligible for an air conditioning efficiency credit.

(5) Air conditioning systems with compressors that are solely powered by electricity shall submit Air Conditioning Idle Test Procedure data to be eligible to generate credits in the 2014 and later model years, but such systems are not required to meet a specific threshold to be eligible to generate such credits, as long as the engine remains off for a period of at least 2 minutes during the air conditioning on portion of the Idle Test Procedure in § 86.165–12(d).

(f) *AC17 reporting requirements.* Manufacturers may use the provisions of this paragraph (f) as an alternative to the use of the Air Conditioning Idle Test to demonstrate eligibility to generate air conditioning efficiency credits for the 2014 through 2016 model years. This paragraph (f) is required for the 2017 through 2019 model years.

(1) The manufacturer shall perform the AC17 test specified in § 86.167–17 of this part on each unique air conditioning system design and vehicle platform combination for which the manufacturer intends to accrue air conditioning efficiency credits. The manufacturer must test at least one unique air conditioning system within each vehicle platform in a model year, unless all unique air conditioning systems within a vehicle platform have been previously tested. A unique air conditioning system design is a system with unique or substantially different component designs or types and/or system control strategies (e.g., fixed-displacement vs. variable displacement compressors, orifice tube vs. thermostatic expansion valve, single vs. dual evaporator, etc.). In the first year of such testing, the tested vehicle configuration shall be the highest production vehicle configuration within each platform. In subsequent model years the manufacturer must test other unique air conditioning systems within the vehicle platform, proceeding from the highest production untested system until all unique air conditioning systems within the platform have been tested, or until the vehicle platform experiences a major redesign. Whenever a new unique air conditioning system is tested, the highest production configuration using that system shall be the vehicle selected for testing. Air conditioning system designs which have similar cooling capacity, component types, and control strategies, yet differ in terms of compressor pulley ratios or condenser or evaporator surface areas will not be considered to be unique system designs. The test results from one unique system design may represent all variants of that design. Manufacturers must use good engineering judgment to identify the unique air conditioning system designs which will require AC17 testing in subsequent model years. Results must be reported separately for all four phases (two phases with air conditioning off and two phases with air conditioning on) of the test to the Environmental Protection Agency, and the results of the calculations required in § 86.167 paragraphs (m) and (n) must also be reported. In each subsequent model year additional air conditioning system designs, if such systems exist, within a vehicle platform that is generating air conditioning credits must be tested using the AC17 procedure. When all unique air conditioning system designs within a platform have been tested, no additional testing is required within that platform, and credits may be carried over to subsequent model years until there is a significant change in the platform design, at which point a new sequence of testing must be initiated. No more than one vehicle from each credit-generating platform is required to be tested in each model year.

(2) 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.

(g) *AC17 validation testing and reporting requirements.* For the 2020 and later model years, manufacturers must validate air conditioning credits by using the AC17 Test Procedure according to the provisions of this paragraph (g).

(1) 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 § 86.167–17 of this part, according to the requirements of this paragraph (g).

(2) Complete the following testing and calculations:

(i) Perform the AC17 test on a vehicle that incorporates the air conditioning system with the credit-generating technologies.

(ii) 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 (g)(2)(i) of this section and selected using good engineering judgment. The tested vehicle may be from an earlier design generation. If the manufacturer cannot identify an appropriate vehicle to test under this paragraph (g)(2)(ii), they may submit an engineering analysis that describes why an appropriate vehicle is not available or not appropriate, and includes data and information supporting specific credit values, using good engineering judgment.

(iii) Subtract the CO_2 emissions determined from testing under paragraph (g)(1)(i) of this section from the CO_2 emissions determined from testing under paragraph (g)(1)(ii) 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 (b) of this section, then the air conditioning system is eligible to generate the maximum allowable value determined in paragraph (b) of this section. If the result is greater than zero but less than the total of the gram per mile credits determined in paragraph (b) 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 (g)(1)(i) of this section from the CO_2 emissions determined from testing under paragraph (g)(1)(ii) of this section and rounding to the nearest 0.1 grams/mile.

(3) For the first model year for which an air conditioning system is expected to generate credits, the manufacturer must select for testing the projected highest-selling configuration within each combination of vehicle platform and unique air conditioning system. The manufacturer must test at least one unique air conditioning system within each vehicle platform in a model year, unless all unique air conditioning systems within a vehicle platform have been previously tested. A unique air conditioning system design is a system with unique or substantially different component designs or types and/or system control strategies (e.g., fixed-displacement vs. variable displacement compressors, orifice tube vs. thermostatic expansion valve, single vs. dual evaporator, etc.). In the first year of such testing, the tested vehicle configuration shall be the highest production vehicle configuration within each platform. In subsequent model years the manufacturer must test other unique air conditioning systems within the vehicle platform, proceeding from the highest production untested system until all unique air conditioning systems within the platform have been tested, or until the vehicle platform experiences a major redesign. Whenever a new unique air conditioning system is tested, the highest production configuration using that system shall be the vehicle selected for testing. Credits may continue to be generated by the air conditioning system installed in a vehicle platform provided that:

(i) 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;

(ii) 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

(iii) The manufacturer continues to test at least one unique air conditioning system within each platform using the air conditioning system, in each model year, until all unique air conditioning systems within each platform have been tested.

(4) Each air conditioning system must be tested and must meet the testing criteria in order to be allowed to generate credits. Credits may continue to be generated by an air conditioning system in subsequent model years if the manufacturer continues to test at least one unique air conditioning system within each platform on an annual basis, unless all systems have been previously tested, as long as the air conditioning system and vehicle platform do not change substantially.

(h) The following definitions apply to this section:

(1) *Reduced reheat, with externally-controlled, variable displacement compressor* means a system in which compressor displacement is controlled via an electronic signal, based on input from sensors (e.g., position or setpoint of interior temperature control, interior temperature, evaporator outlet air temperature, or refrigerant temperature) and air temperature at the outlet of the evaporator can be controlled to a level at 41 °F, or higher.

(2) *Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable displacement compressor* means a system in which the output of either compressor is controlled by cycling the compressor clutch off-and-on via an electronic signal, based on input from sensors (e.g., position or setpoint of interior temperature control, interior temperature, evaporator outlet air temperature, or refrigerant temperature) and air temperature at the outlet of the evaporator can be controlled to a level at 41 °F, or higher.

(3) *Default to recirculated air mode* means that the default position of the mechanism which controls the source of air supplied to the air conditioning system shall change from outside air to recirculated air when the operator or the automatic climate control system has engaged the air conditioning system (i.e., evaporator is removing heat), except under those conditions where dehumidification is required for visibility (i.e., defogger mode). In vehicles equipped with interior air quality sensors (e.g., humidity sensor, or carbon dioxide sensor), the controls may determine proper blend of air supply sources to maintain freshness of the cabin air and prevent fogging of windows while continuing to maximize the use of recirculated air. At any time, the vehicle operator may manually select the non-recirculated air setting during vehicle operation but the system must default to recirculated air mode on subsequent vehicle operations (i.e., next vehicle start). The climate control system may delay switching to recirculation mode until the interior air temperature is less than the outside air temperature, at which time the system must switch to recirculated air mode.

(4) *Blower motor controls which limit waste energy* means a method of controlling fan and blower speeds which does not use resistive elements to decrease the voltage supplied to the motor.

(5) *Improved condensers and/or evaporators* means that the coefficient of performance (COP) of air conditioning system using improved evaporator and condenser designs is 10 percent higher, as determined using the bench test procedures described in SAE J2765 ''Procedure for Measuring System COP of a Mobile Air Conditioning System on a Test Bench,'' when compared to a system using standard, or prior model year, component designs (SAE J2765 is incorporated by reference in § 86.1). The manufacturer must submit an engineering analysis demonstrating the increased improvement of the system relative to the baseline design, where the baseline component(s) for comparison is the version which a manufacturer most recently had in production on the same vehicle design or in a similar or related vehicle model. The dimensional characteristics (e.g., tube configuration/thickness/spacing, and fin density) of the baseline component(s) shall be compared to the new component(s) to demonstrate the improvement in coefficient of performance.

(6) *Oil separator* means a mechanism which removes at least 50 percent of the oil entrained in the oil/refrigerant mixture exiting the compressor and returns it to the compressor housing or compressor inlet, or a compressor design which does not rely on the circulation of an oil/refrigerant mixture for lubrication.

■ 22. Section 86.1869–12 is added to read as follows:

§ 86.1869–12 CO_2 credits for off-cycle CO_2-reducing technologies.

(a) 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. Durability evaluations of off-cycle technologies may occur at any time throughout a model year, provided that the results can be factored into the data provided in the model year report. Off-cycle credits may not be approved for crash-avoidance technologies, safety critical systems or systems affecting safety-critical functions, or technologies designed for the purpose of reducing the frequency of vehicle crashes. Off-cycle credits may not be earned for technologies installed on a motor vehicle to attain compliance with any vehicle safety standard or any regulation set forth in Title 49 of the Code of Federal Regulations. The manufacturer must use one of the three options specified in this section to determine the CO_2 gram per mile credit applicable to an off-cycle technology. Note that the option provided in paragraph (b) of this section applies only to the 2014 and later model years. The manufacturer should notify EPA in their pre-model year report of their intention to generate any credits under this section.

(b) *Credit available for certain off-cycle technologies.* The provisions of this paragraph (b) are applicable only to 2014 and later model year vehicles. EPA may request data, engineering analyses, or other information that supports a manufacturer's use of the credits in this paragraph (b).

(1) The manufacturer may generate a CO_2 gram/mile credit for certain technologies as specified in this paragraph (b)(1). Technology definitions are in paragraph (b)(4) of this section. Calculated credit values shall be rounded to the nearest 0.1 grams/mile.

(i) *Waste heat recovery.* The credit shall be calculated using the following formula, rounded to the nearest 0.1 grams/mile:

$$Credit\left(\frac{g}{mi}\right) = ELR \times 0.007$$

Where:

ELR = the electrical load reduction of the waste heat recovery system, in Watts, calculated as an average over 5-cycle testing.

(ii) *High efficiency exterior lights.* Credits may be accrued for high efficiency lighting as defined in paragraph (b)(4) of this section based on the lighting locations with such lighting installed. Credits for high efficiency lighting are the sum of the credits for the applicable lighting locations in the following table (rounded to the nearest 0.1 grams/mile), or, if all lighting locations in the table are equipped with high efficiency lighting, the total credit for high efficiency lighting shall be 1.0 grams/mile. Lighting components that result in credit levels less than those shown in the following table are not eligible for credits.

Lighting Component	Credit (grams/mile)
Low beam	0.38
High beam	0.05
Parking/position	0.10
Turn signal, front	0.06
Side marker, front	0.06
Tail	0.10
Turn signal, rear	0.06
Side marker, rear	0.06
License plate	0.08

(iii) *Solar panels.* (A) Credits for solar panels used solely for charging the battery of an electric vehicle, plug-in hybrid electric vehicle, or hybrid electric vehicle shall be calculated using the following equation, and rounded to the nearest 0.1 grams/mile:

$$Credit\left(\frac{g}{mi}\right) = 0.04385 \times P_{panel}$$

Where:

P_{panel} is the is the rated power of the solar panel, in Watts, determined under the standard test conditions of 1000 Watts per meter squared direct solar irradiance at a panel temperature of 25 degrees Celsius (+/−2 degrees) with an air mass spectrum of 1.5 (AM1.5).

(B) Credits for solar panels used solely for active vehicle ventilation systems are those specified in paragraph (b)(1)(viii)(E).

(C) Credits for solar panels used both for active cabin ventilation and for charging the battery of an electric vehicle, plug-in hybrid electric vehicle, or hybrid electric vehicle shall be calculated using the following equation, and rounded to the nearest 0.1 grams/mile:

$$Credit\left(\frac{g}{mi}\right) = C_{vent} + 0.04385 \times (P_{panel} - P_{vent})$$

Where:

C_{vent} is the credit attributable to active cabin ventilation from paragraph (b)(1)(viii)(E) of this section;

P_{panel} is the is the rated power of the solar panel, in Watts, determined under the standard test conditions of 1000 Watts per meter squared direct solar irradiance at a panel temperature of 25 degrees Celsius (+/−2 degrees) with an air mass spectrum of 1.5 (AM1.5); and

P_{vent} is the amount of power, in Watts, required to run the active cabin ventilation system.

(iv) *Active aerodynamic improvements.* (A) The credit for active aerodynamic improvements for passenger automobiles shall be calculated using the following equation, and rounded to the nearest 0.1 grams/mile:

$$Credit\left(\frac{g}{mi}\right) = 19.36 \times CD_{reduced}$$

Where:

$CD_{reduced}$ is the percent reduction in the coefficient of drag (C_d), shown as a value from 0 to 1. The coefficient of drag shall be determined using good engineering judgment consistent with standard industry test methods and practices.

(B) The credit for active aerodynamic improvements for light trucks shall be calculated using the following equation, and rounded to the nearest 0.1 grams/mile:

$$Credit\ \left(\frac{g}{mi}\right) = 33.16 \times CD_{reduced}$$

Where:

$CD_{reduced}$ is the percent reduction in the coefficient of drag (C_d), shown as a value from 0 to 1. The coefficient of drag shall be determined using good engineering judgment consistent with standard industry test methods and practices.

(v) *Engine idle start-stop.*

(A) The passenger automobile credit for engine idle start-stop systems is 2.5 grams/mile, provided that the vehicle is equipped with an electric heater circulation system (or a technology that provides a similar function). For vehicles not equipped with such systems the credit is 1.5 grams/mile.

(B) The light truck credit for engine idle start-stop systems is 4.4 grams/mile, provided that the vehicle is equipped with an electric heater circulation system (or a technology that provides a similar function). For vehicles not equipped with such systems the credit is 2.9 grams/mile.

(vi) *Active transmission warm-up.* Systems using a single heat-exchanging loop that serves both transmission and engine warm-up functions are eligible for the credits in either paragraph (b)(1)(vi) or (b)(1)(vii) of this section, but not both.

(A) The passenger automobile credit is 1.5 grams/mile.

(B) The light truck credit is 3.2 grams/mile.

(vii) *Active engine warm-up.* Systems using a single heat-exchanging loop that serves both transmission and engine warm-up functions are eligible for the credits in either paragraph (b)(1)(vi) or (b)(1)(vii) of this section, but not both.

(A) The passenger automobile credit is 1.5 grams/mile.

(B) The light truck credit is 3.2 grams/mile.

(viii*) Thermal control technologies.* 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.

(A) *Glass or glazing.* Glass or glazing credits are calculated using the following equation, and rounded to the nearest 0.1 grams/mile:

$$Credit = \left[Z \times \sum_{i=1}^{n} \frac{T_i \times G_i}{G}\right]$$

Where:

Credit = the total glass or glazing credits, in grams per mile rounded to the nearest 0.1 grams/mile. The credit may not exceed 2.9 g/mi for passenger automobiles or 3.9 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;

Ti = 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 in § 86.1).

Tts_{base} = 62 for the windshield, side-front, side-rear, rear-quarter, and backlite locations, and 40 for rooflite locations.

(B) *Active seat ventilation.* The passenger automobile credit is 1.0 grams/mile. The light truck credit is 1.3 grams/mile.

(C) *Solar reflective surface coating.* The passenger automobile credit is 0.4 grams/mile. The light truck credit is 0.5 grams/mile.

(D) *Passive cabin ventilation.* The passenger automobile credit is 1.7 grams/mile. The light truck credit is 2.3 grams/mile.

(E) *Active cabin ventilation.* The passenger automobile credit is 2.1 grams/mile. The light truck credit is 2.8 grams/mile.

(2) The maximum allowable decrease in the manufacturer's combined passenger automobile and light truck fleet average CO_2 emissions attributable to use of the default credit values in paragraph (b)(1) of this section is 10 grams per mile. If the total of the CO_2 g/mi credit values from the paragraph (b)(1) of this section does not exceed 10 g/mi for any passenger automobile or light truck in a manufacturer's fleet, then the total off-cycle credits may be calculated according to paragraph (f) of this section. If the total of the CO_2 g/mi credit values from the table in paragraph (b)(1) of this section exceeds 10 g/mi for any passenger automobile or light truck in a manufacturer's fleet, then the gram per mile decrease for the combined passenger automobile and light truck fleet must be determined according to paragraph (b)(2)(i) of this section to determine whether the 10 g/mi limitation has been exceeded.

(i) Determine the gram per mile decrease for the combined passenger automobile and light truck fleet using the following formula:

$$Decrease = \frac{Credits \times 1{,}000{,}000}{[(Prod_C \times 195{,}264) + (Prod_T \times 225{,}865)]}$$

Where:

Credits = The total of passenger automobile and light truck credits, in Megagrams, determined according to paragraph (f) of this section and limited to those credits accrued by using the default gram per mile values in paragraph (b)(1) 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.

(ii) If the value determined in paragraph (b)(2)(i) 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 (b)(1) of this section shall be determined using the following formula:

$$Credit\ (Megagrams) = \frac{[10 \times ((Prod_C \times 195{,}264) + (Prod_T \times 225{,}865))]}{1{,}000{,}000}$$

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.

(iii) If the value determined in paragraph (b)(2)(i) 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 (b)(1) of this section do not exceed the allowable limit, and total credits may be determined for each category of vehicles according to paragraph (f) of this section.

(iv) If the value determined in paragraph (b)(2)(i) 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 (f) of this section must not exceed the value determined in paragraph (b)(2)(ii) 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 (b)(2)(ii) of this section.

(3) In lieu of using the default gram per mile values specified in paragraph (b)(1) 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 (c) or (d) of this section.

(4) Definitions for the purposes of this paragraph (b) are as follows:

(i) *Active aerodynamic improvements* means technologies that are automatically activated under certain conditions to improve aerodynamic efficiency (e.g., lowering of the coefficient of drag, or Cd), while preserving other vehicle attributes or functions.

(ii) *High efficiency exterior lighting* means a lighting technology that, when installed on the vehicle, is expected to reduce the total electrical demand of the exterior lighting system when compared to conventional lighting systems. To be eligible for this credit, the high efficiency lighting must be installed in one or more of the following lighting components: low beam, high beam, parking/position, front and rear turn signals, front and rear side markers, taillights, backup/reverse lights, and/or license plate lighting.

(iii) *Engine idle start-stop* means a technology which enables a vehicle to automatically turn off the engine when the vehicle comes to a rest and restarts the engine when the driver applies pressure to the accelerator or releases the brake. Off-cycle engine start-stop credits will only be allowed for a vehicle 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 for that vehicle.

(iv) *Solar panels* means the external installation of horizontally-oriented solar panels, with direct and unimpeded solar exposure to an overhead sun, on an electric vehicle, a plug-in hybrid electric vehicle, a fuel cell vehicle, or a 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 or to essential vehicle systems (e.g., cabin heating or cooling/ventilation). The rated power of the solar panels used to determine the credit value must be determined under the standard test conditions of 1,000 W/m² direct solar irradiance at a panel temperature of 25 +/− 2° C with an air mass of 1.5 spectrum (AM1.5).

(v) *Active transmission warmup* means a system that uses waste heat from the vehicle to quickly warm the transmission fluid to an operating temperature range using a heat exchanger, increasing the overall transmission efficiency by reducing parasitic losses associated with the transmission fluid, such as losses related to friction and fluid viscosity.

(vi) *Active engine warmup* means a system that uses waste heat from the vehicle 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 allows a faster transition from cold operation to warm operation, decreasing CO_2 emissions, and increasing fuel economy.

(vii) *Waste heat recovery* means a system that captures heat that would otherwise be lost through the engine, exhaust system, or the radiator or other sources and converting that heat to electrical energy that is used to meet the electrical requirements of the vehicle or used to augment the warming of other load reduction technologies (e.g., cabin warming, active engine or transmission warm-up technologies). The amount of energy recovered is the average value over 5-cycle testing.

(viii) *Active seat ventilation* means a device which draws air, pushes or forces air, or otherwise transfers heat from the seating surface which is in contact with the seat occupant and exhausts it to a location away from the seat. At a minimum, the driver and front passenger seat must utilize this technology for a vehicle to be eligible for credit.

(ix) *Solar reflective surface coating* means a vehicle paint or other 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 (incorporated by reference in § 86.1). The coating must be applied at a minimum to all of the approximately horizontal surfaces of the vehicle that border the passenger and luggage compartments of the vehicle, (e.g., the rear deck lid and the cabin roof).

(x) *Passive cabin ventilation* means ducts, devices, or methods which utilize convective airflow to move heated air from the cabin interior to the exterior of the vehicle.

(xi) *Active cabin ventilation* means devices which mechanically move heated air from the cabin interior to the exterior of the vehicle.

(xii) *Electric heater circulation system* means a system installed in a vehicle equipped with an engine idle start-stop system that continues to circulate heated air to the cabin when the engine is stopped during a stop-start event. This system must be calibrated to keep the engine off for a minimum of one minute when the external ambient temperature is 30 °F and when cabin heating is enabled.

(c) *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. This method may not be used for technologies that include elements (e.g., driver-selectable systems) that require additional analyses, data collection, projections, or modeling, or other assessments to determine a national average benefit of the technology. 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. If a specific technology is not expected to change emissions on one of the five test procedures, the manufacturer may submit an engineering analysis to the EPA that demonstrates that the technology has no effect. If EPA concurs with the analysis, then multiple tests are not required using that test procedure; instead, only one of that test procedure shall be required—either with or without the technology installed and operating—and that single value will be used for all of the 5-cycle weighting calculations. 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.

(1) 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 § 600.113–12 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.

(2) 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 § 600.113–12 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 (c)(1) 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 including the off-cycle benefit of the technology but excluding any benefit of the technology on the FTP and HFET.

(3) Subtract the combined city/highway value determined in paragraph (c)(1) of this section from the value determined in paragraph (c)(2) of this section and round to the nearest 0.1 grams/mile. The result is the off-cycle benefit of the technology or technologies being evaluated, subject to EPA approval.

(4) Submit all test values to EPA, and include an engineering analysis describing the technology and how it provides off-cycle emission benefits. EPA may request additional testing if we determine that additional testing would be likely to provide significantly greater confidence in the estimates of off-cycle technology benefits.

(d) *Technology demonstration using alternative EPA-approved methodology.* (1) 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 (c) of this section insufficiently characterizes the effectiveness of the off-cycle technology. In cases where the EPA 5-cycle methodology described in paragraph (c) of this section cannot adequately measure the emission reduction attributable to an 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:

(i) Use modeling, on-road testing, on-road data collection, or other approved analytical or engineering methods;

(ii) Be robust, verifiable, and capable of demonstrating the real-world emissions benefit with strong statistical significance;

(iii) 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;

(iv) Result in data on a model type basis unless the manufacturer demonstrates that another basis is appropriate and adequate.

(2) *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.

(3) With respect to fuel consumption improvement values applicable to the determination of average fuel economy under 600.510–12(c)(3) for the 2017 and later model years, EPA will consult with the U.S. Department of Transportation, National Highway Traffic Safety Administration, prior to making a decision on a manufacturer's application submitted under the requirements of this paragraph (d).

(e) *Review and approval process for off-cycle credits.* (1) *Initial steps required.* (i) A manufacturer requesting off-cycle credits under the provisions of paragraph (c) of this section must conduct the testing and/or simulation described in that paragraph.

(ii) A manufacturer requesting off-cycle credits under the provisions of paragraph (d) 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.

(iii) A manufacturer requesting off-cycle credits under paragraphs (b), (c), or (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.

(2) *Data and information requirements.* The manufacturer seeking off-cycle credits must submit an application for off-cycle credits determined under paragraphs (c) and (d) of this section. The application must contain the following:

(i) 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.

(ii) A list of the vehicle model(s) which will be equipped with the technology.

(iii) A detailed description of the test vehicles selected and an engineering analysis that supports the selection of those vehicles for testing.

(iv) All testing and/or simulation data required under paragraph (c) or (d) of this section, as applicable, plus any other data the manufacturer has considered in the analysis.

(v) For credits under paragraph (d) 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.

(vi) 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.

(vii) 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.

(3) *EPA review of the off-cycle credit application.* Upon receipt of an application from a manufacturer, EPA will do the following:

(i) Review the application for completeness and notify the manufacturer within 30 days if additional information is required.

(ii) Review the data and information provided in the application to determine if the application supports the level of credits estimated by the manufacturer.

(iii) For credits under paragraph (d) of this section, EPA will make the application available to the public for comment, as described in paragraph (d)(2) 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 (e)(3).

(4) *EPA decision.* (i) For credits under paragraph (c) of this section, EPA will notify the manufacturer of its decision within 60 days of receiving a complete application.

(ii) For credits under paragraph (d) 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.

(iii) 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.

(f) *Calculation of total off-cycle credits.* Total off-cycle credits in Megagrams of CO_2 (rounded to the nearest whole number) shall be calculated separately for passenger automobiles and light trucks according to the following formula:

Total Credits (Megagrams) = (Credit × Production × VLM) ÷ 1,000,000

Where:

Credit = the credit value in grams per mile determined in paragraph (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 (b), (c), or (d) of this section applies.

VLM = vehicle lifetime miles, which for passenger automobiles shall be 195,264 and for light trucks shall be 225,865.

■ 23. Section 86.1870–12 is revised to read as follows:

§ 86.1870–12 CO_2 credits for qualifying 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 section. Credits may be generated under either paragraph (a) or (b) of this section for a qualifying pickup truck, but not both.

(a) *Credits for implementation of hybrid electric technology.* Full size pickup trucks that implement hybrid electric technologies may be eligible for an additional credit under this paragraph (a). Pickup trucks earning the credits under this paragraph (a) may not earn the credits described in paragraph (b) of this section. To claim this credit the manufacturer must measure the recovered energy over the Federal Test Procedure according to § 600.116–12(c) to determine whether a vehicle is a mild or strong hybrid electric vehicle. To provide for EPA testing, the vehicle must be able to broadcast battery pack voltage via an on-board diagnostics parameter ID channel.

(1) Full size pickup trucks that are mild hybrid 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 in a model year, the manufacturer must produce a quantity of mild hybrid electric 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 that model year.

Model year	Required minimum percent of full size pickup trucks (percent)
2017	20
2018	30
2019	55
2020	70
2021	80

(2) Full size pickup trucks that are strong hybrid 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 in a model year, the manufacturer must produce a quantity of strong hybrid electric 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 in that model year.

(b) *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 (b), carbon-related exhaust emission values may include any applicable air conditioning leakage and/or efficiency credits as determined in § 86.1867 and § 86.1868. Pickup trucks earning the credits under this paragraph (b) may not earn credits described in paragraph (a) of this section and may not earn credits based on the production multipliers described in § 86.1866–12(b).

(1) Full size pickup trucks that are produced in the 2017 through 2021 model years and 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 a model year, the manufacturer must produce a quantity of full size pickup trucks that meet the initial emission eligibility requirements

of this paragraph (b)(1) 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 that model year.

Model year	Required minimum percent of full size pickup truck (percent)
2017	15
2018	20
2019	28
2020	35
2021	40

(2) Full size pickup trucks that are produced in the 2017 through 2025 model years and 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 four subsequent model years (a total of five consecutive 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 in a model year, the manufacturer must produce a quantity of full size pickup trucks that meet the emission requirements of this paragraph (b)(2) 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 that 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. Use good engineering judgment to determine whether a pickup truck has been subject to a major redesign.

(c) *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:

$$\text{Total Credits (Megagrams)} = ([(10 \times \text{Production}_{MHEV}) + (10 \times \text{Production}_{T15}) + (20 \times \text{Production}_{SHEV}) + (20 \times \text{Production}_{T20})] \times 225{,}865) \div 1{,}000{,}000$$

Where:

Production_{MHEV} = The total number of mild hybrid electric full size pickup trucks produced with a credit value of 10 grams per mile from paragraph (a)(1) of this section.

Production_{T15} = The total number of full size pickup trucks produced with a performance-based credit value of 10 grams per mile from paragraph (b)(1) of this section.

Production_{SHEV} = The total number of strong hybrid electric full size pickup trucks produced with a credit value of 20 grams per mile from paragraph (a)(2) of this section.

Production_{T20} = The total number of full size pickup trucks produced with a performance-based credit value of 20 grams per mile from paragraph (b)(2) of this section.

■ 24. Section 86.1871–12 is added to read as follows:

§ 86.1871–12 Optional early CO_2 credit programs.

Manufacturers may optionally generate CO_2 credits in the 2009 through 2011 model years for use in the 2012 and later model years subject to EPA approval and to the provisions of this section. Manufacturers may generate early fleet average credits, air conditioning leakage credits, air conditioning efficiency credits, early advanced technology credits, and early off-cycle technology credits. Manufacturers generating any credits under this section must submit an early credits report to the Administrator as required in this section. The terms ''sales'' and ''sold'' as used in this section shall mean vehicles produced for U.S. sale, where ''U.S.'' means the states and territories of the United States.

(a) *Early fleet average CO_2 reduction credits.* Manufacturers may optionally generate credits for reductions in their fleet average CO_2 emissions achieved in the 2009 through 2011 model years. To generate early fleet average CO_2 reduction credits, manufacturers must select one of the four pathways described in paragraphs (a)(1) through (4) of this section. The manufacturer may select only one pathway, and that pathway must remain in effect for the 2009 through 2011 model years. Fleet average credits (or debits) must be calculated and reported to EPA for each model year under each selected pathway. Early credits are subject to five year carry-forward restrictions based on the model year in which the credits are generated.

(1) *Pathway 1.* To earn credits under this pathway, the manufacturer shall calculate an average carbon-related exhaust emission value to the nearest one gram per mile for the classes of motor vehicles identified in this paragraph (a)(1), and the results of such calculations will be reported to the Administrator for use in determining compliance with the applicable CO_2 early credit threshold values.

(i) An average carbon-related exhaust emission value calculation will be made for the combined LDV/LDT1 averaging set, where the terms LDV and LDT1 are as defined in § 86.1803.

(ii) An average carbon-related exhaust emission value calculation will be made for the combined LDT2/HLDT/MDPV averaging set, where the terms LDT2, HLDT, and MDPV are as defined in § 86.1803.

(iii) Average carbon-related exhaust emission values shall be determined according to the provisions of § 600.510–12 of this chapter, except that:

(A) [Reserved]

(B) The average carbon-related exhaust emissions for alcohol fueled model types shall be calculated according to the provisions of § 600.510–12(j)(2)(ii)(B) of this chapter, without the use of the 0.15 multiplicative factor.

(C) The average carbon-related exhaust emissions for natural gas fueled model types shall be calculated according to the provisions of § 600.510–12(j)(2)(iii)(B) of this chapter, without the use of the 0.15 multiplicative factor.

(D) The average carbon-related exhaust emissions for alcohol dual fueled model types shall be the value measured using gasoline or diesel fuel, as applicable, and shall be calculated according to the provisions of § 600.510–12(j)(2)(vi) of this chapter, without the use of the 0.15 multiplicative factor and with F = 0. For the 2010 and 2011 model years only, if the California Air Resources Board has approved a manufacturer's request to use a non-zero value of F, the manufacturer may use such an approved value.

(E) The average carbon-related exhaust emissions for natural gas dual fueled model types shall be the value measured using gasoline or diesel fuel, as applicable, and shall be calculated according to the provisions of § 600.510–12(j)(2)(vii) of this chapter, without the use of the 0.15 multiplicative factor and with F = 0. For the 2010 and 2011 model years only, if the California Air Resources Board has approved a manufacturer's request to use a non-zero value of F, the manufacturer may use such an approved value.

(F) Carbon-related exhaust emission values for electric, fuel cell, and plug-in hybrid electric model types shall be included in the fleet average determined under paragraph (a)(1) of this section only to the extent that such vehicles are not being used to generate early advanced technology vehicle credits under paragraph (c) of this section.

(iv) Fleet average CO_2 credit threshold values.

Model year	LDV/ LDT1	LDT2/ HLDT/ MDPV
2009	323	439
2010	301	420
2011	267	390

(v) Credits are earned on the last day of the model year. Manufacturers must calculate, for a given model year, the number of credits or debits it has generated according to the following equation, rounded to the nearest megagram:

CO_2 Credits or Debits (Mg) = [(CO_2 Credit Threshold − Manufacturer's Sales Weighted Fleet Average CO_2 Emissions) × (Total Number of Vehicles Sold) × (Vehicle Lifetime Miles)] ÷ 1,000,000

Where:

CO_2 Credit Threshold = the applicable credit threshold value for the model year and vehicle averaging set as determined by paragraph (a)(1)(iv) of this section;

Manufacturer's Sales Weighted Fleet Average CO_2 Emissions = average calculated according to paragraph (a)(1)(iii) of this section;

Total Number of Vehicles Sold = The number of vehicles domestically sold as defined in § 600.511–80 of this chapter; and

Vehicle Lifetime Miles is 195,264 for the LDV/LDT1 averaging set and 225,865 for the LDT2/HLDT/MDPV averaging set.

(vi) Deficits generated against the applicable CO_2 credit threshold values in paragraph (a)(1)(iv) of this section in any averaging set for any of the 2009–2011 model years must be offset using credits accumulated by any averaging set in any of the 2009–2011 model years before determining the number of credits that may be carried forward to the 2012. Deficit carry forward and credit banking provisions of § 86.1865–12 apply to early credits earned under this paragraph (a)(1), except that deficits may not be carried forward from any of the 2009–2011 model years into the 2012 model year, and credits earned in the 2009 model year may not be traded to other manufacturers.

(2) *Pathway 2.* To earn credits under this pathway, manufacturers shall calculate an average carbon-related exhaust emission value to the nearest one gram per mile for the classes of motor vehicles identified in paragraph (a)(1) of this section, and the results of such calculations will be reported to the Administrator for use in determining compliance with the applicable CO_2 early credit threshold values.

(i) Credits under this pathway shall be calculated according to the provisions of paragraph (a)(1) of this section, except credits may only be generated by vehicles sold in a model year in California and in states with a section 177 program in effect in that model year. For the purposes of this section, ''section 177 program'' means State regulations or other laws that apply to vehicle emissions from any of the following categories of motor vehicles: Passenger 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.

(ii) A deficit in any averaging set for any of the 2009–2011 model years must be offset using credits accumulated by any averaging set in any of the 2009–2011 model years before determining the number of credits that may be carried forward to the 2012 model year. Deficit carry forward and credit banking provisions of § 86.1865–12 apply to early credits earned under this paragraph (a)(1), except that deficits may not be carried forward from any of the 2009–2011 model years into the 2012 model year, and credits earned in the 2009 model year may not be traded to other manufacturers.

(3) *Pathway 3.* Pathway 3 credits are those credits earned under Pathway 2 as described in paragraph (a)(2) of this section in California and in the section 177 states determined in paragraph (a)(2)(i) of this section, combined with additional credits earned in the set of states that does not include California and the section 177 states determined in paragraph (a)(2)(i) of this section and calculated according to this paragraph (a)(3).

(i) Manufacturers shall earn additional credits under Pathway 3 by calculating an average carbon-related exhaust emission value to the nearest one gram per mile for the classes of motor vehicles identified in this paragraph (a)(3). The results of such calculations will be reported to the Administrator for use in determining compliance with the applicable CO_2 early credit threshold values.

(ii) An average carbon-related exhaust emission value calculation will be made for the passenger automobile averaging set. The term ''passenger automobile'' shall have the meaning given by the Department of Transportation at 49 CFR 523.4 for the specific model year for which the calculation is being made.

(iii) An average carbon-related exhaust emission value calculation will be made for the light truck averaging set. The term ''light truck'' shall have the meaning given by the Department of Transportation at 49 CFR 523.5 for the specific model year for which the calculation is being made.

(iv) Average carbon-related exhaust emission values shall be determined according to the provisions of § 600.510–12 of this chapter, except that:

(A) Vehicles sold in California and the section 177 states determined in paragraph (a)(2)(i) of this section shall not be included.

(B) The average carbon-related exhaust emissions for alcohol fueled model types shall be calculated according to the provisions of § 600.510–12(j)(2)(ii)(B) of this chapter, without the use of the 0.15 multiplicative factor.

(C) The average carbon-related exhaust emissions for natural gas fueled model types shall be calculated according to the provisions of § 600.510–12(j)(2)(iii)(B) of this chapter, without the use of the 0.15 multiplicative factor.

(D) The average carbon-related exhaust emissions for alcohol dual fueled model types shall be calculated according to the provisions of § 600.510–12(j)(2)(vi) of this chapter, without the use of the 0.15 multiplicative factor and with F = 0.

(E) The average carbon-related exhaust emissions for natural gas dual fueled model types shall be calculated according to the provisions of § 600.510–12(j)(2)(vii) of this chapter, without the use of the 0.15 multiplicative factor and with F = 0.

(F) Electric, fuel cell, and plug-in hybrid electric model type carbon-related exhaust emission values shall be included in the fleet average determined under paragraph (a)(1) of this section only to the extent that such vehicles are not being used to generate early advanced technology vehicle credits under paragraph (c) of this section.

(v) Pathway 3 fleet average CO_2 credit threshold values.

(A) For 2009 and 2010 model year passenger automobiles, the fleet average

CO_2 credit threshold value is 323 grams/mile.

(B) For 2009 model year light trucks the fleet average CO_2 credit threshold value is 381 grams/mile, or, if the manufacturer chose to optionally meet an alternative manufacturer-specific light truck fuel economy standard calculated under 49 CFR 533.5 for the 2009 model year, the gram per mile fleet average CO_2 credit threshold shall be the CO_2 value determined by dividing 8887 by that alternative manufacturer-specific fuel economy standard and rounding to the nearest whole gram per mile.

(C) For 2010 model year light trucks the fleet average CO_2 credit threshold value is 376 grams/mile, or, if the manufacturer chose to optionally meet an alternative manufacturer-specific light truck fuel economy standard calculated under 49 CFR 533.5 for the 2010 model year, the gram per mile fleet average CO_2 credit threshold shall be the CO_2 value determined by dividing 8887 by that alternative manufacturer-specific fuel economy standard and rounding to the nearest whole gram per mile.

(D) For 2011 model year passenger automobiles the fleet average CO_2 credit threshold value is the value determined by dividing 8887 by the manufacturer-specific passenger automobile fuel economy standard for the 2011 model year determined under 49 CFR 531.5 and rounding to the nearest whole gram per mile.

(E) For 2011 model year light trucks the fleet average CO_2 credit threshold value is the value determined by dividing 8887 by the manufacturer-specific light truck fuel economy standard for the 2011 model year determined under 49 CFR 533.5 and rounding to the nearest whole gram per mile.

(vi) Credits are earned on the last day of the model year. Manufacturers must calculate, for a given model year, the number of credits or debits it has generated according to the following equation, rounded to the nearest megagram:

CO_2 Credits or Debits (Mg) = [(CO_2 Credit Threshold − Manufacturer's Sales Weighted Fleet Average CO_2 Emissions) × (Total Number of Vehicles Sold) × (Vehicle Lifetime Miles)] ÷ 1,000,000

Where:

CO_2 Credit Threshold = the applicable credit threshold value for the model year and vehicle averaging set as determined by paragraph (a)(3)(v) of this section.

Manufacturer's Sales Weighted Fleet Average CO_2 Emissions = average calculated according to paragraph (a)(3)(iv) of this section.

Total Number of Vehicles Sold = The number of vehicles domestically sold as defined in § 600.511 of this chapter except that vehicles sold in California and the section 177 states determined in paragraph (a)(2)(i) of this section shall not be included.

Vehicle Lifetime Miles is 195,264 for the LDV/LDT1 averaging set and 225,865 for the LDT2/HLDT/MDPV averaging set.

(vii) Deficits in any averaging set for any of the 2009–2011 model years must be offset using credits accumulated by any averaging set in any of the 2009–2011 model years before determining the number of credits that may be carried forward to the 2012. Deficit carry forward and credit banking provisions of § 86.1865–12 apply to early credits earned under this paragraph (a)(3), except that deficits may not be carried forward from any of the 2009–2011 model years into the 2012 model year, and credits earned in the 2009 model year may not be traded to other manufacturers.

(4) *Pathway 4.* Pathway 4 credits are those credits earned under Pathway 3 as described in paragraph (a)(3) of this section in the set of states that does not include California and the section 177 states determined in paragraph (a)(2)(i) of this section and calculated according to paragraph (a)(3) of this section. Credits may only be generated by vehicles sold in the set of states that does not include California and the section 177 states determined in paragraph (a)(2)(i) of this section.

(b) *Early air conditioning leakage and efficiency credits.* (1) Manufacturers may optionally generate air conditioning refrigerant leakage credits according to the provisions of § 86.1867 and/or air conditioning efficiency credits according to the provisions of § 86.1868 in model years 2009 through 2011. The early credits are subject to five year carry forward limits based on the model year in which the credits are generated. Credits must be tracked by model type and model year.

(2) Manufacturers must be participating in one of the early fleet average credit pathways described in paragraphs (a)(1), (2), or (3) of this section in order to generate early air conditioning credits for vehicles sold in California and the section 177 states as determined in paragraph (a)(2)(i) of this section. Manufacturers that select Pathway 4 as described in paragraph (a)(4) of this section may not generate early air conditioning credits for vehicles sold in California and the section 177 states as determined in paragraph (a)(2)(i) of this section. Manufacturers not participating in one of the early fleet average credit pathways described in this section may generate early air conditioning credits only for vehicles sold in states other than in California and the section 177 states as determined in paragraph (a)(2)(i) of this section.

(c) *Early advanced technology vehicle incentive.* Vehicles eligible for this incentive are electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles, as those terms are defined in § 86.1803–01. If a manufacturer chooses to not include electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles in their fleet averages calculated under any of the early credit pathways described in paragraph (a) of this section, the manufacturer may generate early advanced technology vehicle credits pursuant to this paragraph (c).

(1) The manufacturer shall record the sales and carbon-related exhaust emission values of eligible vehicles by model type and model year for model years 2009 through 2011 and report these values to the Administrator under paragraph (e) of this section.

(2) Manufacturers may use the 2009 through 2011 eligible vehicles in their fleet average calculations starting with the 2012 model year, subject to a five-year carry-forward limitation.

(i) Eligible 2009 model year vehicles may be used in the calculation of a manufacturer's fleet average carbon-related exhaust emissions in the 2012 through 2014 model years.

(ii) Eligible 2010 model year vehicles may be used in the calculation of a manufacturer's fleet average carbon-related exhaust emissions in the 2012 through 2015 model years.

(iii) Eligible 2011 model year vehicles may be used in the calculation of a manufacturer's fleet average carbon-related exhaust emissions in the 2012 through 2016 model years.

(3)(i) To use the advanced technology vehicle incentive, the manufacturer will apply the 2009, 2010, and/or 2011 model type sales volumes and their model type emission levels to the manufacturer's fleet average calculation.

(ii) The early advanced technology vehicle incentive must be used to offset a deficit in one of the 2012 through 2016 model years, as appropriate under paragraph (c)(2) of this section.

(iii) The advanced technology vehicle sales and emission values may be included in a fleet average calculation for passenger automobiles or light trucks, but may not be used to generate credits in the model year in which they are included or in the averaging set in which they are used. Use of early advanced technology vehicle credits is limited to offsetting a deficit that would otherwise be generated without the use of those credits. Manufacturers shall report the use of such credits in their model year report for the model year in which the credits are used.

(4) Manufacturers may use zero grams/mile to represent the carbon-related exhaust emission values for the electric operation of 2009 through 2011 model year electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles subject to the limitations in § 86.1866. The 2009 through 2011 model year vehicles using zero grams per mile shall count against the 200,000 or 300,000 caps on use of this credit value, whichever is applicable under § 86.1866.

(d) *Early off-cycle technology credits.* Manufacturers may optionally generate credits for the implementation of certain CO_2-reducing technologies according to the provisions of § 86.1869 in model years 2009 through 2011. The early credits are subject to five year carry forward limits based on the model year in which the credits are generated. Credits must be tracked by model type and model year.

(e) *Early credit reporting requirements.* Each manufacturer shall submit a report to the Administrator, known as the early credits report, that reports the credits earned in the 2009 through 2011 model years under this section.

(1) The report shall contain all information necessary for the calculation of the manufacturer's early credits in each of the 2009 through 2011 model years.

(2) The early credits report shall be in writing, signed by the authorized representative of the manufacturer and shall be submitted no later than 90 days after the end of the 2011 model year.

(3) Manufacturers using one of the optional early fleet average CO_2 reduction credit pathways described in paragraph (a) of this section shall report the following information separately for the appropriate averaging sets (e.g. LDV/LDT1 and LDT2/HLDT/MDPV averaging sets for pathways 1 and 2; LDV, LDT/2011 MDPV, LDV/LDT1 and LDT2/HLDT/MDPV averaging sets for Pathway 3; LDV and LDT/2011 MDPV averaging sets for Pathway 4):

(i) The pathway that they have selected (1, 2, 3, or 4).

(ii) A carbon-related exhaust emission value for each model type of the manufacturer's product line calculated according to paragraph (a) of this section.

(iii) The manufacturer's average carbon-related exhaust emission value calculated according to paragraph (a) of this section for the applicable averaging set and region and all data required to complete this calculation.

(iv) The credits earned for each averaging set, model year, and region, as applicable.

(4) Manufacturers calculating early air conditioning leakage and/or efficiency credits under paragraph (b) of this section shall report the following information for each model year separately for passenger automobiles and light trucks and for each air conditioning system used to generate credits:

(i) A description of the air conditioning system.

(ii) The leakage and efficiency credit values and all the information required to determine these values.

(iii) The total credits earned for each averaging set, model year, and region, as applicable.

(5) Manufacturers calculating early advanced technology vehicle credits under paragraph (c) of this section shall report, for each model year and separately for passenger automobiles and light trucks, the following information:

(i) The number of each model type of eligible vehicle produced.

(ii) The carbon-related exhaust emission value by model type and model year.

(6) Manufacturers calculating early off-cycle technology credits under paragraph (d) of this section shall report, for each model year and separately for passenger automobiles and light trucks, all test results and data required for calculating such credits.

PART 600—FUEL ECONOMY AND GREENHOUSE GAS EXHAUST EMISSIONS OF MOTOR VEHICLES

■ 25. The authority citation for part 600 continues to read as follows:

Authority: 49 U.S.C. 32901–23919q, Pub. L. 109–58.

Subpart A—General Provisions

■ 26. Section 600.002 is amended as follows:

■ a. By revising the definition for ''base tire.''

■ b. By revising the definition for ''combined fuel economy.''

■ c. By adding a definition for ''emergency vehicle'' in alphabetical order.

■ d. By revising the definition for ''fuel economy.''

The revisions and addition read as follows:

§ 600.002 Definitions.

* * * * *

Base tire means the tire size specified as standard equipment by the manufacturer on each unique combination of a vehicle's footprint and model type. Standard equipment is defined in 40 CFR 86.1803–01.

* * * * *

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.

* * * * *

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 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.

* * * * *

Subpart B—Fuel Economy and Carbon-Related Exhaust Emission Test Procedures

■ 27. 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.

* * * * *

■ 28. Section 600.113–12 is amended by revising paragraphs (g)(2)(iv)(C) and (j) through (n) 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_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.

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)(1) For automobiles fueled with liquefied petroleum gas and automobiles designed to operate on gasoline and liquefied petroleum gas, the fuel economy in miles per gallon of liquefied petroleum gas is to be calculated using the following equation:

$$mpg_e = \frac{(CWF_{fuel} \times SG_{fuel} \times 3781.8)}{((CWF_{HC} \times HC) + (0.429 \times CO) + (0.273 \times CO_2))}$$

Where:

mpg_e = miles per gasoline gallon equivalent of liquefied petroleum gas.

CWF_{fuel} = carbon weight fraction based on the hydrocarbon constituents in the liquefied petroleum gas fuel as obtained in paragraph (f)(3) of this section and rounded according to paragraph (g)(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.

3781.8 = Grams/mile of H_2O per gallon conversion factor.

CWF_{HC} = Carbon weight fraction of exhaust hydrocarbons = CWF_{fuel} as determined in paragraph (f)(4) of this section and rounded according to paragraph (f)(3) of this section.

HC = Grams/mile HC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

(2)(i) For automobiles fueled with liquefied petroleum gas and automobiles designed to operate on gasoline and liquefied petroleum gas, the carbon-related exhaust emissions in grams per mile while operating on liquefied petroleum gas is to be calculated for 2012 and later model year vehicles using the following equation and rounded to the nearest 1 gram per mile:

$$CREE = (CWF_{HC}/0.273 \times HC) + (1.571 \times CO) + CO_2$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002.

CWF_{HC} = Carbon weight fraction of exhaust hydrocarbons = CWF_{fuel} 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.

(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:

$$CREE = [(CWF_{exHC}/0.273) \times NMHC] + (1.571 \times CO) + CO_2 + (298 \times N_2O) + (25 \times CH_4)$$

Where:

CREE means the carbon-related exhaust emission value as defined in § 600.002.

CWF_{HC} = Carbon weight fraction of exhaust hydrocarbons = CWF_{fuel} as determined in paragraph (f)(2)(ii) of this section and rounded according to paragraph (g)(3) of this section.

NMHC = Grams/mile HC as obtained in paragraph (g)(2) of this section.

CO = Grams/mile CO as obtained in paragraph (g)(2) of this section.

CO_2 = Grams/mile CO_2 as obtained in paragraph (g)(2) of this section.

N_2O = Grams/mile N_2O as obtained in paragraph (g)(2) of this section.

CH_4 = Grams/mile CH_4 as obtained in paragraph (g)(2) of this section.

(n) Manufacturers shall determine CO_2 emissions and carbon-related exhaust emissions for electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles according to the provisions of this paragraph (n). Subject to the limitations on the number of vehicles produced and delivered for sale as described in § 86.1866 of this chapter, the manufacturer may be allowed to use a value of 0 grams/mile to represent the emissions of fuel cell vehicles and the proportion of electric operation of a electric vehicles and plug-in hybrid electric vehicles that is derived from electricity that is generated from sources that are not onboard the vehicle, as described in paragraphs (n)(1) through (3) of this section. For purposes of labeling under this part, the CO_2 emissions for electric vehicles shall be 0 grams per mile. Similarly, for purposes of labeling under this part, the CO_2 emissions for plug-in hybrid electric vehicles shall be 0 grams per mile for the proportion of electric operation that is derived from electricity that is generated from sources that are not onboard the vehicle. For manufacturers no longer eligible to use 0 grams per mile to represent electric operation, and for all 2026 and later model year electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles, the provisions of this paragraph (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 limited number of vehicles produced and delivered for sale as described in § 86.1866–12(a) of this chapter.

$$CREE_{UP} = \frac{EC}{GRIDLOSS} \times AVGUSUP$$, and

$$CREE_{GAS} = \frac{2478}{8887} \times TargetCO_2$$,

Where:

EC = The vehicle energy consumption in watt-hours per mile, for combined FTP/HFET operation, determined according to procedures established by the Administrator under § 600.116–12.

GRIDLOSS = 0.93 for the 2012 through 2016 model years, and 0.935 for the 2017 and later model years (to account for grid transmission losses).

AVGUSUP = 0.642 for the 2012 through 2016 model years, and 0.534 for the 2017 and later model years (the nationwide average electricity greenhouse gas emission rate at the powerplant, in grams per watt-hour).

2478 is the estimated grams of upstream greenhouse gas emissions per gallon of gasoline.

8887 is the estimated grams of CO_2 per gallon of gasoline.

$TargetCO_2$ = The CO_2 Target Value for the fuel cell or electric vehicle determined according to § 86.1818 of this chapter for the appropriate model year.

(2) For plug-in hybrid electric vehicles the carbon-related exhaust emissions in grams per mile is to be calculated according to the provisions of § 600.116, except that the CREE for charge-depleting operation shall be the sum of the CREE associated with gasoline consumption and the net upstream CREE determined according to paragraph (n)(1)(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 (n)(1) of this section, except that $CREE_{UP}$ shall be determined according to procedures established by the Administrator under § 600.111–08(f). As described in § 86.1866 of this chapter the value of CREE may be set equal to zero for a certain number of 2012 through 2025 model year fuel cell vehicles.

■ 29. 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 addition 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 following clarifications and modifications:

* * * * *

(c) *Determining the proportion of recovered energy for hybrid electric vehicles.* Testing of hybrid electric vehicles under this part may include a determination of the proportion of 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 § 86.1870–12, and requires the measurement of electrical current (in amps) flowing into the hybrid system battery for the duration of the test. Hybrid electric vehicles are tested for fuel economy and GHG emissions using the 4-bag FTP as required by § 600.114(c). Alternative measurement and calculation methods may be used with prior EPA approval.

(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:

$$P_{roadload} = -\left(\frac{V_{mph} \times 0.44704 \times 4.448 \times \left(A + (B \times V_{mph}) + (C \times V_{mph}^{2})\right)}{1000}\right)$$

Where:

$P_{roadload}$ is the road load power in kilowatts, where road load is negative because it always represents a deceleration (i.e., resistive) force on the vehicle;

A, B, and C are the vehicle-specific dynamometer road load coefficients in lb-force, lb-force/mph, and lb-force/mph^2, respectively;

V_{mph} = velocity in miles/hour, expressed to the nearest 0.01 miles/hour;

0.44704 converts speed from miles/hour to meters/second;

4.448 converts pound force to Newtons; and

1,000 converts power from Watts to kilowatts.

(B) Determine the applied deceleration power at each sampling point in time, t, in kilowatts, using the following equation. Positive values indicate acceleration and negative values indicate deceleration.

$$P_{accel} = \frac{ETW \times (V_t \times 0.44704) \times \left(0.44704 \times \frac{(V_t - V_{t-1})}{0.1}\right)}{2.205 \times 1000}$$

Where:

ETW = the vehicle Equivalent Test Weight (lbs);

V_t = velocity in miles/hour, rounded to the nearest 0.01 miles/hour, at each sampling point;

V_{t-1} = the velocity in miles/hour at the previous time point in the 10 Hz speed vs. time table, rounded to the nearest 0.01 miles/hour;

0.1 represents the time in seconds between each successive velocity data point;

0.44704 converts speed from miles/hour to meters/second;

2.205 converts weight from pounds to kilograms; and

1,000 converts power from Watts to kilowatts.

(C) Determine braking power in kilowatts using the following equation. Note that during braking events, P_{brake}, P_{accel}, and $P_{roadload}$ will all be negative (i.e., resistive) forces on the vehicle.

$$P_{brake} = P_{accel} - P_{roadload}$$

Where:

P_{accel} = the value determined in paragraph (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) 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 36000 (to convert 10 Hz data to hours) and rounded to the nearest 0.01 kilowatt hours.

(2) Calculate the actual amount of energy recovered (E_{rec}) by a hybrid electric vehicle when tested on the FTP according to the provisions of this part, as follows:

(i) Measure the electrical current in Amps to and from the hybrid electric vehicle battery during the FTP. Measurements should be made directly upstream of the battery at a 10 Hz sampling rate.

(ii) At each sampling point where current is flowing into the battery, calculate the current flowing into the battery, in Watt-hours, as follows:

$$E_t = \frac{V_{nominal} \times I_t}{36{,}000}$$

Where:

E_t = the current flowing into the battery, in Watt-hours, at time t in the test;

I_t = the electrical current, in Amps, at time t in the test; and

$V_{nominal}$ = the nominal voltage of the hybrid battery system determined according to paragraph (c)(4) of this section.

(iii) The total energy recovered (E_{rec}) is the absolute value of the sum of all values of E_t that represent current flowing into the battery, divided by 1000 (to convert Watt-hours to kilowatt-hours).

(3) The percent of braking energy recovered by a hybrid system relative to the total available energy is determined by the following equation, rounded to the nearest one percent:

$$Energy\ Recovered\ \% = \frac{E_{rec}}{E_{brake}} \times 100$$

Where:

E_{rec} = The actual total energy recovered, in kilowatt hours, as determined in paragraph (c)(2) of this section; and

E_{brake} = The theoretical maximum amount of energy, in kilowatt hours, that could be recovered by a hybrid electric vehicle over the FTP test cycle, as determined in paragraph (c)(1) of this section.

(4)(i) Determination nominal voltage ($V_{nominal}$) using the following equation:

$$V_{nominal} = \frac{V_S + V_F}{2}$$

Where:

V_S is the battery voltage measured at the start of the FTP test, where the measurement is made after the key-on event but not later than 10 seconds after the key-on event; and

V_F is the battery voltage measured at the conclusion of the FTP test, where the measurement is made before the key-off event but not earlier than 10 seconds prior to the key-off event.

(ii) If the absolute value of the measured current to and from the battery during the measurement of either V_S or V_F exceeds three percent of the maximum absolute value of the current measured over the FTP, then that V_S or V_F value is not valid. If no valid voltage measurement can be made using this method, the manufacturer must develop an alternative method of determining nominal voltage. The alternative must be developed using good engineering judgment and is subject to EPA approval.

Subpart C—Procedures for Calculating Fuel Economy and Carbon-Related Exhaust Emission Values

■ 30. Section 600.210–12 is amended by revising paragraphs (a) introductory text and (a)(5) to read as follows:

§ 600.210–12 Calculation of fuel economy and CO_2 emission values for labeling.

(a) *General labels.* Except as specified in paragraphs (d) and (e) of this section, fuel economy and CO_2 emissions for general labels may be determined by one of two methods. The first is based on vehicle-specific model-type 5-cycle data as determined in § 600.209–12(b). This method is available for all vehicles and is required for vehicles that do not qualify for the second method as described in § 600.115 (other than electric vehicles). The second method, the derived 5-cycle method, determines fuel economy and CO_2 emissions values from the FTP and HFET tests using equations that are derived from vehicle-specific 5-cycle model type data, as determined in paragraph (a)(2) of this section. Manufacturers may voluntarily lower fuel economy values and raise CO_2 values if they determine that the label values from any method are not representative of the fuel economy and CO_2 emissions for that model type. MPG values may not be lowered without also making a corresponding change to the CO_2 value for a model type.

* * * * *

(5) *General alternate fuel economy and CO_2 emissions label values for fuel cell vehicles.* Determine FTP-based city and HFET-based highway fuel economy label values for fuel cell vehicles using procedures specified by the Administrator. Convert kilograms of hydrogen/mile results to miles per kilogram of hydrogen and miles per gasoline gallon equivalent. CO_2 label information is based on tailpipe emissions only, so CO_2 emissions from fuel cell vehicles are assumed to be zero.

* * * * *

Subpart D—Fuel Economy Labeling

■ 31. 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: x 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.

■ 32. Section 600.310–12 is amended by revising paragraph (a) to read as follows:

§ 600.310–12 Fuel economy label format requirements—electric vehicles.

* * * * *

(a) Include the following statement instead of the statement specified in § 600.302–12(b)(4): ''Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets a MPG and costs $ b to fuel over 5 years. Cost estimates are based on c miles per year at $ d per kW-hr. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.'' For a, b, c, and d, insert the appropriate values established by EPA.

* * * * *

■ 33. 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.

* * * * *

Subpart F—Procedures For Determining Manufacturer's Average Fuel Economy and Manufacturer's Average Carbon-Related Exhaust Emissions

■ 33. 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 (i).

■ h. By revising paragraph (j)(2)(vii).

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:

$$\text{Average MPG} = \frac{1}{\left[\frac{1}{MPG} - (FCIV_{AC} + FCIV_{OC} + FCIV_{PU})\right]}$$

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;

$FCIV_{AC}$ = Air conditioning fuel economy credits for a category of vehicles, in gallons per mile, determined according to paragraph (c)(3)(i) of this section;

$FCIV_{OC}$ = 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

$FCIV_{PU}$ = 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)(A) 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, except for natural gas dual fuel vehicles that do not meet the criteria in paragraph (c)(2)(vii)(B) the Utility Factor shall be 0.5. 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

(B) Natural gas dual fuel model types must meet the following criteria to qualify for use of a Utility Factor greater than 0.5:

(*1*) The driving range using natural gas must be at least two times the driving range using gasoline.

(*2*) The natural gas dual fuel vehicle must be designed such that gasoline is used only when the natural gas tank is effectively empty, except for limited use of gasoline that may be required to initiate combustion.

(3) *Fuel consumption improvement.* Calculate the separate air conditioning, off-cycle, and pickup truck fuel consumption improvement as follows:

(i) Air conditioning fuel consumption improvement values are calculated separately for each category identified in paragraph (a)(1) of this section using the following equation:

$$FCIV_{AC}\ (\text{gal/mi}) = \frac{(ACCredit \times 1{,}000{,}000)}{(VLM \times Production \times 8887)}$$

Where:

$FCIV_{AC}$ = the fleet production-weighted total value of air conditioning efficiency credits (fuel consumption improvement value) 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 applicable vehicle category, in megagrams, from 40 CFR 86.1868–12(c), and rounded to the nearest whole number;

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 applicable category of vehicles.

(ii) Off-cycle technology fuel consumption improvement values are calculated separately for each category identified in paragraph (a)(1) of this section using the following equation:

$$FCIV_{OC}\ (gal/mi) = \frac{(OCCredit \times 1{,}000{,}000)}{(VLM \times Production \times 8887)}$$

Where:

$FCIV_{OC}$ = the fleet production-weighted total value of off-cycle technology credits (fuel consumption improvement value) 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 applicable vehicle category, in megagrams, from 40 CFR 86.1869–12(e), and rounded to the nearest whole number;

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 applicable category of vehicles.

(iii) Full size pickup truck fuel consumption improvement values are calculated for the light truck category identified in paragraph (a)(1) of this section using the following equation:

$$FCIV_{PU}\ (gal/mi) = \frac{(PUCredit \times 1{,}000{,}000)}{(225{,}865 \times Production \times 8887)}$$

Where:

$FCIV_{PU}$ = the fleet production-weighted total value of full size pickup truck credits (fuel consumption improvement value) 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 86.1870–12(c), and rounded to the nearest whole number; 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

* * * * *

(i) For model years 2012 through 2015, and for each category of automobile identified in paragraph (a)(1) of this section, the maximum decrease in average carbon-related exhaust emissions determined in paragraph (j) of this section attributable to alcohol dual fuel automobiles and natural gas dual fuel automobiles shall be calculated using the following formula, and rounded to the nearest tenth of a gram per mile:

$$Maximum\ Decrease = \frac{8887}{\left[\frac{8887}{FltAvg} - MPG_{MAX}\right]} - FltAvg$$

Where:

FltAvg = The fleet average CREE value in grams per mile, rounded to the nearest whole number, for passenger automobiles or light trucks determined for the applicable model year according to paragraph (j) of this section, except by assuming all alcohol dual fuel and natural gas dual fuel automobiles are operated exclusively on gasoline (or diesel) fuel. For the purposes of these calculations, the values for natural gas dual fuel automobiles using the optional Utility Factor approach in paragraph (j)(2)(vii) of this section shall not be the gasoline CREE values, but the CREE values determined in paragraph (j)(2)(vii) of this section.

MPG_{MAX} = The maximum increase in miles per gallon determined for the appropriate model year in paragraph (h) of this section.

(1) The Administrator shall calculate the decrease in average carbon-related exhaust emissions to determine if the maximum decrease provided in this paragraph (i) has been reached. The Administrator shall calculate the average carbon-related exhaust emissions for each category of automobiles specified in paragraph (a) of this section by subtracting the average carbon-related exhaust emission values determined in paragraph (j) of this section from the average carbon-related exhaust emission values calculated in accordance with this section by assuming all alcohol dual fuel and natural gas dual fuel automobiles are operated exclusively on gasoline (or diesel) fuel. For the purposes of these calculations, the values for natural gas dual fuel automobiles using the optional Utility Factor approach in paragraph (j)(2)(vii) of this section shall not be the gasoline CREE values, but the CREE values determined in paragraph (j)(2)(vii) of this section. The difference is limited to the maximum decrease specified in paragraph (i) of this section.

(2) [Reserved]

(j) * * *

(2) * * *

(vii)(A) For natural gas dual fuel model types, for model years 2016 and later, or optionally for model years 2012 through 2015, 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, except for natural gas dual fuel vehicles that do not meet the criteria in paragraph (j)(2)(vii)(B) the Utility Factor shall be 0.5. 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

(B) Natural gas dual fuel model types must meet the following criteria to qualify for use of a Utility Factor greater than 0.5:

(*1*) The driving range using natural gas must be at least two times the driving range using gasoline.

(*2*) The natural gas dual fuel vehicle must be designed such that gasoline is used only when the natural gas tank is effectively empty, except for limited use of gasoline that may be required to initiate combustion.

* * * * *

■ 34. Section 600.514–12 is amended as follows:

■ a. By revising paragraph (b)(1)(v).

■ b. By revising paragraph (b)(1)(vii).

■ c. By redesignating paragraph (b)(1)(ix) as (x).

■ d. By adding paragraphs (b)(1)(ix).

The revisions and addition 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, plug-in hybrid electric vehicles, dedicated compressed natural gas vehicles, and dual fuel natural gas vehicles using (or projected to use) the advanced technology vehicle credit and incentives program, including the projected use of production multipliers;

(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 amends 49 CFR Chapter V as follows:

PART 523—VEHICLE CLASSIFICATION

■ 35. 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.

■ 36. 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 size specified as standard equipment by the manufacturer on each unique combination of a vehicle's footprint and model type. Standard equipment is defined in 40 CFR 86.1803–01.

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 has the meaning given in 40 CFR 86.1803–01.

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 vehicle has the meaning given in in 40 CFR 86.1803–01.

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 vehicle has the meaning given in 40 CFR 86.1803–01.

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

■ 37. 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

■ 38. 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).

The revisions and addition read as follows:

§ 531.5 Fuel economy standards.

(a) Except as provided in paragraph (f) 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/ft²)	*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:

$$CAFE_{required} = \frac{\Sigma_i PRODUCTION_i}{\Sigma_i \frac{PRODUCTION_i}{TARGET_i}}$$

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.

TABLE III—PARAMETERS FOR THE PASSENGER AUTOMOBILE FUEL ECONOMY TARGETS, MYS 2012–2025

Model year	Parameters			
	a (mpg)	*b* (mpg)	*c* (gal/mi/ft²)	*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

TABLE III—PARAMETERS FOR THE PASSENGER AUTOMOBILE FUEL ECONOMY TARGETS, MYS 2012–2025—Continued

Model year	Parameters			
	a (mpg)	*b* (mpg)	*c* (gal/mi/ft^2)	*d* (gal/mi)
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	36.7
2018	38.0
2019	39.4
2020	40.9
2021	42.7
2022	44.7
2023	46.8
2024	49.0
2025	51.3

(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.

* * * * *

■ 39. Revise § 531.6 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.

(b) The eligibility of a manufacturer to increase its fuel economy performance through use of an off-cycle technology requires an application request made to EPA in accordance with 40 CFR Part 86.1869–12 and an approval granted by EPA made in consultation with NHTSA. In order to expedite NHTSA's consultation with EPA, a manufacturer's application as part of the off-cycle credit approval process under 40 CFR 86.1869–12(b) or 40 CFR 86.1869–12(c) shall also be submitted to NHTSA at the same time if the manufacturer is seeking off-cycle fuel economy improvement values under the CAFE program for those technologies. For off-cycle technologies which are covered under 40 CFR 86.1869–12(b) or 40 CFR 86.1869–12(c), NHTSA will consult with EPA regarding NHTSA's evaluation of the specific off-cycle technology to ensure its impact on fuel economy and the suitability of using the off-cycle technology to adjust the fuel economy performance. NHTSA will provide its views on the suitability of the technology for that purpose to EPA. NHTSA's evaluation and review will consider:

(1) Whether the technology has a direct impact upon improving fuel economy performance;

(2) Whether the technology is related to crash-avoidance technologies, safety critical systems or systems affecting safety-critical functions, or technologies designed for the purpose of reducing the frequency of vehicle crashes;

(3) Information from any assessments conducted by EPA related to the application, the technology and/or related technologies; and

(4) Any other relevant factors.

■ 40. 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

APPENDIX TABLE I—Continued

Model type				Description	Actual measured fuel economy (mpg)	Volume
Group	Carline name	Basic engine (L)	Transmission class			
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:

Manufacturer X calculates a fuel economy target standard for each unique model type and footprint combination.

APPENDIX TABLE II

Model type				Description	Base tire size	Wheelbase (inches)	Track width F&R average (inches)	Footprint (ft²)	Volume	Fuel economy target standard (mpg)
Group	Carline name	Basic engine (L)	Transmission class							
1	PC A FWD	1.8	A5	2-door sedan.	205/75R14	99.8	61.2	42.4	1,500	35.01
2	PC A FWD	1.8	M6	2-door sedan.	215/70R15	99.8	60.9	42.2	2,000	35.14
3	PC A FWD	2.5	A6	4-door wagon.	215/70R15	100.0	60.9	42.3	2,000	35.08
4	PC A AWD	1.8	A6	4-door wagon.	235/60R15	100.0	61.2	42.5	1,000	35.95
5	PC A AWD	2.5	M6	2-door hatchback.	225/65R16	99.6	59.5	41.2	3,000	35.81
6	PC B RWD.	2.5	A6	4-door wagon.	265/55R18	109.2	66.8	50.7	8,000	30.33
7	PC B RWD.	2.5	A7	4-door sedan.	235/65R17	109.2	67.8	51.4	2,000	29.99
8	PC C AWD.	3.2	A7	4-door sedan.	265/55R18	111.3	67.8	52.4	5,000	29.52
9	PC C FWD	3.2	M6	2-door coupe.	225/65R16	111.3	67.2	51.9	3,000	29.76
Total									27,500	

Note to Appendix 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 =

$$= \frac{(Manufacturer's\ Domestic\ Passenger\ Automobile\ Production\ for\ Applicable\ Model\ Year)}{\sum_i \left(\frac{Group_1\ Production}{Group_1 Target\ Standard} + \frac{Group_2\ Production}{Group_2 Target\ Standard} + \cdots \frac{Group_9\ Production}{Group_9 Target\ Standard}\right)}$$

$$= \frac{(27{,}500)}{\left(\frac{1500}{35.01} + \frac{2000}{35.14} + \frac{2000}{35.08} + \frac{1000}{35.95} + \frac{3000}{35.81} + \frac{8000}{30.33} + \frac{2000}{29.99} + \frac{5000}{29.52} + \frac{3000}{29.79}\right)}$$

= 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

■ 41. 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.

■ 42. 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:

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

TABLE III—Continued

Model year	Combined standard	
	Captive imports	Other
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

TABLE IV—Continued

Model year	Standard
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/ft²)	*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/ft²)	*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:

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

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.

TABLE VII—PARAMETERS FOR THE LIGHT TRUCK FUEL ECONOMY TARGETS FOR MYS 2017–2025

Model year	Parameters							
	a (mpg)	*b* (mpg)	*c* (gal/mi/ft²)	*d* (gal/mi)	*e* (mpg)	*f* (mpg)	*g* (gal/mi/ft²)	*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) 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 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.

■ 43. Amend § 533.6 by revising paragraph (b) and adding paragraph (c) 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 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 performance-based technologies for full-size pickup trucks.

(c) The eligibility of a manufacturer to increase its fuel economy performance through use of an off-cycle technology requires an application request made to EPA in accordance with 40 CFR Part 86.1869–12 and an approval granted by EPA made in consultation with NHTSA. In order to expedite NHTSA's consultation with EPA, a manufacturer's application as part of the off-cycle credit approval process under 40 CFR 86.1869–12(b) or 40 CFR 86.1869–12(c) shall also be submitted to NHTSA at the same time if the manufacturer is seeking off-cycle fuel economy improvement values under the CAFE program for those technologies. For off-cycle technologies which are covered under 40 CFR 86.1869–12(b) or 40 CFR 86.1869–12(c), NHTSA will consult with EPA regarding NHTSA's evaluation of the specific off-cycle technology to ensure its impact on fuel economy and the suitability of using the off-cycle technology to adjust the fuel economy performance. NHTSA will provide its views on the suitability of the technology for that purpose to EPA. NHTSA's evaluation and review will consider:

(1) Whether the technology has a direct impact upon improving fuel economy performance;

(2) Whether the technology is related to crash-avoidance technologies, safety critical systems or systems affecting safety-critical functions, or technologies designed for the purpose of reducing the frequency of vehicle crashes.

(3) Information from any assessments conducted by EPA related to the application, the technology and/or related technologies; and

(4) Any other relevant factors.

■ 44. Revise Appendix A to part 533 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

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.

Manufacturer X calculates a fuel economy target standard for each unique model type and footprint combination.

APPENDIX TABLE II

Model type				Description	Base tire size	Wheelbase (inches)	Track width F&R average (inches)	Footprint (ft²)	Volume	Fuel economy target standard (mpg)
Group	Carline name	Basic engine (L)	Transmission class							
1	Pickup A 2WD	4	A5	Reg cab, MB	235/75R15	100.0	68.8	47.8	800	27.30
2	Pickup B 2WD	4	M5	Reg cab, MB	235/75R15	100.0	68.2	47.4	200	27.44
3	Pickup C 2WD	4.5	A5	Reg cab, LB	255/70R17	125.0	68.8	59.7	300	23.79
4	Pickup C 2WD	4	M5	Ext cab, MB	255/70R17	125.0	68.8	59.7	400	23.79
5	Pickup C 4WD	4.5	A5	Crew cab, SB	275/70R17	150.0	69.0	71.9	400	22.27
6	Pickup D 2WD	4.5	A6	Crew cab, SB	255/70R17	125.0	68.8	59.7	400	23.79
7	Pickup E 2WD	5	A6	Ext cab, LB	255/70R17	125.0	68.8	59.7	500	23.79
8	Pickup E 2WD	5	A6	Crew cab, MB	285/70R17	125.0	69.2	60.1	500	23.68
9	Pickup F 2WD	4.5	A5	Reg cab, LB	255/70R17	125.0	68.9	59.8	1,600	23.76
10	Pickup F 4WD	4.5	A5	Ext cab, MB	275/70R17	150.0	69.0	71.9	800	22.27
11	Pickup F 4WD	4.5	A5	Crew cab, SB	285/70R17	150.0	69.2	72.1	800	22.27
Total									6,700	

Note to Appendix 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 =

$$= \frac{(\text{Manufacturer's Light Truck Production for Applicable Model Year})}{\sum_i \left(\frac{\text{Group}_1\ \text{Production}}{\text{Group}_1\ \text{Target Standard}} + \frac{\text{Group}_{2a}\ \text{Production}}{\text{Group}_2\ \text{Target Standard}} + \ldots \frac{\text{Group}_{11}\ \text{Production}}{\text{Group}_{11}\ \text{Target Standard}}\right)}$$

$$= \frac{(6{,}700)}{\left(\frac{800}{27.80} + \frac{200}{27.44} + \frac{300}{25.79} + \frac{400}{23.79} + \frac{400}{22.27} + \frac{400}{23.79} + \frac{500}{23.79} + \frac{500}{23.68} + \frac{1600}{23.76} + \frac{800}{22.27} + \frac{800}{22.27}\right)}$$

= 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 =

$$= \frac{(\text{Manufacturer's Light Truck Production for Applicable Model Year})}{\sum_i \left(\frac{\text{Group}_1\ \text{Production}}{\text{Group}_1\ \text{Performance}} + \frac{\text{Group}_2\ \text{Production}}{\text{Group}_2\ \text{Performance}} + \cdots \frac{\text{Group}_{11}\ \text{Production}}{\text{Group}_{11}\ \text{Performance}}\right)}$$

$$= \frac{(27{,}500)}{\left(\frac{1500}{14.0} + \frac{2000}{34.6} + \frac{2000}{33.8} + \frac{1000}{34.4} + \frac{3000}{32.9} + \frac{8000}{32.2} + \frac{2000}{33.1} + \frac{5000}{30.6} + \frac{3000}{28.5}\right)}$$

= 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).

PART 536—TRANSFER AND TRADING OF FUEL ECONOMY CREDITS

■ 45. The authority citation for part 536 it is revised to read as follows:

Authority: 49 U.S.C. 32903; delegation of authority at 49 CFR 1.50.

■ 46. 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.

■ 47. 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).

* * * * *

■ 48. Amend § 536.10 by revising paragraphs (b) and (c) and adding paragraph (d) to read as follows:

§ 536.10 Treatment of dual-fuel and alternative-fuel vehicles—consistency with 49 CFR part 538.

* * * * *

(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 hybrid 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).

PART 537—AUTOMOTIVE FUEL ECONOMY REPORTS

■ 49. 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.

■ 50. Amend § 537.5 by revising paragraph (c)(4) to read as follows:

§ 537.5 General requirements for reports.

* * * * *

(c) * * *

(4) Be submitted on CD–ROM for confidential reports provided in accordance with Part 537.12 and by email for non-confidential (i.e., redacted) versions of reports. The content of reports must be provided in a pdf or MS Word format except for the information required in 537.7 which must be provided in a MS Excel format. Submit 2 copies of the CD–ROM to: Administrator, National Highway Traffic Administration, 1200 New Jersey Avenue SW., Washington, DC 20590, and submit reports electronically to the following secure email address: *cafe@dot.gov*;

* * * * *

■ 51. Amend § 537.7 by revising paragraphs (b)(3), (c)(4), (c)(5) and adding (c)(7) 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 (b)(3)(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.

(E) Optionally, beginning model year 2013, the target standard for each unique model type and footprint entry listed in accordance with the equation provided in 49 CFR 531 Figure 3.

(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.

(E) Optionally, beginning model year 2013, the target standard for each unique model type and footprint entry listed in accordance with the equation provided in 49 CFR 533 Figure 4.

* * * * *

(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) (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;

(xvii) Frontal area;

(xviii) 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);

(xix) 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'' for each function) 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 which should be the difference between the values provided in (4)(xvi)(B)(1) and (2) above; 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.

* * * * *

(7) Identify any air-conditioning (AC), off-cycle and full-size pick-up truck technologies used each model year to calculate the average fuel economy specified in 40 CFR 600.510–12.

(i) Provide a list of each air conditioning efficiency improvement technology utilized in your fleet(s) of vehicles for each model year. For each technology identify vehicles by make and model types that have the technology, which compliance category those vehicles belong to and the number of vehicles for each model equipped with the technology. For each compliance category (domestic passenger car, import passenger car and light truck) report the ''Air conditioning fuel consumption improvements'' value in gallons/mile in accordance with the equation specified in 40 CFR 600.510–12(c)(3)(i).

(ii) Provide a list of off-cycle efficiency improvement technologies utilized in your fleet(s) of vehicles for each model year that is pending or approved by EPA. For each technology identify vehicles by make and model that have the technology, which compliance category those vehicles belong to, the number of vehicles for each model equipped with the technology, and the associated fuel efficiency credits (grams/mile) available for each technology. For each compliance category (domestic passenger car, import passenger car and light truck) calculate the fleet ''Off-Cycle Credit'' value in gallons/mile in accordance with the equation specified in 40 CFR 600.510–12(c)(3)(ii).

(iii) Provide a list of full-size pick-up trucks in your fleet that meet the mild and strong hybrid vehicle definitions. For each mild and strong hybrid type, identify vehicles by make and model that have the technology, the number of vehicles produced for each model equipped with the technology, the total number of full size pick-up trucks produced with and without the technology, the calculated percentage of hybrid vehicles relative to the total number of vehicles produced and the associated fuel efficiency credits (grams/mile) available for each technology. For the light truck compliance category calculate the fleet ''Pick-up Truck Credit'' value in gallons/mile in accordance with the equation specified in 40 CFR 600.510–12(c)(3)(iii).

(iv) For each model year and compliance category, provide the ''MPG'' and ''Average MPG'' which are the fleet CAFE value before and the revised fleet CAFE value after taking into consideration adjustments for AC, Off-Cycle and full-size pick-up truck technologies calculated in accordance with 40 CFR 600.510–12 (c)(1)(ii).

■ 52. 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: August 28, 2012.

Ray LaHood,

Secretary, Department of Transportation.

Dated: August 28, 2012.

Lisa P. Jackson,

Administrator, Environmental Protection Agency.

[FR Doc. 2012–21972 Filed 10–12–12; 8:45 am]

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